Preliminary paper: please do not quote without authors' permission.

Workers' perceptions of risk and occupational injuries

Monica Galizzi and Tommaso Tempesti

University of Massachusetts Lowell

Paper submitted to the "Risk, Perception, and Response" Conference (Harvard University, March 2014)

Corresponding AUTHOR:

Monica Galizzi, Ph.D.
Department of Economics, University of Massachusetts Lowell
One University Avenue, FA 302 J, Lowell, MA 01854, USA
Phone: (978) 934-2790   Fax: (978) 934-3071
Email: Monica_Galizzi@uml.edu

Acknowledgments and Disclaimer:

We thank Laura Punnett who offered useful insights on this study.

The findings and conclusions of this paper are those of the authors and do not imply endorsement by any component of Harvard University or other sponsors of this workshop. Comments should be directed to the authors.

ABSTRACT:

This study explores the relationship between individuals' risk tolerance and occupational injuries. We analyze data from a national representative survey of U.S. workers which includes information about injuries, risk tolerance, cognitive and non-cognitive attributes, and risky behaviors. We measure risk tolerance through questions regarding individuals' willingness to gamble on their life-time income. We estimate zero-inflated count models to assess the role played by such measures on workers' recurrent injuries. Finally, we discuss several recommendations for occupational safety policies.

Our results highlight the concurrent and changing role played by individual, work and environmental factors in explaining recurrent accidents. They show that risk tolerance and cognitive as well as non-cognitive abilities affect recurrent injuries, although not always in the direction that proponents of the concept of proneness would expect. Our measure of risk preferences show that individuals who are somewhat more risk prone have fewer recurrent injuries than those who are risk averse. But the relationship is not monotonic and, therefore, not easy to predict. Furthermore, some variables play a different role in affecting the probability of any first injury as opposed to the probability of further injuries. This suggests that the experience of a first injury somehow changes workers' safety consciousness. At the same time, we find that individuals' "revealed risky preferences" - specific risky behaviors - are related to higher injury probabilities. Demanding working conditions, measures of socio-economic status, health, and safety problems experienced by workers during their youth remain among the most important factors explaining the phenomena of recurrent injuries.

KEYWORDS: occupational injuries, risk tolerance, count data, accident proneness, determinants of health

1. INTRODUCTION

The purpose of this study is to assess the relationship existing between workers' risk tolerance and a specific labor market outcome: occupational injuries. In the U.S., the most recent estimates from the Bureau of Labor Statistics (BLS) reported almost three million non-fatal injuries among workers employed in the private sector in 2012. This corresponds to an incidence rate of 3.4 cases per 100 equivalent full-time workers. Among these, 1.8 cases referred to serious injuries that involved days away from work, job transfers, or restrictions [(1)]. While these numbers confirm the declining trend in the number of non-fatal occupational accidents reported by the BLS since 1992, they hide an important fact: the high costs that such injuries and illnesses cause. For 2011 the National Safety Council estimated that the cost of work injuries amount to $188.9 billion [(2)]. These expenses are carried by workers, employers and third parties in terms of wage and lost productivity, medical expenses, administrative expense, and employers' uninsured costs. These costs have increased over time. In fact, the latest Council estimates suggest a 43% increase in nominal costs over the last decade.

While a rich body of epidemiological research has focused on the determinants of on-the-job injuries, the economic literature has mainly focused on the assessment of the long term economic outcomes suffered by injured workers in terms of income losses [(3,4)], wealth or consumption losses [(5)], or compromised future employment opportunities [(6)]. Few economic studies have explored the characteristics of workers who are being injured, and, among these, who suffer recurrent injuries or workers' compensation claims [(7,8)]. Our focus is especially on repetitive injuries. Among all types of injuries, repetitive cases account for the majority of days in hospital care and of medical costs [9,10]. To the best of our knowledge, no other studies have explored the potential relationship between the phenomenon of recurrent occupational injuries and individual propensity toward risk. This is a surprising gap in the literature given that economic analysis usually examines occupational injuries through the theory of compensating wage differentials. Such theory assumes that workers differ in terms of their risk propensity. Our analysis tries to cast some light on the validity of such assumption.

We are building on a previous study [8] that highlighted the role of early socioeconomic and health status as determinants of future occupational injuries. We study data from a national representative survey of U.S. workers, the National Longitudinal Survey of Youth 1979 (NLSY79). This survey includes information about workers' injuries, risk tolerance, cognitive and non-cognitive attributes, and risky behaviors. These data allow us to compare injured with uninjured workers. This is a key feature that is often missing in most of the analyses that have focused on the phenomenon of recurrent injuries and have used workers' compensation administrative data. We find that the number of injuries follows a U-shape with respect to risk levels, first decreasing as risk tolerance increases and then increasing again, with the most risk tolerant workers having a similar injury rate to the most risk averse category. Injuries are instead consistently and significantly related to different risky behaviors. Measures of socio-economic status and health or safety problems experienced by workers during their youth remain among the most important factors explaining the phenomena of recurrent injuries.

2. LITERATURE REVIEW

2.1 "Accident proneness" versus "differential accident involvement"

The majority of studies which have examined the phenomenon of repetitive occupational injuries have made use of workers' compensation data. They have found that a large percentage of claimants (generally between twenty and fifty percent depending on the study as described in Galizzi[8] ended up filing for additional workers' compensation claims in the years following their originally reported occupational injury. Similar results are found also in studies that have made use of survey data [8,11,12,]. This result is not new. In fact, almost one hundred years ago, Greenwood and Woods [14] had already found that a relatively small proportion of individuals employed in a British factory accounted for the majority of accidents. They attributed this to workers' personality characteristics. This finding is often considered the originator of the concept of accident proneness, i.e. the tendency of some individuals to experience more accidents than otherwise identical people [15]. This concept came under attack during the 1970s. It was accused of leading to the attitude of "blaming the victim" that had developed within the occupational safety community. This attitude resulted in dismissal of the role played by dangerous working conditions in determining injuries [16]. Critics argued that the statistical evidence of accident proneness in large samples was very weak [17]. Furthermore, a valid test of accident proneness implied the ability to control for the exposure to risk, for unknown or non-observable personal and non-personal factors, and for potential underreporting of injuries [18]. It was argued that given equal individual initial liability, an accident could alter the probability of subsequent injuries [19].

As a result of these arguments the research focus shifted toward the study of the role played by specific organizational characteristics. These characteristics included safety practices, safety leadership, financial resources, use of shifts, subcontracting, and temporary workers, as well as the degree of workload and job security. These occupational features have been found to play both a direct and indirect role on the probability of work accidents. In fact, challenging working conditions can lead to workers' stress, and therefore, increased employees' vulnerability [11,12,13,20,21,22,23]. For example, fixed term contracts lead to higher accident probabilities both because they characterize lower investment in human capital (including safety training) by companies and because they may induce workers to increase their effort to secure rehiring [24].

During the last few years, however, the concept of accident proneness has witnessed a resurgence. This is partly due to the accumulating evidence that some individuals experience more injuries than we would expect based on a purely random distribution of events [15]. At the same time, the research community has increased ability to collect data with richer individual information and measures of personality traits. This facilitates the task of identifying which attributes – innate or learned – may render some individuals more likely to become involved in accidents than others. In this sense, despite the continuous use of the term proneness, most new studies fall under the study of "differential accident involvement"[19] or "accident liability".[18] In this context, environmental, organizational and human attributes are seen as complementary, potentially changing over time interactively [11,19]. For example, repetitive injuries are related to physical disabilities, chronic health problems, [12,13] and poor mental health.[25] However, individuals with higher scores of self-reported cognitive failures (in perception, memory and motor function) are also more likely to experience recurrent workplace accidents. However, this happens when these individuals are put under job-related stress.[26] Psychological stress can be caused not only by occupational stressors [11,22], but also by family stressors. [11,13,27,28] In this context, cultural norms may also play a large role in affecting individuals' responses to occupational safety and experiences with injuries [29]. For example, men may experience more occupational injuries not only because of the types of jobs and industry that employ them, but also because of their dismissal of safety practices due to their enacting "working – class masculinity" [30,31], or their lower perception of risk [32,33]. It has also been established that work injuries are related to risky behaviors such as alcohol, tobacco, and narcotics abuse, not using seat belts, or lack of health insurance [12,28,34,35,36,37]. To the best of our knowledge, however, no study has explicitly tested whether differences in risk tolerance are reflected in different likelihood of occupational accidents.

2.2 Workers and their attitudes toward risk

The economic literature has studied the hypothesis of workers' heterogeneous preferences toward occupational risk in the context of the theory of compensating wage differentials. Such theory predicts that workers will sort themselves into safer or more dangerous occupations on the basis of their own risk tolerance. Such workers' sorting and the differences in firms' abilities to reduce risk will then produce a wage offer curve where more risky jobs will be compensated with higher pay. Most of the empirical research on this topic has focused on proving the existence of compensating wage differentials. However, very little work has been conducted to assess the validity of the theory's basic assumptions: that workers' differences in risk propensity will be reflected in different occupational hazards they will accept. This lack of analysis is largely due to the difficulty of measuring workers' risk aversion. In our study, we analyze the relationship between the likelihood of recurrent work injuries and a measure of risk tolerance, originally developed by Barsky et al. , [38] through questions regarding individuals' willingness to gamble on their life-time income.

Economists have long studies decision under uncertainty. The usual approach is to adopt the expected utility approach. Suppose that an individual, Jane, is facing a choice: either she keeps her current income (equal to I), or she accepts a "gamble" with a 50% chance that her income will double and a 50% chance that her income will be cut by a third. The utility of keeping I is equal to U (I), where U (.) is Jane's utility from the certain outcome I. According to the expected utility approach, the utility that Jane derives from the gamble is instead 0.5*U(2I)+0.5*U(0.66I): that is, Jane's utility from a gamble is equal to her expected utility from that gamble. In many economic models, agents are then supposed to maximize their expected utility. A key parameter of choice under uncertainty relates to the curvature of the utility function. Under specific functional form assumptions about U(.), this curvature can then be indexed by a coefficient of risk aversion.[1] Given the importance of this parameter in economic theory, it is not surprising that there have been a variety of approaches aim at measuring an individual's risk aversion.

Lottery questions such as the one above have the advantage of being more directly tied to economic theory. By asking a respondent which gambles she is willing to accept or reject, one can put bounds on the respondent's coefficient of risk aversion. Another advantage is that these questions allow us to distinguish the role of belief from the role of risk aversion in a respondent's choices. Indeed, someone may engage in a behavior that is considered risky either because he is more tolerant of risk, or because he is less aware of the consequences of such behavior. By explicitly specifying the probability distribution of the uncertain outcomes, the lottery questions allow us to keep beliefs constant and so derive a better measure of risk aversion.

Some studies show that these lottery questions are able to predict risky behavior such as stockholding, self-employment, and timing to marriage.(38,39,) On the contrary, Dohmen et al.(42) show that the lottery question is a good predictor of financial risk taking behavior (e.g. holding stocks), but not of risk taking behavior in other contexts, such as health related decisions. A possible reason of this is that attitude toward risk is context specific: some individuals may be more willing to take risks in a certain area, e.g. financial decisions, but not in others, e.g. health. Given that the lottery question asks about willingness to take financial risks,

[1] For an axiomatization of the expected utility approach, see chapter 6 of Mas-Colell, Whinston and Green (41).

it is not surprising then that it may not be a very good predictor of risk-taking behavior in other areas. Dohmen et al.[42] show that a more general measure of risk-taking attitude (a 0-10 self-rating scale described below) is instead a better predictor of risk-taking behavior. It is worth noting, however, that this scale does allow us to distinguish the role of beliefs from the one of risk aversion. The data used in our study, the NLSY79, contains these and similar scales of risk and we use them in some of our specifications.

2.3 Risk and "revealed preferences"

Risk measures based on lottery questions and self-rating scales both share a limitation. Individuals may report that they would choose A over B, while when faced with a real choice between A and B, they may end up opting for B. Economists have therefore also focused on a different approach. For example, Leigh[34] used a composed measure of 'risk avoidance' that was constructed around nine different workers' observed choices that capture risk and time preferences. He found it to be negatively related to the probability of taking risky jobs, but also determined by family economic background and race. Viscusi and Hersch[43] measured risk preferences toward occupational health using the preferences that individuals reveal by undertaking one specific type of risky behavior: smoking. Their findings indicate that smokers – and therefore individuals with higher tolerance toward health risks – are indeed also more prone to suffer occupational injuries. They also face worse labor market opportunities, which lead them to lower earnings compared to nonsmokers. Deleire and Levy[44] and Grazier and Sloane[45] follow yet another approach when looking for proxies of risk aversion. They use workers' family structure as an exogenous determinant of individuals' aversion to risk. Their results show that single parents are indeed the most averse to risk as suggested by their choice of safer jobs. Differences in occupational hazard also explain part of the occupational gender segregation. In our study, we are contributing to this body of literature by testing the relationship between risky behaviors and the likelihood of recurrent work injuries after controlling for different job characteristics.

3. THE DATA

This study makes use of data contained in the National Longitudinal Survey of Youth 1979 (NLSY79), a nationally representative panel survey of US workers sponsored by the Bureau of Labor Statistics (BLS), U.S. Department of Labor. A total of 12,686 men and women were first interviewed in 1979 when they were between the ages of 14 and 22. Until 1994 the survey was conducted on an annual basis, and since 1994 it has been administered every other year for a total of 24 rounds. Between 1988 and 2000 the survey also collected information about job related injuries and illnesses. In the year 1993, 2002, 2004, 2006 and 2010, individuals also answered questions designed to capture their risk tolerance. From 1988 to 2000 a total of 3,280 NLSY79 individuals reported that they suffered at least one occupational injury or illness for a total of 5,185 incidents.[2] This represent 26% of the initial population surveyed by the NLSY79 (n=12,686). Table 1 shows that incidence rates were substantially lower for women and ranged

[2]In 1988, individuals were asked whether they had had an incident at any job that resulted in an injury or illness during the "past 12 months". In the following survey rounds, the same question referred to the time "since the last interview". In our analysis we do not distinguish between injuries and illnesses because only 8% of all the recalled incidents resulted in illnesses.

from a low of 2.6% for women in 1993 to a high 8.5% for men in 1988. The decreasing trends found among male workers correspond to the tendency reported by the BLS over the same period. Interestingly enough, however, female workers are not characterized by a similar decline.

Thirty seven percent of all 3,280 workers who had experienced one on the job incident reported additional on the job injuries (range, 1-7; Figure 1). However, our analysis focuses on a smaller group of individuals for whom we have all the available information about potential recurrent occupational injuries in the workplace. For this reason, we limit our analysis to a subset of 6,731 individuals who worked for at least one week between 1986 and 2000 and who participated in all survey rounds from 1988 to 2000 (the period when workplace injury information was collected). Among this subgroup, 33.5% of individuals (n=2,255) experienced at least one occupational injury or illness, for a total of 3,747 incidents (Table 2). Among those who reported at least one injury, 40% (n=913) reported two or more occupational incidents during the surveyed years.

The key explanatory variable in our analysis is the risk tolerance measure, which was not collected before 1993. Because of the possibility that previous occupation accidents may affect risk propensity, we also focused separately on the subsample of individuals who had never reported having an injury before the 1994 survey round. Richer details about the representativeness of the sample are contained in Galizzi.[(8)]

3.1 The demographic, occupational, and personality characteristics

Table 3 describes some individual characteristics for our larger subsample as of 1988, the first year that respondents were asked about occupational injuries. Since the NLSY79 is a multi-stage, random sample which over-sampled blacks and Hispanics, descriptive results are reported after being adjusted by survey weights that account for the representativeness of individuals continuously surveyed between 1988 and 2000. Such weights remove the over-sampling effects and allow the answers to be considered as national totals: 79% of workers were white, 15% were black, and 6% were Hispanic. Table 3 has three columns of data. The first column tracks those individuals who never reported an occupational injury during the survey rounds between 1988 and 2000, while the second and third column track those who reported one or more on the job incidents, respectively. In 1988 the typical respondent was 27 years old. As expected, those who sustained an injury were typically male, had less education and less tenure on the job. Workers who reported more injuries as of 1988 were working longer hours or on rotating shifts.

We exploit the richness of the NLSY79 data to extract additional information about many potential determinants of injuries. The early rounds of the NLSY79 enable us to calculate whether any of the following conditions had happened before respondents turned 23 years old[3]: a total family income above or below the poverty level; suffering any work limiting health conditions; and exposure to unhealthy or dangerous jobs at an early age. Table 3 shows that

[3] In calculating the variables capturing early socio-economic and health status we chose to study records until age 22 because this was the highest age reported by the oldest surveyed individuals in 1979, the first round of the NLSY79. Also in our models we do not include age as a regressor because of its very limited variation in the NLSY79: in 1988 respondents' age ranged between 23 and 32 years.

individuals who experienced work limiting health conditions and dangerous occupations in their early years were injured more frequently. In some of our specifications we control for these early factors.

A recent set of studies found that individuals' cognitive skills and personality traits (also called "non-cognitive skills") are relevant for many labor market outcomes [(46)]. We used the Armed Forces Qualification Test (AFQT) as a measure of cognitive skill. This is expressed as a percentile score.[4] The AFQT percentile depends on intelligence skills such as arithmetic reasoning, word knowledge, paragraph comprehension and numerical operations.[5]

We use the Rotter scale to measure how much the respondents believe to have control over their lives. The range of the scale is 4 to 16, with 16 indicating lack of control over one's own life.[6] We also use the Rosenberg Self-Esteem Scale from 1980. Each respondent is asked 10 statements about themselves with which they are asked to strongly agree (4), agree (3), disagree (2), or strongly disagree (1). The responses are then summed to create a score which can range from 10 to 40. To facilitate interpretation of the coefficients, in our regressions we standardize the AFQT, Rotter and Rosenberg scale to have mean zero and standard deviation equal to one.

---

[4] In 2006 the NLSY renormed the AFQT percentiles controlling for age. We use this renormed version of the AFQT.

[5] More details on the construction of the AFQT are available here: http://nlsinfo.org/content/cohorts/nlsy79/topical-guide/education/aptitude-achievement-intelligence-scores#asvab

[6] It is worth noting that the original Rotter scale was based on the answer to twenty questions while the NLSY retains only four of the original questions. While this scale has predictive power, e.g. it correlates well with education, the internal consistency of the scale is quite low (Cronbach alpha is .36). See: http://nlsinfo.org/content/cohorts/nlsy79/topical-guide/attitudes

When we focus on the subsample of workers who did not have any injury before 1994, we also add to our covariates the Center for Epidemiological Studies Depression Scale (CES-D). This scale is obtained by summing the answers to 20 questions about various symptoms of depression. Responses range from 0 (rarely or none of the time/1 day) to 3 (most or all of the time/5-7 days) for each question. The score ranges from 0 to 60. Data on depression comes from 1992, the earliest year for which this scale is available. Again, we standardize this variable in our regressions.

3.2 The Measures of Risk Attitude

In 1993, 2002, 2004 and 2006 each respondent was asked the following question:[7]

Suppose that you are the only income earner in the family, and you have a good job guaranteed to give you your current (family) income every year for life. You are given the opportunity to take a new and equally good job, with a 50-50 chance that it will double your (family) income and a 50-50 chance that it will cut your (family) income by a third. Would you take the new job?

If she answered no (yes), she was then asked whether she would accept a job with a 50-50 chance that it will double her family income and a 50-50 chance that it will cut her family income by 20 percent (half). So there are four possible patterns of response and we construct 4 categories of risk tolerance. The most risk averse respondents reject both lotteries while the most risk tolerant ones accept both. Those with intermediate risk aversion accept one lottery

[7] The question was asked again in 2010 but rephrased to address the concern about "status quo bias" (38).

(either the first or the second one) but not the other. So we have four levels of risk tolerance, 1 through 4, with 4 indicating the highest level of risk tolerance.

Table 4 shows that in the NLSY79 risk tolerance tends to decreases over time. For example, the proportion of individuals most averse to risk (i.e. those in risk category 1) increased from 46% in 1993 to 57% in 2006. This difference may be due to change in individual characteristics, such as age, but also to measurement error.[39,47,48] Indeed, as Tables 5, 6 and 7 show, a large fraction of individuals changes risk category from one survey year to the next. For example, 50% of those who were in risk category 2 in 1993 are in risk category 1 in 2002.

As mentioned above, in our analysis we focus on the risk tolerance variable from 1993. This is the earliest risk tolerance variable available. Risk tolerance may be affected by past injuries, and we have data available on injuries up to the year 2000). We use the risk variables from other years to confirm the robustness of our regressions.

In this regard it is helpful to compare the risk tolerance variable from hypothetical income lotteries to other measures of risk attitude that the NLSY79 collected in 2010. That year, a general measure of risk-taking attitude was collected. The respondent was asked to rate herself on a 0-10 rating scale, where 0 means "unwilling to take any risks" and 10 means "fully prepared to take risks." As Figure 1 shows, some responses bunch up at 0 and at 5 and women tend to be more risk-averse than men. As Table 5 shows, we find that the willingness to take risks, as measured by the 0-10 scale, increases with risk tolerance, as measured by the lottery question in 1993.[8],[9] Dohmen et al.[(42)] 2005 also find that that the responses to the lottery questions are strongly correlated with responses to the general risk question. In addition they show that the lottery question is a good predictor of financial risk taking behavior (e.g. holding stocks) but not of risk taking behavior in other contexts such as health related decisions. On the contrary, Spivey,[(41)] using the NLSY79 and the risk attitude variable from 1993, shows that risk attitude is a good predictor of timing to marriage. As additional robustness checks, in our regressions we use both the general measure of willingness to take risk and the specific measure of willingness to take risk in health decisions as alternative measures of risk attitude.

Finally, our other measures of risk attitudes are based on data from risky behaviors. The assumption is that, other things equal, more risk tolerant individuals will engage in more risky behaviors such as smoking or using drugs. In this regard, we use a dummy variable for the respondent smoking more 100 cigarettes in her life (using the data from 1992), information on the number of times the respondent used marijuana or hashish in life (1988), or cocaine (1988), and on the number of days the respondent used alcohol in the last month (1988).

4. REGRESSION ANALYSIS

Unlike other data sources that are limited to workers who had experienced at least one work-related problem, the NLSY79 also covers workers who never experienced an injury; and

[8] Dohmen et al.[(42)] use German data to compare various measures of risk attitude. In particular, they study a lottery measure similar to the NLSY one and a 0-10 self-rated scale of willingness to take risk which is very similar to the 0-10 scale available in the NLSY79 for 2010.
[9] We also regress the 0-10 risk-taking scale on dummies for each risk tolerance category in 1993. The coefficients on each dummy are statistically significant.

for those who did, it allows identification of a very early episode, although not necessarily the first (occupational injuries could have happened to the NLSY79 respondents before 1987). Therefore the data allows us to study factors that may explain recurrent episodes of work-related injury and illness through a regression model in which the dependent variable is the expected number of occupational injuries or illnesses for each individual.

Our dependent variable - the number of work-related injuries - assumes values bounded from below by zero. Moreover, as shown in Table 2, there is a preponderance of zero counts as the majority of the surveyed individuals did not report any occupational incidents. As discussed in Galizzi,[(8)] an appropriate model in our case is the zero-inflated count model which we also adopt when modeling counts of injuries. Such a model estimates simultaneously a binary probability model to determine whether a zero or a non-zero outcome occurs, and a count model to estimate what predicts the frequency of positive outcomes. We use the logit for the binary model and the negative binomial model for the positive outcomes.

4.1 The risk/job lottery measure and the recurrence of occupational injuries

NLSY79 respondents were first asked about their experience with on-the-job injuries and illnesses in 1988, although the occupational incidents they reported could have happened before that year. Only 5% of all the reported on-the-job injuries and illness had happened in 1987. Therefore, in examining the determinants of the total count of work-related injuries recalled by individuals between 1988 and 2000, we use information about individual and occupational characteristics as of 1988as explanatory variables. Also, because occupational injuries can only occur when workers are employed, our model accounted for different "exposure" in terms of the number of weeks during which each person was working during the survey years 1987 and 2000.

We start with a basic model where our covariates include dummies for each level of risk tolerance, demographic characteristics and a dummy for whether the worker had children or not as of 1988.[10] The results are shown in Model 1 (Table 9). The results include two columns. In the left column are the results of the logit model where the outcome of interest is whether a worker has zero injuries or not (zero injuries constitute a "success," i.e. are coded with 1 in this logit model). According to this model, women have a higher chance of not being injured (i.e. a higher chance of being in the zero injury group). On the other hand, having a child appears to reduce the chance of not being injured. This is likely due to the correlation between having a child and being married. We decided not to include a dummy for married status because marriage may be itself a function of risk, as argued in Spivey.[(41)] Race dummies are not significant, a result which is confirmed in other models. Finally, risk levels do not affect the probability of not being injured.

As to the count model, the effect of gender and having children is in line with the logit results: conditional on having a chance of getting injured, women have fewer injuries and those with children have more. As to the effect of risk attitudes, workers with a moderate risk tolerance have significantly lower counts of injuries than those who are most risk-averse (again,

[10] Following chapter 2 of the NLSY79 User Guide[(49)] we did not weight our regressions, but instead used dummy variables for the black and Hispanic oversamples.

conditional on having a chance of getting injured). However, this result is not monotonic, as workers with higher risk tolerance do not have significantly lower counts of injuries than those who are most risk-averse. We also graph the predicted injury counts by risk levels in Figure 2. Notice that this prediction incorporates both the results of the logit model and of the count model.[11] From the graph it appears that the number of injuries follows a *U-shape with respect to risk levels*. As we will see, this pattern is robust to other specifications.

In Model 2 (Table 9) we also control for cognitive and non-cognitive skills by adding dummies for completing high-school, more schooling than high-school, the standardized AFQT (an intelligence test), the standardized Rotter (the higher this scale, the lower the control the individual believes to have over his own life) and the standardized Rosenberg scale (a measure of self-esteem). Relative to workers with less than a high-school degree, more educated workers have a higher chance of having zero injuries (though these coefficients are not significant) and a lower injury count. AFQT has a significant impact on the chance of not getting injured, but no impact on the injury count. The locus of control and self-esteem scales have no effect on either the odds of not being injured or the injury counts. Relative to Model 1, the dummy for having children has no impact on the likelihood of not getting injured. Also, the

[11] According to the Stata 12 Manual for the zinb command, the predicted number of events for individual j is given by (1-p_j)(exp(x_j b) * exposure_j) where p_j is the predicted probability of a zero outcome and exposure is the number of units of time j has been exposed to the risk of injury (in our case, the number of weeks worked). The means in Figure 2 are computed using the command “margins”. This command sets the risk level to category 1 for all workers, leaving the other x_j variables unchanged. Then it computes the predicted injury count for each worker according to the formula above and finally it averages these counts across all workers. This gives the predicted count of injury for risk category 1 graphed in Figure 2. The predicted counts for other risk categories are computed analogously.

female dummy has a moderately significant negative effect on the odds of not getting injured. However, the coefficient on the female dummy in the count model increases in magnitude so that the predicted number of injuries for female is 0.48 versus 0.65 for males. The number of injuries still follows a U-shape with respect to risk levels, first decreasing as risk tolerance increases from category 1 to 2 and then increasing again, with the most risk tolerant categories 3 and 4 having a similar injury rate to the most risk averse category 1.

In Model 3 (Table 9) we also add a dummy variable for having work limiting health issues before the age of 23, a dummy for living in a household in poverty before the age of 23, and a dummy for self-reported exposure to an unsafe and unhealthy job before 1983. These covariates try to control for workers' early experiences which may be both correlated with their risk attitudes, their occupational choices, and with their injuries. All of these dummies have the expected sign in both the logit and the count models, but only the coefficients in the count model are significant. For instance, having early health issues reduces (non-significantly) the chances of not getting injured and significantly increases the count of injuries (conditional on having a chance of getting injured). The number of injuries still follows a U-shape with respect to risk levels and the results for the other covariates are similar to Model 2, with the exception of the Standardized Rosenberg which now significantly increases injuries in the count model.

A possible concern is that our risk attitude measure was collected in 1993 while our reported on-the-job injuries were recorded in the 1988-2000 period. But an early injury may have affected risk attitudes in 1993, possibly biasing our estimates of the effect of risk attitudes on injuries. To lessen this concern, we also analyze a subsample of workers who had not experienced any injury before 1994. Obviously, the sample size is smaller, and, as shown in Table 2, the range of the counts of injuries becomes smaller. For comparison with the previous regressions, we first use the zero-inflated count model. These results are shown in Table 10. As can be seen in Figure 3, the U-shape of injuries in risk levels characterizes this subsample as well. Here the standardized Rotter is significant in the count model.

For this smaller subsample we also estimate a logit model to estimate the occurrence of any first injury after 1993 (Table 11). In this way we are also able to add a measure of standardized depression among our covariates (this was not feasible in the zero-inflated count model, as the model did not converge when depression was added to it).[12] We also control for weeks worked after 1993 (the equivalent of our exposure variable in the count model) to account for the fact that workers employed for more weeks during this period may have had more opportunities to be injured. We find that a higher level of depression does increase the odds of getting injured. The U-shape pattern of injuries relative to the risk tolerance levels remains. The results on other coefficients are broadly in line with the ones obtained from the previous models.

Our models so far do not account for the characteristics of the workers' jobs. This is because risk tolerance may affect which job, industry and occupation in which a worker is employed. For example, workers with a higher risk tolerance may end up working in jobs with a

[12] Notice that depression was first collected in 1992. We decided to omit it in the regressions using the whole sample because depression in 1992 may not only affect injuries during the 1988-2000 period but may have been also caused by those same injuries.

higher risk of injury. If one includes job characteristics among the covariates, then this possible effect of risk tolerance is partialled out and the coefficients on the risk tolerance dummies may underestimate the effect of risk tolerance on injuries. In Table 12 we present the results of the zero-inflated count model when controlling for the characteristics of the worker's job in 1988, industry dummies and occupation dummies. We find that having a fixed shift does reduce the injury count while working longer hours increases it. Having a contract regulated by a collective bargaining agreement is associated with an increase in the injury count, possibly reflecting the fact that workers in riskier jobs tend to unionize more. The pattern of predicted injuries relative to risk tolerance levels is represented in Figure 5 where again a U-shape occurs.

4.2 Using Other Measures of Risk Attitude

The same lottery question was also asked in 2002, 2004 and 2006. Therefore we can use the risk tolerance measures from those years as robustness checks. For each of these measures, we rerun our zero-inflated count Model 3 (Table 9) using that measure instead of the risk tolerance measure from 1993. For the data from 2004, the zero-inflated count model has a variance matrix which is nonsymmetric or highly singular. Even if the model converges, the standard errors of the coefficients cannot be computed. For this reason, we use an ordinary least squares regression using number of injuries in the 1988-2000 period as dependent variable, and as regressors we use all the regressors in Model 3 from Table 9 substituting the risk tolerance measure from 1993 with the risk tolerance measure from 2004. We also add to the regressors the exposure variable, i.e. weeks worked since 1986 to 2000. The predicted counts from these models are contained in Figure 6, 7 and 8. As it can be seen in these figures, the U-shape found above also appears when using measures from these years.

We also use some of the 1-10 risk-taking scales collected in 2010 to measure risk attitude. For similar reasons as above, we utilize an OLS regression. We use the number of injuries in the 1988-2000 period as dependent variables. We use all the regressors from Model 3 in Table 9 substituting the risk tolerance measure from 1993 first with the general risk taking scale from 2010, and then with the risk taking scale in health choices, also collected 2010. As above, we also add the exposure variable (weeks worked from 1986 to 2000) to the regressors. The results are graphically represented in Figure 9 and 10. These figures show that there is no association between the risk-taking scales and the number of injuries.

Finally, we also use as measure of risk tolerance the following variables: a dummy for smoking at least 100 cigarettes before 1992; a dummy for having used cocaine at least once by 1988; a dummy for having used marijuana at least once by 1988; a dummy for having had six or more drinks at least once in the month before the 1988 interview. Figures 11-14 graphically represent the results from using each of these variables in turn in our regressions. All “revealed preference” measures of risk tolerance are associated with a higher count of injuries.

5. DISCUSSION

5.1 The contribution of our study

The goal of this study was to analyze the phenomenon of recurrent on-the-job injuries and individual liability by focusing on the role played by individual risk preferences. To the best of our knowledge, this represents the first analysis on the topic that makes use of a survey measure which was specifically designed to assess individuals' risk tolerance. This is also one of the few studies that explores the problem of recurrent work injuries by making use of a national sample of individuals. As such, this study has two features which are rarely found in prior research: first, in the analysis it is the possible to examine the phenomenon not only within a population of injured workers (or of employees with workers' compensation claims), but also to compare the experience of injured and non-injured workers over time. Second, this is one of the few studies on the topic that uses zero inflated count models. We do so because of the dominance of non-injured workers in our sample ("zero injuries cases") and because of the likelihood that recurrent accidents are correlated ("over dispersion"). Zero inflated models permit us to simultaneously analyze the role played by different regressors both on the likelihood of ever experiencing an occupational injury, and on the number of potential recurrent accidents. Finally, compared to previous studies on the topics, ours has two additional strengths: collection of our longitudinal data started when most of the surveyed individuals were teens. Therefore, the available information also captures workers' early socio-economic, health and employment statuses. Recent economic research has stressed the important role played by such variables in explaining workers' future health and economic outcomes.[50,51] Also, the richness of the original data permit us to analyze our specific labor market outcomes – injuries – as if determined not only by a variety of measures of risk preference (including measures of "revealed" preferences), but also by workers' cognitive and non-cognitive abilities. Again, these are variables that are becoming increasingly important in labor economics research.[(46)]

5.2 The role of risk tolerance and other personal traits

We study the occupational injuries reported by surveyed workers between 1988 and 2000. Our main focus refers the role played by a measure of risk tolerance that was collected in 1993: a job/lottery question. We find that such an index does not affect the probability of experiencing a first injury but significantly affects the count of future injuries. The pattern of the estimated parameter is somehow difficult to assess, however. In fact, we find that individuals with some tolerance for risk are characterized by a smaller number of recurrent injuries compared to workers with no risk tolerance. However, this effect is not monotonic, with the most risk tolerant workers having a count of injuries similar to the most risk-averse ones. This estimation result is consistent across all our different model specifications, including our estimations that control for the potential endogeneity of our risk measure: when we estimate the effect of risk propensity only among those individuals who experienced a first work accident in the years that followed the first survey round when the risk attitudes question was asked. Therefore, our result suggests that risk attitudes cannot be used to support the controversial hypothesis of injury proneness. If anything, the workers who are somewhat more risk tolerant than the most risk-averse ones are characterized by safer work experiences. We are aware that our risk attitude measure may be subject to criticism. In fact, although other studies have found it to be predictive of other labor market and personal decisions,[39,40,52] it is a measure that may be more suitable to assess financial decisions. It may not be the best instrument to capture a general coefficient of people risk aversion, and may fail to appropriately measure risk aversion in the more specific context of health decisions.[42] When we test our model with both a more general measure of risk aversion and the health specific risk assessment question which were collected by the NLSY79 in 2010, we find no evidence of a relationship between risk tolerance and past experience of recurrent occupational injuries. However, the interpretation of this last finding is complicated by the fact that such new risk tolerance measures were collected many years (between ten and twenty-two) after the injuries were reported. We still find a positive relationship between risk attitudes and probability of injuries, however, when we measure such attitudes in terms of "revealed preferences," through the analysis of risky behaviors such as smoking, drinking, and using marijuana or cocaine. These results are consistent with what was found in previous studies.[34,43] But when we interpret these results it is important to notice that behaviors such as drinking and drugs consumptions may indicate both a risk attitude and a health condition that may affect workers' performances and put them at higher risk of accidents. Although the analysis of these pathways goes beyond the main scope of this study, our data show that a health condition such as a depression puts workers at higher risk of work accidents.

In terms of cognitive and non-cognitive skills our results also suggest different effects on the likelihood of experiencing any injury and on the count of total injuries. We find that a higher level of education does not prevent occupational injuries but significantly reduces the likelihood of recurrent ones. This could indicate that more educated individuals face better accommodation or greater choice of future jobs after an injury. Interestingly, a higher AFQT score has exactly the opposite effect: higher intelligence is found to predict a lower likelihood of getting injured, but does not play a role on injuries count. But when our regression also controls for job attributes, higher intelligence is significantly and positively associated with a larger number of recurrent injuries. As far as our measures of non-cognitive skills are concerned, the Rosenberg scale of self-esteem and the Rotter scale of locus of control do not play a consistently significant role across all our model specifications. We find that a higher level of self-esteem is associated significantly with a higher count of injuries, but only when we control also for early determinants of injuries. Also, a higher predisposition toward feeling "external locus of control" is associated with a higher injury count in our after 1993 subsample.

Finally, despite our improved ability to control for a variety of psychological traits, the results of this study confirm some findings reported in our previous research.(8) We again find that a very important determinant of recurrent injuries is the information about the socio-economic status experienced by workers in their youth, before any occupational injury was reported: early health problems, early household poverty, and early exposure to unsafe and unhealthy jobs.

Overall, our results do not support the hypothesis of injury "proneness" but are more in line with an explanation of recurrent occupational injuries based on the hypothesis of "liability"[18] or "differential accident involvement" ,[19] i.e. the concurrent and changing role played by individual, work and environmental factors in explaining repetitive accidents. Our results suggest that individual risk tolerance, cognitive and non-cognitive abilities are important in explaining recurrent occupational injuries, although they are not always significant and not always in the direction proponents of the idea of injury proneness would expect. Demanding working conditions (long hours, irregular shifts) also matter, but so do workers' early health and socio economic statuses. These last characteristics suggest the existence of a pathway into a segmented labor market, a labor market where "bad" jobs are associated with higher risk of recurrent work accidents and, possibly, lower wages. [36,43]

Clearly the interpretation of our results needs to be tested with further research that will overcome some of the limitations of our analysis. This topic needs to be studied with different measures of risk tolerance, measures which may be better designed to capture risk aversion in the specific context of health choices. We need data that will permit to study these measures before individuals start cumulating labor market experience, and data that will permit to assess how such measures change over time. We need further studies to expand our preliminary analysis of the role played by working conditions and risk propensities in explaining injuries. We need to study both how risk attitudes affect workers' occupational choices and how features of the work environment can change risk attitudes over time.[48,53]

5.3 Policy implications and future research

Despite their limitations, our findings have implications for governments' and firms' accident prevention policies. The declining trend in the number of reported injuries experienced by the U.S. labor marker since 1992 has reduced the attention paid toward public policies designed to address problems of occupational health and safety. The medical and indirect cost of work injuries and illnesses has not diminished, however: at almost $189 billion the 2011 estimated cost of occupational injuries was larger than the combined profits reported by the sixteen largest Fortune 500 companies. But only one third of such expenses were covered by workers' compensation insurance,(2) a result that is consistent with what previously found by Leigh(54) and is supported by our data: only 45% of our injured workers reported filing for workers' compensation. These figures imply that a very large part of the costs of occupational injuries is carried directly by workers, firms, and health care providers. We also know that most studies consistently report that at least thirty 30 percent of injured workers get injured again,(8) and that across all occupational and non- occupational injuries repetitive accidents account for the majority of medical costs.(9,55) In a country that is searching for ways to reduce overall medical costs it is urgent to better understand the phenomenon of recurrent injuries and to develop strategies to prevent them.

The increased availability of tests to assess ability and personality traits has led to a discussion concerning the appropriateness of using such tests as selection tools in occupational settings.(56,57) As in the case of drugs and alcohol screening, these suggested practices raise potential privacy concerns. In addition, if the goal of such tests is to identify workers at greater risk of recurrent injuries, our results suggest that measures of risk attitudes and non-cognitive skills would not be appropriate selection tools. Again, our measure of risk preferences shows that individuals who are somewhat more risk prone have fewer recurrent injuries than the ones who are risk averse but the relationship is not monotonic and, therefore, not easy to predict. At the same time, our evidence attributes a stronger predictive power to individuals' "revealed risky preferences," i.e. specific risky behaviors that we find to be related to higher injury probabilities. But the existing relevant literature has produced mixed evidence about the effectiveness of alcohol and drug screening of employees.[58] Furthermore, our additional results show that heavy workload (hours and irregular shift), early low socio-economic status, and early health problems are very important determinants of recurrent injuries. Although our study was not designed to explore this connection, it would be possible to argue that such early determinants of recurrent injuries are simultaneously causing accidents and risky behaviors. Then, the focus should shift toward policies which more carefully monitor working conditions and employers' adherence to occupational safety regulations. Regulations may also be designed to make sure that companies' experience ratings (designed to assess their workers' compensation insurance premiums) differentially weight first and recurrent injuries. The focus also moves toward potential income redistribution and preventive medicine policies that can alleviate the more general relationships existing between low family income, poor health, and poor current and future occupational choices faced by young individuals.

Our results suggest another potential strategy to specifically prevent recurrent injuries. A feature of our findings is the different role played by risk attitudes and cognitive and non-cognitive attributes in affecting the probability of any injury or several recurrent ones. This overall result seems to indicate that the experience of a first injury somehow changes the worker. The "risky" and the more educated person may become more safety conscious. The smarter and more self-confident one may actually lower precautions. The same is true for the one who is more likely to attribute what happens in his/her life to the external environment. Although these results are not always robust across all our model specifications, they reinforce the validity of the emerging literature that is showing how the "external" causal attribution of work injury, i.e. blaming the employer or other environmental factors, can lead to changes in safety consciousness and increase in risk exposures.[33,59,60] This suggests the need to introduce safety systems into workplaces where managers and workers not only work together in designing safety practices,[61,62] but also meet to reflect on the causes that have led to the work accident. Possibly this should happen on an external site with the mediation of an external safety specialist.[23,63]

In conclusion, to further advance our understanding of recurrent injuries, and to increase our confidence in making policy recommendations to reduce the costs of recurrent work injuries, we need further research in two main directions. We need to better identify what are the very early determinants of risky attitudes, behaviors and work related health problems. We also need to further investigate what happens to employees after a first injury both in terms of their psychological reaction, and in terms of the relationship with their employers and coworkers.

References

1. U.S. Bureau of Labor Statistics, U.S. Department of Labor. Employer-reported workplace injuries and illnesses – 2012. USDL-13-2119.2013 http://www.bls.gov/news.release/pdf/osh.pdf

2. National Safety Council. Injury facts. 2013 edition. Itasca, IL:2013.

3. Reville RT. Contributions to Economic Analysis, vol. 241. ed. John C. Haltiwanger. The impact of a disabling workplace injury on earnings and labor force participation. Amsterdam, New York and Oxford: Elsevier Science; 1999. p. 147-173.

4. Boden LI, Galizzi M. Income losses of women and men injured at work. J Human Resources. 2003;38(3):722-57.

5. Galizzi M, Zagorsky JL.. How do on-the-job injuries and illnesses impact wealth? Labour Economics 2009;16(1): 26-36.

6. Butler RJ, Johnson WG, Baldwin ML. Managing work disability: Why first return to work is not a measure of success. Industrial and Labor Relations Review. 1995;48(3): 452-69.

7. Campolieti M. Recurrence in workers' compensation claims: Estimates from a multiple spell hazard model. J. Risk Uncertainty. 2001;23(1): 75-94.

8. Galizzi M. On the recurrence of occupational injuries and workers' compensation claims. Health Econ. 2013;22(5): 582-99.

9. Jansson B, Stenbacka M, Leifman A, Romelsjö A. A small fraction of patients with repetitive injuries account for a large portion of medical costs. European Journal of Public Health 2004;14 (2):161-7.

10. Gawande A. The hot spotters. The New Yorker. 2011 Jan 24.41-51

11. Kirschenbaum A, Oigenblick L, Goldberg AI. Well being, work environment and work accidents. Soc Sci Med. 2000 Mar 50(5): 631-9.

12. Gauchard GC, Mur JM, Touron C, Benamghar L, Dehaene D, Perrin P, Chau N.. Determinants of accident proneness: A case-control study in railway workers. Occup Med 2006 May;56(3):187-90.

13. Kamel MI, Atta HY, Foda NT, Mostafa YA, Youssef RM. 1998. Personal factors and working conditions as predictors of work injuries among industrial workers. J Egypt Public Health Assoc 1998;73(3-4):255-74.

14. Greenwood M, Woods HM. A report on the incidence of industrial accidents upon individuals with special reference to multiple accidents. 1919 London: Industrial Fatigue Research Board.

15. Visser E, Pijl YJ, Stolk RP, Neeleman J, Rosmalen JGM. Accident proneness, does it exist? A review and meta-analysis. Accid Anal Prev 2007:39(3):556-64.

16. Sass R, Crook G. Accident proneness: Science or non-science? Int J Health Serv. 1981;11(2):175-90.

17. Cameron C. Accident proneness. Accid Anal Prev. 1975;7(1):49-53.

18. Bernacki EJ. Accident proneness or accident liability: Which model for industry? Connecticut Medicine. 1976;40(8):535-8.

19. McKenna FP. Accident proneness: A conceptual analysis. Accid AnalPrev. 1983;15(1):65-71.

20. Leigh JP . Individual and job characteristics as predictors of industrial accidents. Accid Anal Prev 1986;18(3):209-16.

21. Roberts JT. Psychosocial effects of workplace hazardous exposures: Theoretical synthesis and preliminary findings. Soc Prob. 1993; 40(1):74-89.

22. Abbe OO, Harvey CM, Ikuma LH, Aghazadeh F. Modeling the relationship between occupational stressors, psychosocial/physical symptoms and injuries in the construction industry. Intl J Indust Ergonom. 2011;41(2) :106-17.

23. de Koster RBM, Daan Stam D, Balk BM. Accidents happen: The influence of safety-specific transformational leadership, safety consciousness, and hazard reducing systems on warehouse accidents. *J Op Manage.* 2011;29(7):753-65.

24. Guadalupe M. The hidden costs of fixed term contracts: The impact on work accidents. Labour Econ. 2003;10(3):339-57.

25. Cherry N, Burstyn I, Beach J. Mental ill-health and second claims for work-related injury. Occup Med. 2012;62(6):462-5.

26. Day AJ, Brasher K, Bridger RS. Accident proneness revisited: The role of psychological stress and cognitive failure. Accid Anal Prev.2012;49(11):532-5.

27. Kang Y, Hahm H, Yang S, Kim T. Application of the life change unit model for the prevention of accident proneness among small to medium sized industries in Korea. Indust Health 2008;46(5):470-6.

28. Badri A, Nadeau S, Gbodossou A. Proposal of a risk-factor-based analytical approach for integrating occupational health and safety into project risk evaluation. Accid Anal Prev. 2012;48(9):223-34.

29. Kouabenan DR. Role of beliefs in accident and risk analysis and prevention. Safety Sci. 2009:47(6):767-76.

30. Paap K. Working construction: Why white working-class men put themselves voluntarily in harm's way. Ithaca, NY: Cornell University Press; 2006.

31. Veevers JE, Gee EM. Playing it safe: Accident mortality and gender roles. Sociol. Focus. 1986:19(4):349-60.

32. Savage I. Demographic influences on risk perceptions. Risk Anal. 1993;13(4):413-20.

33. Landry LG. Preventing occupational injuries: Women's perception of risk from musculoskeletal exposures. *AAOHN J.* 2006;54(2):75-83.

34. Leigh JP. Who chooses risky jobs? Soc Sci Med. 1986;23(1):57-64.

35. Dawson DA. Heavy drinking and the risk of occupational injury. Accid Anal Prev 1994;26(5):655-65.

36. Hersch J, Viscusi WK. 1998. Smoking and other risky behaviors. J Drug Iss. 1998;28(3):645-61.

37. Macdonald S, Hall W, Roman P, Stockwell T, Coghlan M, Nesvaag S. Testing for cannabis in the work-place: A review of the evidence. Addiction 2010;105(3):408-16.

38. Barsky RB. Preference parameters and behavioral heterogeneity: An experimental approach in the health and retirement study. Quarterly J Econ. 1997;112(2):537-79.

39. Ahn T. Attitudes toward risk and self-employment of young workers. Labour Econ. 2010;17(2):434-42.

40. Spivey C. Desperation or desire? the role of risk aversion in marriage. Econ Inquiry. 2010;48(2):499-516.

41. Mas-Colell A, Whinston MD, Green JR. Microeconomic Theory. Oxford University Press; 1995.

42. Dohmen T, Falk A, Huffman D, Sunde U, Schupp J, Wagner GG. "Individual Risk Attitudes: New Evidence from a Large, Representative, Experimentally-Validated Survey" DIW Berlin 2005, Discussion Papers.

43. Viscusi WK, Hersch J. 2001. Cigarette smokers as job risk takers. RevEcon Stat. 2001;83(2):269-80.

44. DeLeire T, Levy H. 2004. Worker sorting and the risk of death on the job. J Labor Econ. 2004;22(4):925-53.

45. Grazier S, Sloane PJ. Accident risk, gender, family status and occupational choice in the UK. Labour Econ. 2008;15(5):938-57.

46. Heckman JJ, Stixrud J, Urzua S. The effects of cognitive and noncognitive abilities on labor market outcomes and social behavior. J Labor Econ. 2006;24(3):411-82.

47. Kimball MS, Sahm CR, Shapiro MD. Imputing risk tolerance from survey responses. J Am Stat Assoc. 2008:103(483) :1028-38.

48. Cho IS. "Are Risk Attitudes Fixed Factors Or Fleeting Feelings?" Iowa State University, Department of Economics, Staff General Research Papers, 2013.

http://search.ebscohost.com/login.aspx?direct=true&db=ecn&AN=1348254&site=ehost-live; http://www.econ.iastate.edu/sites/default/files/publications/papers/p15751-2013-01-10.pdf.

49. Zagorsky JL. NLSY79 Users' Guide. Columbus, Ohio: Center For Human Resource Research, The Ohio State University; 1997.

50. Smith JP. The impact of childhood health on adult labor market outcomes. Rev Econ Stat. 2009;91(3):478-89.

51. Fletcher JM, Sindelar JL, Yamaguchi S. Cumulative effects of job characteristics on health. Health Econ. 2011;20(5):553-70.

52. Light A, Ahn T. Divorce as risky behavior. Demography 2010;47(4):895-921.

53. Liu L, Rettenmaier AJ. 2007. Effects of mortality risk on risk-taking behavior. Econ Lett. 2007;94(1):49-55.

54. Leigh JP. Economic burden of occupational injury and illness in the united states. The Milbank Quart. 2011;89(4):728-72.

55. Mautner DB, Pang H, Brenner JC, Shea JA, Gross KS, Frasso R, Cannuscio CC. 2013. Generating hypotheses about care needs of high utilizers: Lessons from patient interviews. Pop Health Mgmt. 2013;16 (10/02): S,26; S-33.

56. Burkolter D, Kluge A, Sauer J, Ritzmann S. 2009. The predictive qualities of operator characteristics for process control performance: The influence of personality and cognitive variables. Ergonomics. 2009:52(3):302-11.

57. Finomore V, Matthews G, Shaw T, Warm J. Predicting vigilance: A fresh look at an old problem. Ergonomics 2009;52(7):791-808.

58. Cashman CM, Ruotsalainen JH, Greiner BA, Beirne PV, Verbeek JS. Alcohol and drug screening of occupational drivers for preventing injury. The Cochrane Database of Systematic Reviews. 2009;(2) (04/15): CD006566.

59. Gonçalves SM, Pedroso SM, Agostinho da Silva S, Lima ML, Meliá JL. The impact of work accidents experience on causal attributions and worker behaviour. Safety Sci. 2088;46(6):992-1001.

60. Niza C, Silva S, Lima ML. Occupational accident experience: Association with workers' accident explanation and definition. Safety Sci. 2008:46(6): 959-71.

61. Attwood D, Khan F, Veitch B. Can we predict occupational accident frequency?. Process Safety Environ Protec. 2006;84(3):208-11.

62. Geller SE. Psychological science and safety: Large-scale success at preventing occupational injuries and fatalities. Curr Dir Psych Sci. 2011;20(2):109-14.

63. Mbaye S, Kouabenan DR. How perceptions of experience-based analysis influence explanations of work accidents. J Safety Rsch 2013;47(12):75-83.

Table 1. NLSY79: Number and Rates by Gender of occupational incidents reported in different survey years

NLSY79		**Any Occupational Injury or Illness**		
Survey Year	**Total Interviewed**	**Number of reported cases**	**Injuries Incidence Rates**	
			Men	**Women**
1988*	10465	849	8.5 %	4.8 %
1989	10605	614	6.4 %	3.2 %
1990	10436	620	6.1 %	3.7 %
1992**	9016	563	6.7 %	3.0 %
1993	9011	449	4.4 %	2.6 %
1994	8891	411	3.6 %	2.7 %
1996	8636	610	5.7 %	3.9 %
1998	8399	563	5.0 %	3.9 %
2000	8033	506	4.5 %	3.4 %

*Injuries reported at each survey round usually occurred in the same calendar year but could refer to previous years as well (especially after 1994). In particular, of the 849 injuries/illnesses recalled in 1988, 70% had happened in 1988, 29% in 1987, and 1% had happened in previous years starting in 1977.

** The survey did not ask questions about injuries in 1991.

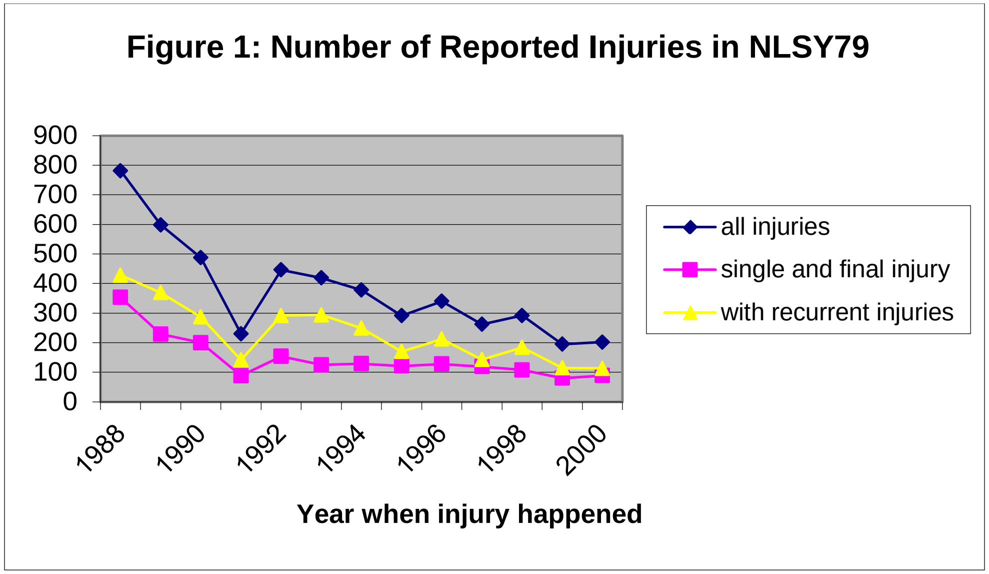


Figure 1: Number of Reported Injuries in NLSY79
900
800
700
600
500
400
300
200
100
0
1988
1990
1992
1994
1996
1998
2000
Year when injury happened
all injuries
single and final injury
with recurrent injuries

Table 2. Percent of individuals with single and multiple occupational injuries

	NLSY79 Sub Samples*			
	Individuals who participated to all survey rounds **from 1988 to 2000**			
	All	**Men**	**Women**	**No injury before 1994**
Number of Injuries	**(n=6,731)** (1)	**(n=3,191)** (2)	**(n=3,540)** (3)	**(n=5,254)** (4)
0	4,476 (66.5 %)	1,913(60 %)	2,563 (72.4 %)	4,476 (85.2%)
1	1,342 (19.9 %)	724(22.7 %)	618 (17.5 %)	641 (12.2 %)
2	551 (8.2 %)	307(9.6 %)	244 (6.9 %)	112 (2.1 %)
3	221 (3.3 %)	150(4.7 %)	71 (2.0 %)	25 (0.5 %)
4	91 (1.4 %)	62(1.9 %)	29 (0.8 %)	0 (0 %)
5	30 (0.5 %)	19 (0.6%)	11 (0.3%)	0 (0 %)
6+	20 (0.3 %),	16(0.5 %),	4 (0.1 %),	0 (0 %)

*Individuals who worked at least one week between 1986 to 2000.

Table 3: NLSY 1988-2000 Subsample* of ALL Workers as of 1988 (Weighted Summary Statistics)

	No occupational injury (n=4476) Mean	***Only one occupational injury*** (n=1342) Mean	***Recurrent occupational injuries*** (n=913) Mean
Age	**27**	**27**	**27**
White	**0.79**	**0.79**	**0.83**
Black	**0.15**	**0.14**	**0.11**
Hispanic	**0.06**	**0.07**	**0.06**
Female	**0.56**	**0.44**	**0.39**
Cognitive skills:			
Education			
< High School	**0.09**	**0.14**	**0.14**
High School	**0.41**	**0.48**	**0.59**
> High School	**0.50**	**0.39**	**0.26**
AFQT	**53**	**48**	**46**
Non Cognitive Skills:			
Rotter	**8**	**9**	**9**
Rosenberg	**23**	**22**	**22**
Before 1988:			
In Poverty before Age 23	**0.36**	**0.37**	**0.39**
Health Limitation before Age 23	**0.16**	**0.19**	**0.23**
Dangerous/Unhealthy Jobs before 1983	**0.46**	**0.57**	**0.69**
As of 1988:			
Children	**0.48**	**0.52**	**0.56**
Tenure (weeks)	**152**	**146**	**136**
Weekly Worked Hours	**41**	**43**	**44**
Fixed Shifts	**0.86**	**0.84**	**0.81**
Collective Bargaining	**0.11**	**0.13**	**0.20**
Risk Categories 1993			
1:	**0.45**	**0.46**	**0.50**
2:	**0.14**	**0.12**	**0.09**
3:	**0.18**	**0.18**	**0.16**
4:	**0.23**	**0.24**	**0.24**
Depression (CES-D)	**8**	**10**	**11**
After First Injury:			
Lost Wages		**0.24**	**0.29**
Filed for Workers Compensation		**0.45**	**0.46**

Note: * Individuals who participated to all survey rounds from 1988 to 2000 and who had some weeks of work during the same period

Table 4 Risk Tolerance Over Time

Risk Category	1993	2002	2004	2006
1	46%	55	53	57
2	12	11	16	11
3	17	16	14	15
4	25	18	17	18
N	6804	6275	5952	5996

Table 5 Risk Tolerance Transition Matrix 1993-2002

	Risk Tolerance 2002			
Risk Tolerance 1993	1	2	3	4
1	65%	9	13	13
2	50	17	17	16
3	48	13	22	17
4	43	10	17	30

Table 6 Risk Tolerance Transition Matrix 2002-2004

	Risk Tolerance 2004			
Risk Tolerance 2002	1	2	3	4
1	64%	15	10	10
2	44	24	18	13
3	42	18	21	20
4	36	13	15	35

Table 7 Risk Tolerance Transition Matrix 2004-2006

	Risk Tolerance 2006			
Risk Tolerance 2004	1	2	3	4
1	68%	9	12	11
2	55	17	16	13
3	41	15	22	22
4	37	10	19	35

Table 8 Average Willingness to Take Risk by Risk Tolerance

Risk Tolerance 1993	Mean General Willingness to Take Risk (2010)
1	4.5
2	4.7
3	5.0
4	5.2
Total	4.8
N	6031

Table 9 **Count Models of Recurrent Injuries**

	Model 1		Model 2		Model 3	
	No Injury Outcome	Count Outcome	No Injury Outcome	Count Outcome	No Injury Outcome	Count Outcome
Risk-Averse			Reference Group			
Moderately Risk Tolerant	0.28	-0.22*	-0.32	-0.23***	-0.55	-0.22**
Strongly Risk Tolerant	0.02	-0.08	0.15	-0.03	0.18	-0.01
Very Strongly Risk Tolerant	-0.16	-0.06	-0.1	-0.02	-0.02	-0.01
Female	0.72***	-0.19***	-0.73*	-0.36***	-1.20*	-0.37***
Hispanic			Reference Group			
Black	0.39	-0.02	0.83	-0.04	1.66	-0.05
White	0.43	0.12	0.91	0.17**	1.58	0.13*
Has Children	-0.67***	0.19***	0.01	0.17***	0	0.10*
Less Than High-School			Reference Group			
High-School			7.82	-0.14**	5.93	-0.15**
More than High-School			21.37	-0.40***	18.17	-0.44***
Standardized AFQT			0.69**	-0.02	0.84*	0.03

Standardized Rotter			-0.24	0.02	-0.11	0.04
Standardized Rosenberg			0.17	0.01	0.19	0.06**
Health issues before age 23					-0.35	0.32***
In poverty before age 23					-0.31	0.13**
Unsafe job before 1983					-0.37	0.26***
Constant	-1.49***	-6.68***	-23.69	-6.61***	-20.95	-6.82***
Observations	6680		6254		5039	

Note: *p < 0.10, **p < 0.05, p < 0.01 Results from three zero-inflated count models. Each model has a logit component - used to model the probability of a worker having *zero* injuries – and a negative binomial model which models the count of injuries for the workers having a chance of getting injured.

Table 10: Count Models of Recurrent Injuries, after 1993 Sample

	Zero Outcome	Count Model
Count of Injuries After 1993		
Risk-Averse	Reference Group	
Moderately Risk Tolerant	-24.5	-0.44***
Strongly Risk Tolerant	0.58	0
Very Strongly Risk Tolerant	-0.01	0.04
Female	-15.51	-0.36***
Hispanic	Reference Group	
Black	3.2	-0.16
White	1.83	-0.1
Has Children	0.48	0.22**
Less Than High-School	Reference Group	
High-School	-2.84	-0.31**
More than High-School	-1.32	-0.67***
Standardized AFQT	2.17*	0.17**
Standardized Rotter	1.25	0.11**
Standardized Rosenberg	0.33	0.07
Health issues before age 23	-1.12	0.28**
In poverty before age 23	-0.33	0.20**
Unsafe job before 1983	-0.5	0.12
Constant	-2.71	-6.93***
Observations	3784	

Table 11: Probability of First Injury After 1993 (Logit Model)

	Coefficients
Risk-Averse	Reference Group
Moderately Risk Tolerant	-0.34**
Strongly Risk Tolerant	-0.12
Very Strongly Risk Tolerant	-0.11
Female	-0.20**
Hispanic	Reference Group
Black	-0.37***
White	-0.18
Has Children	0.26***
Less Than High-School	Reference Group
High-School	-0.06
More than High-School	-0.51***
Standardized AFQT	0.05
Standardized Rotter	0.02
Standardized Rosenberg	0.06
Health issues before age 23	0.26**
In poverty before age 23	0.19*
Unsafe job before 1983	0.13
Standardized Depression	0.19***
Weeks Worked After 1993	0.00***
Constant	-2.33***
Observations	3886

Note 1 *p < 0.10, **p < 0.05, p < 0.01

Table 12: Count Models of Recurrent Injuries Adding Job Covariates

	Zero Outcome	Count Outcome
Risk-Averse	Reference Group	
Moderately Risk Tolerant	-0.67	-0.17
Strongly Risk Tolerant	-1.26	-0.16**
Very Strongly Risk Tolerant	0.89	0.03
Female	-0.91	-0.15*
Hispanic	Reference Group	
Black	2.32*	-0.09
White	1.91*	0.11
Has Children	-0.09	0.03
Less Than High-School	Reference Group	
High-School	-0.24	-0.1
More than High-School	0.04	-0.47***
Standardized AFQT	0.95**	0.10**
Standardized Rotter	-0.47*	0
Standardized Rosenberg	0.2	0.04
Health issues before age 23	-1.3	0.18**
In poverty before age 23	-0.27	0.04
Unsafe job before 1983	-0.09	0.23***
Tenure (weeks)	0	-0.00***
Collective Bargaining	-0.26	0.18**
Weekly Worked Hours	-0.03*	0.01***
Fixed Shifts	0.5	-0.21**
Occupation Dummies	Yes	Yes
Industry Dummies	Yes	Yes
Constant	-0.88	-7.21***
Observations	3758	

Note *p < 0.10, **p < 0.05, p < 0.01

Figure 1 Willingness to Take Risk 0-10 Scale by Gender

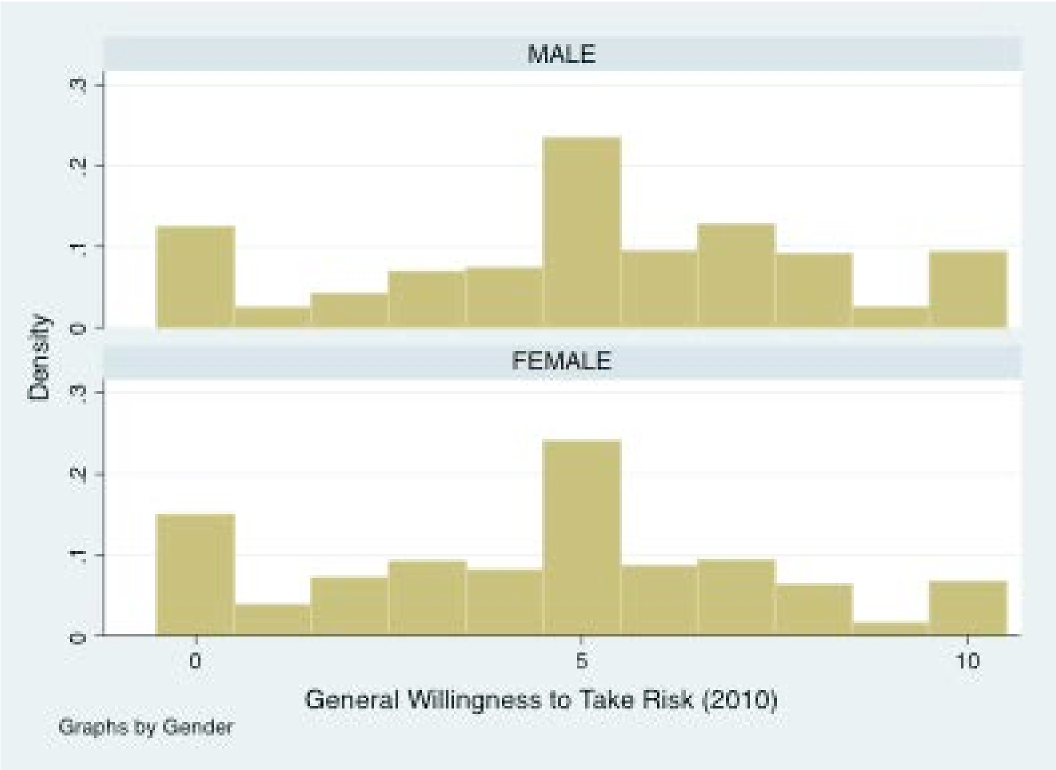
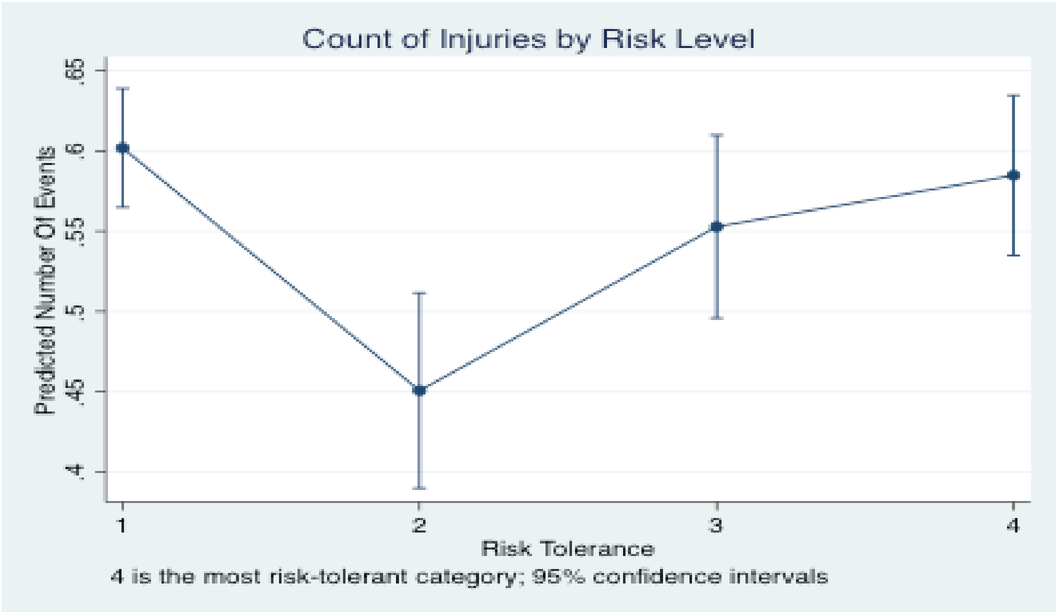
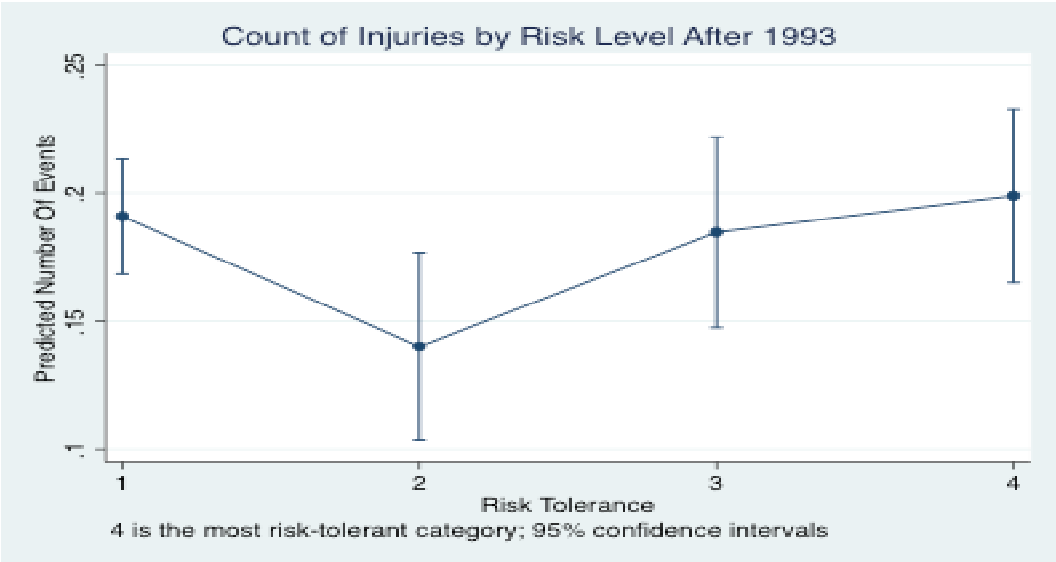


Figure 2 Count of Injury for Model 1



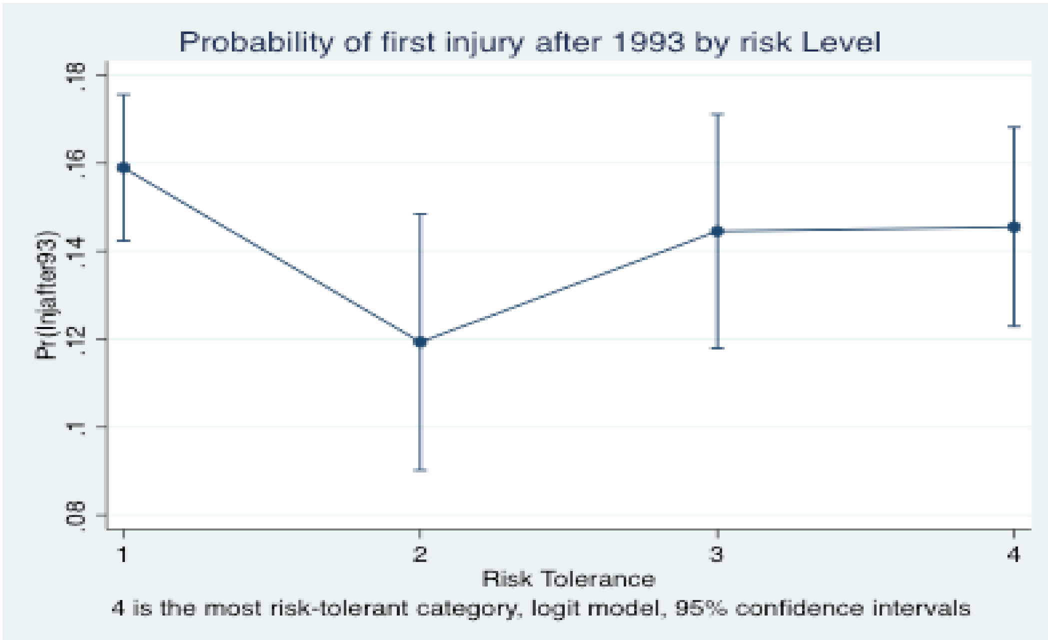
Note: Predicted counts by risk tolerance levels. The predictions are obtained from Model 1 in Table 9, which uses the zero-inflated count model for count of injuries.

Figure 3 Count of Injury for Sample After 1993



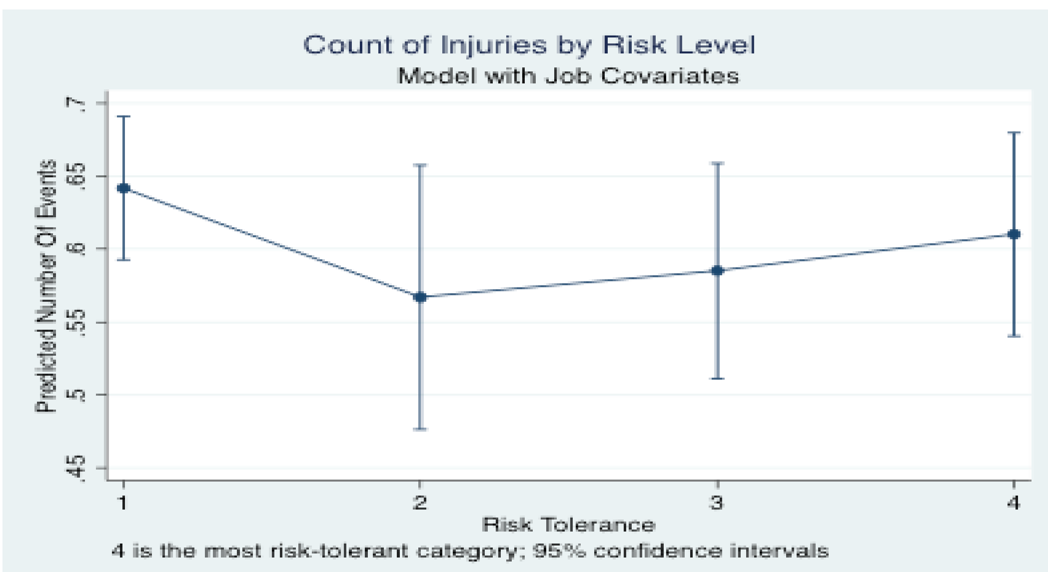
Note: Predicted counts of injuries by risk tolerance levels. The predictions are obtained from the zero-inflated count model in Table 10. The model is applied only to those workers who had no injury before 1994.

Figure 4



Note: Predicted probability of injury by risk tolerance levels. The predictions are obtained from the logit model in Table 10. The model is applied only to those workers who had no injury before 1994.

Figure 5



Note: Predicted counts by risk tolerance levels. The predictions are obtained from the model in Table 11, which uses the zero-inflated count model for count of injuries and also controls for job covariates.

Figure 6

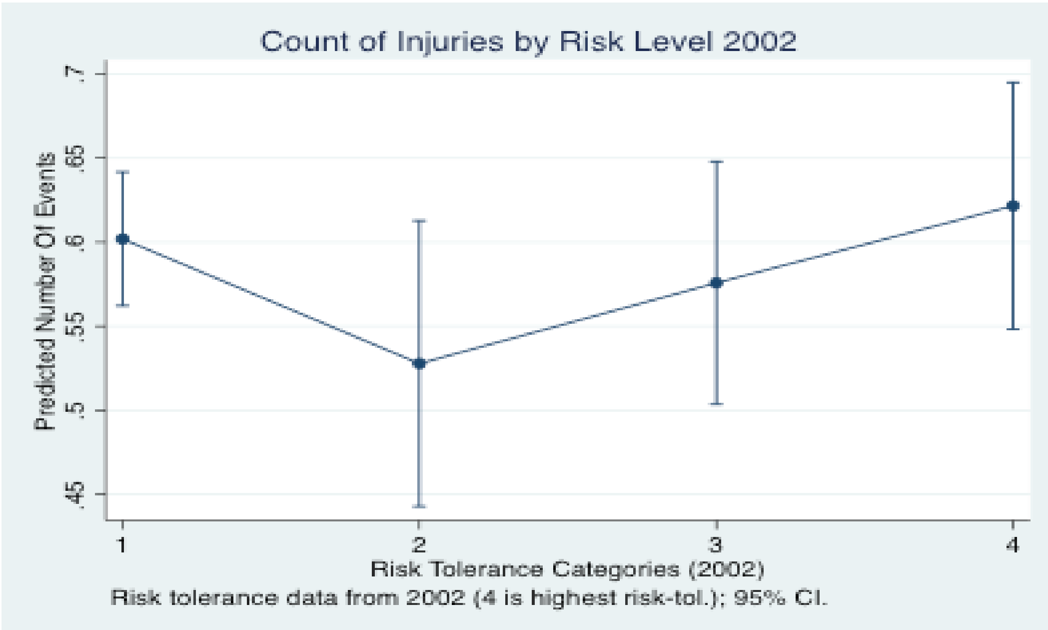


Figure 7

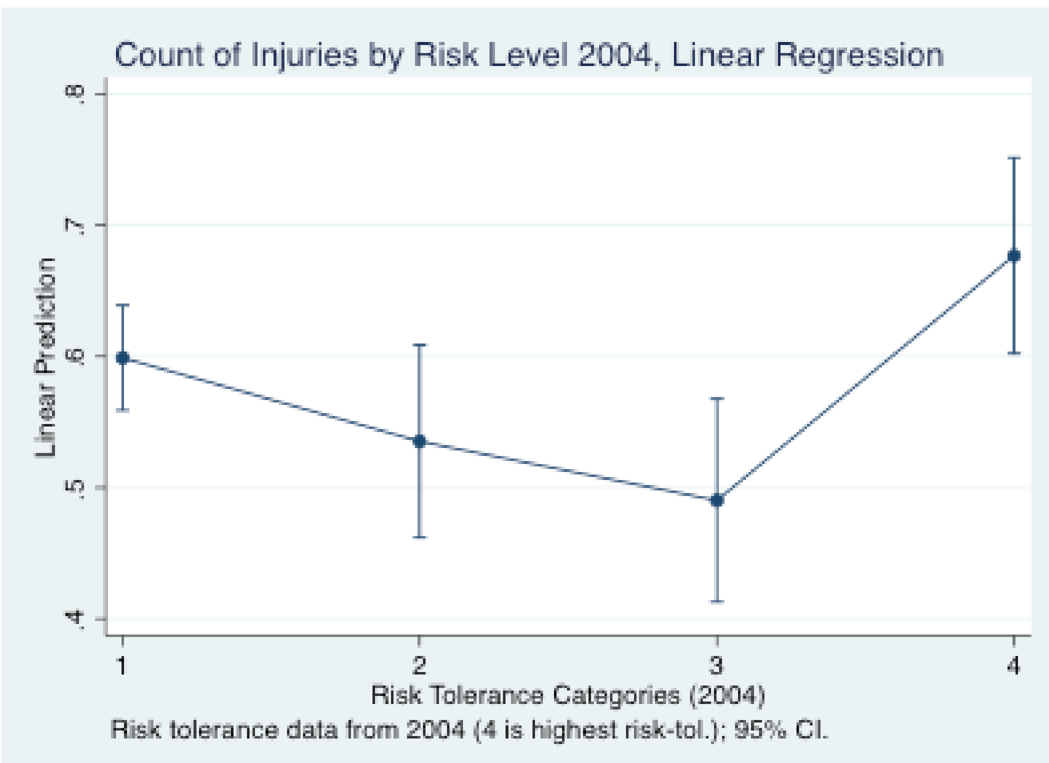


Figure 8

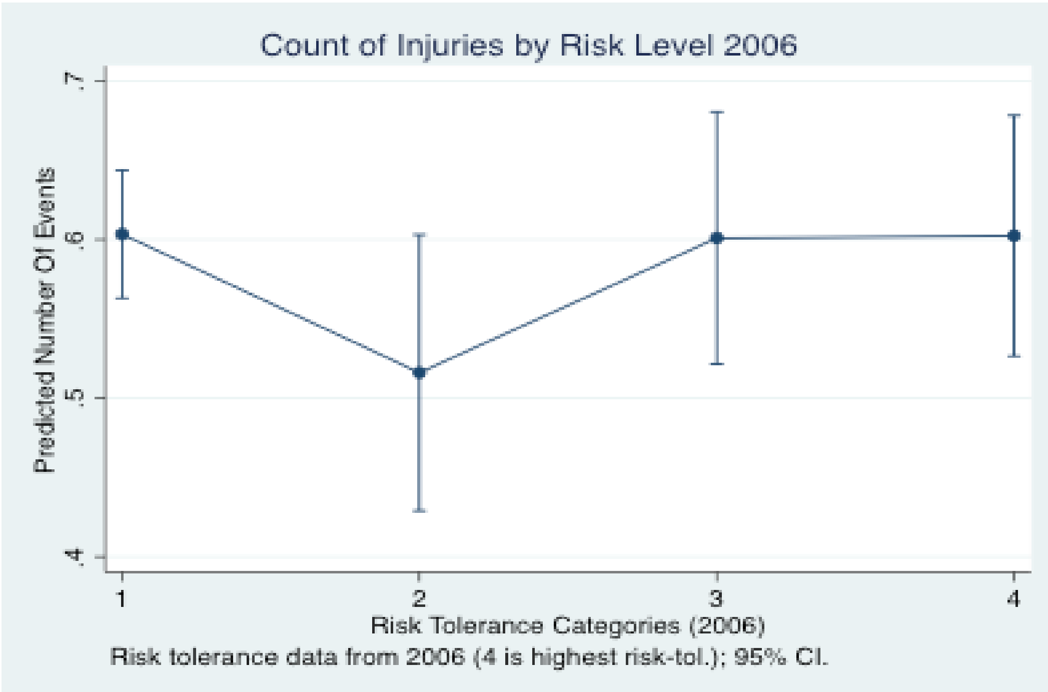


Figure 9

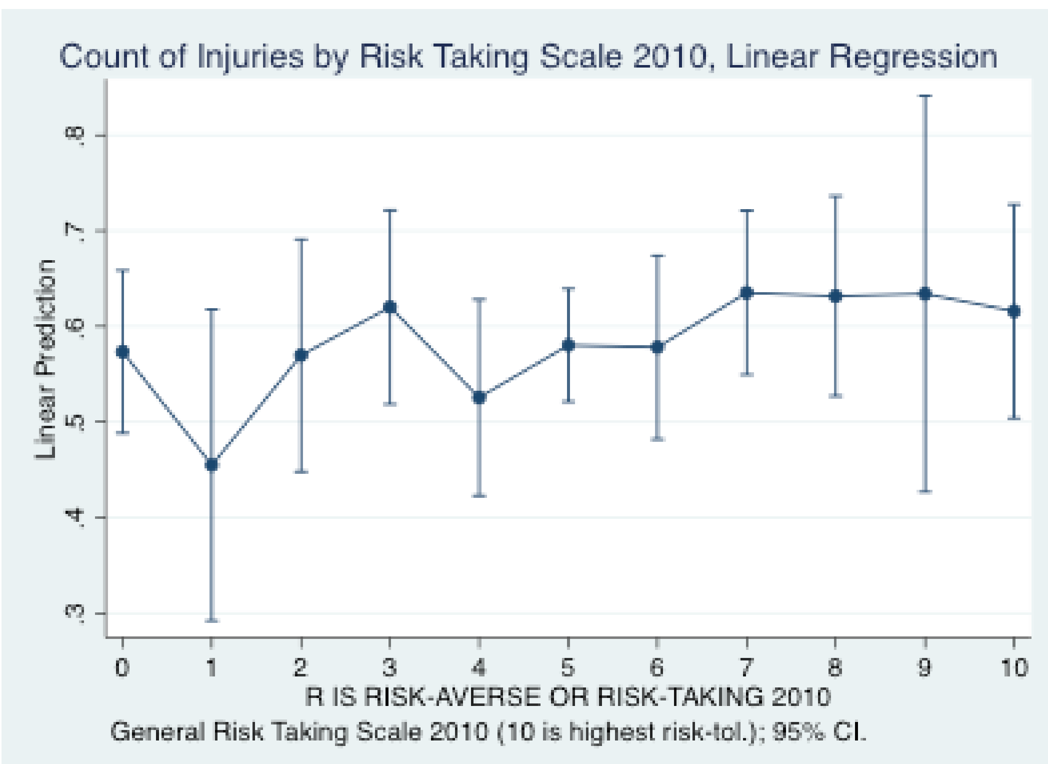


Figure 10

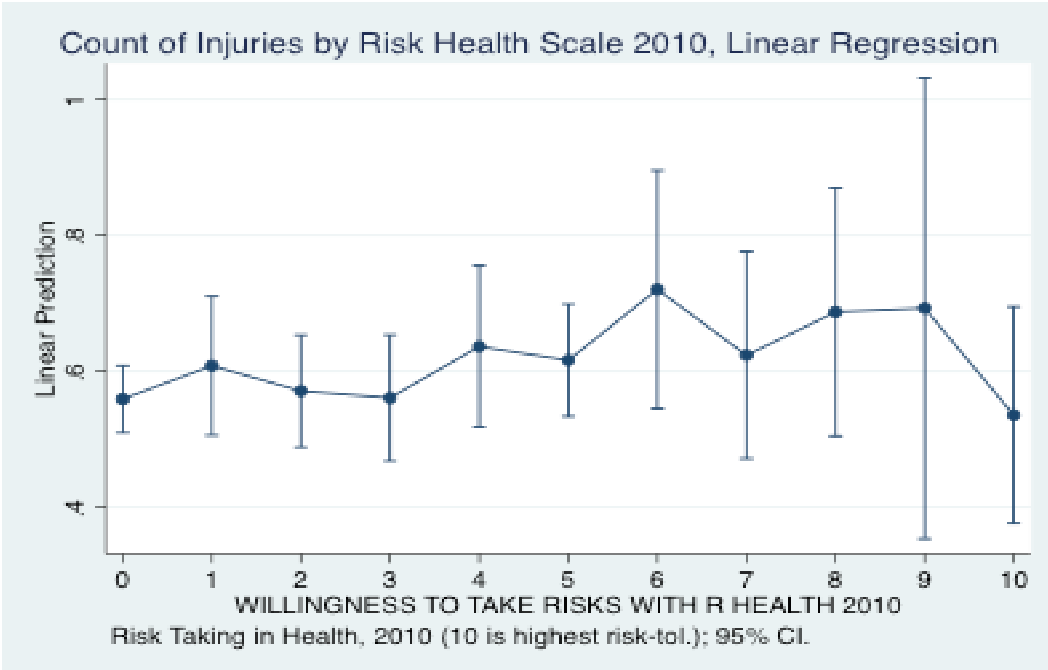


Figure 11

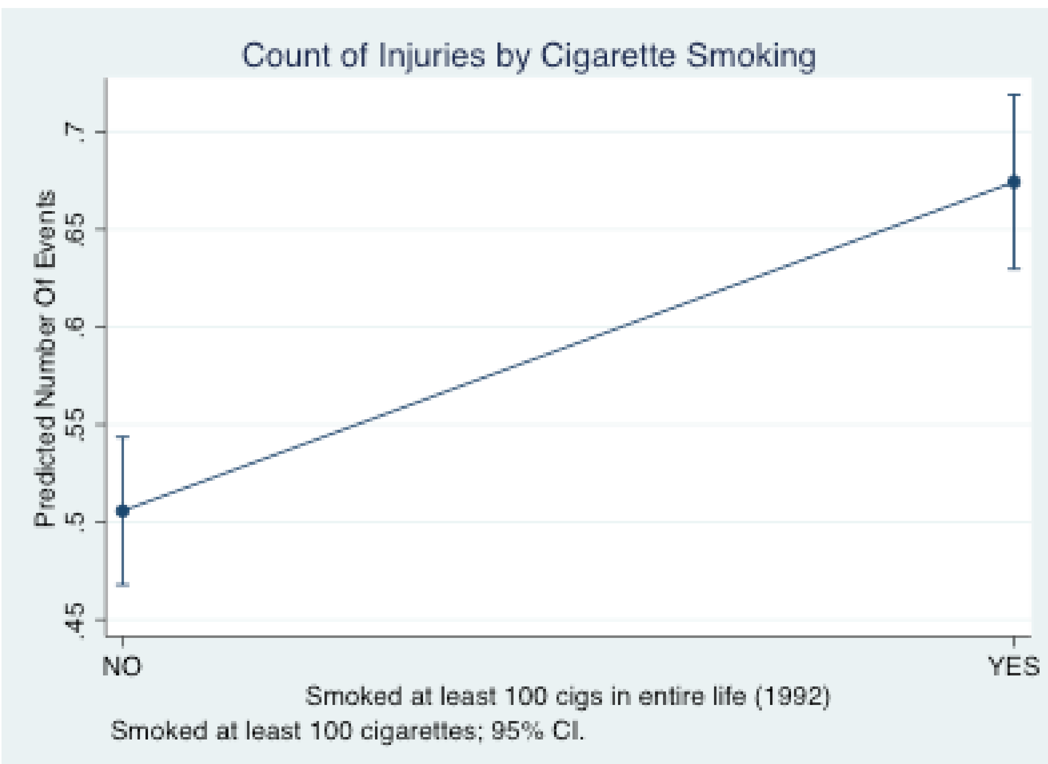


Figure 12

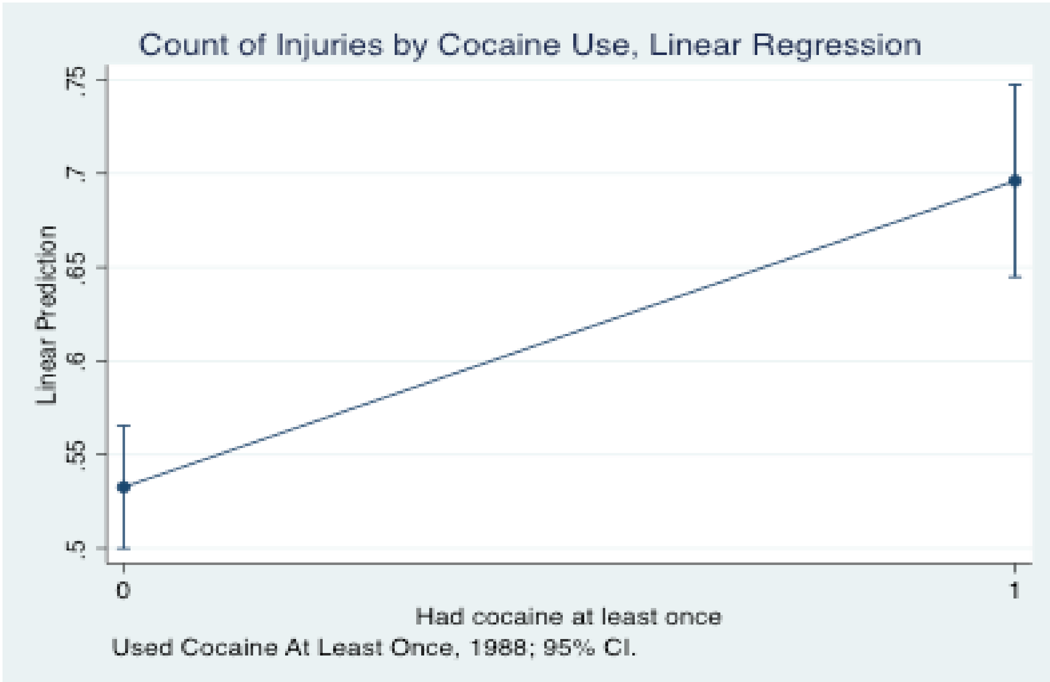


Figure 13

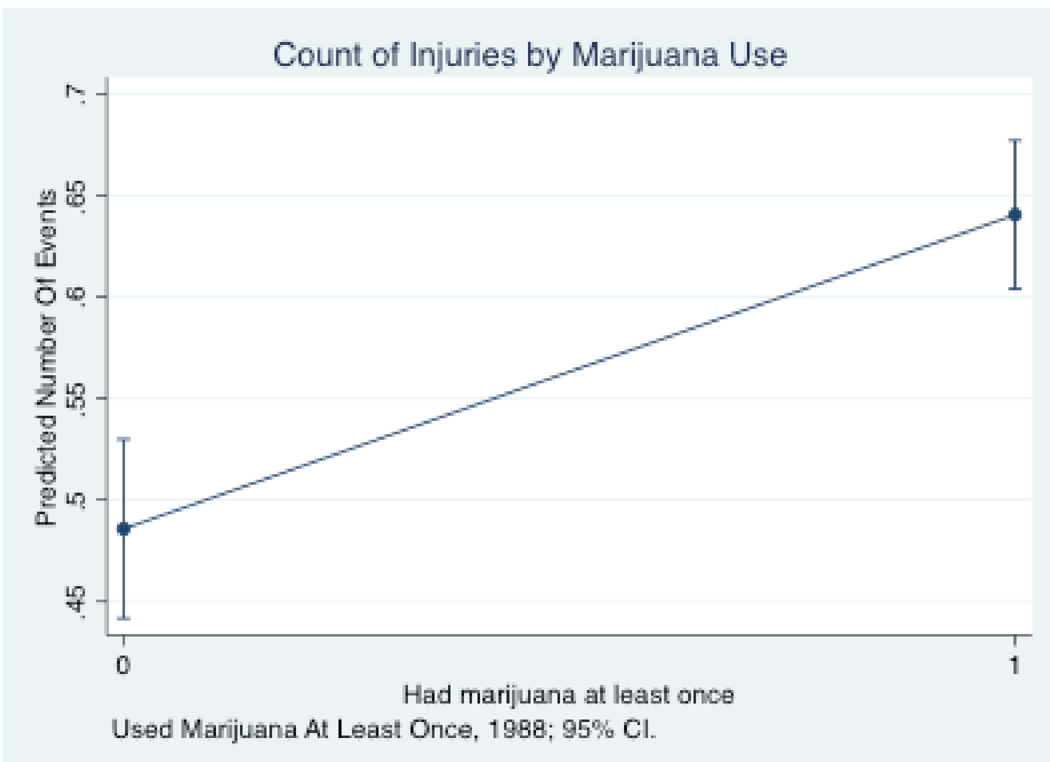
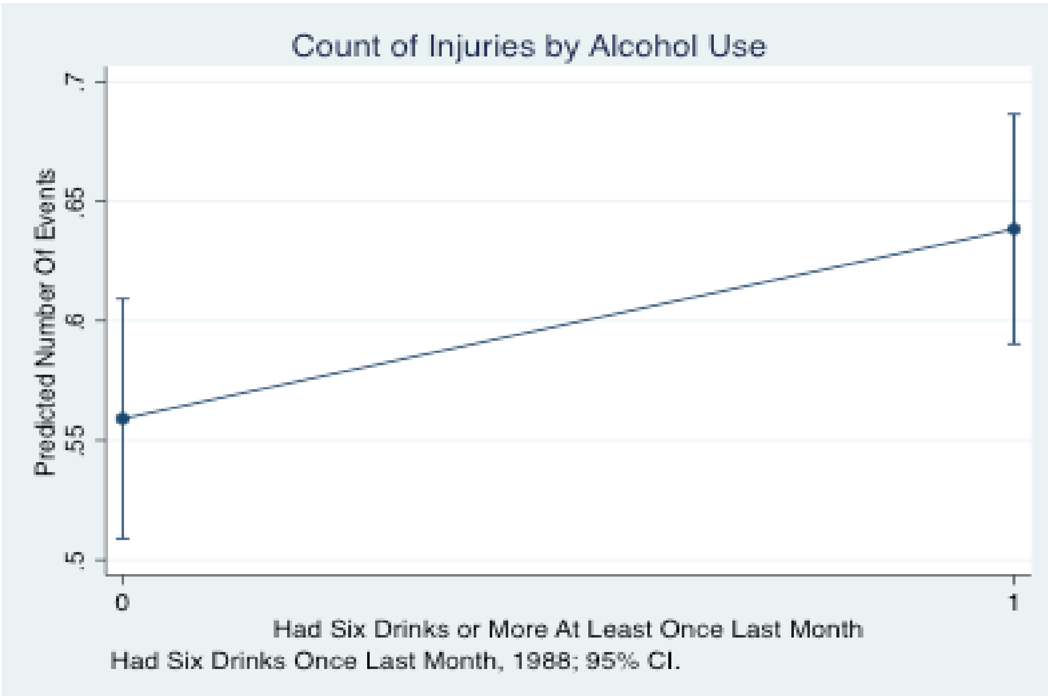


Figure 14


Count of Injuries by Alcohol Use
Predicted Number Of Events
.5
.55
.6
.65
.7
0
1
Had Six Drinks or More At Least Once Last Month
Had Six Drinks Once Last Month, 1988; 95% CI.