Final Report prepared for National Institute for Occupational Safety and Health on"Understanding Occupational Injury and Illness Trends"

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ABSTRACT

Occupational injury rates in the US have been in steady decline through the 1990s. After an increase in the injury rate from 1983 to 1992, the rate of non-fatal injuries in the US workplace declined from 8.3 cases per 100 full-time employees in 1990 to 5.9 cases in 1999, a 29% drop. The composition of occupational injuries also appears to have changed in the '90s. Specifically, the rate of cases involving only restricted work has risen by 50% (from 0.8 in 1992 to 1.2 in 1999) while those more serious injuries involving days away from work have declined by almost 30% (from 3 in 1992 to 1.9 in 1999).

Our research probed this trend, its causes, and its economic consequences. As proposed, we merged data from the Bureau of Labor Statistics' (BLS) Annual Surveys of Occupational Injury and Illness with other establishment-level data on training, benefits, and anti-drug programs to analyze the effect of a wide range of policies and establishment characteristics on the reported injury rate.

We find that the reasonable accommodations mandate of the Americans with Disabilities Act (ADA) is linked to an increase in the rate of restricted work during the 1990s. The rate of cases with no lost work is also associated with the accommodations mandate suggesting a possible mis-reporting of restricted work injuries as no-lost-work cases. Unexpectedly, the ADA's accommodation provision also appears to increase the rate of days away from work cases though this effect appears to be limited to large firms. Besides ADA effects, workers' compensation changes in the 1990s that have restricted the compensability of injuries appear to uniformly depress the reported rate of all types of occupational injuries.

Our research on the relationship between safety training and occupational injuries suggest that safety training increases the reporting of injuries but also has real safety effects on days-away injuries, especially in smaller firms. Safety training appears to be more effective in preventing severe injuries in large firms than in small ones.

We find a 10% lower rate of injuries involving lost-work in the full sample of establishments that used drug testing. Firms with drug testing have a 17% lower rate of minor injuries involving no lost work with the biggest difference (43%) occurring in the transportation and public utility industry. Controlling for other characteristics, the *presence* of an Employee Assistance Program (EAP) was associated with a significant reduction in no lost-work injuries across firms of different sizes and in the manufacturing industry while being only weakly associated with more serious lost-work cases. However, lost work injuries appear to be more responsive to specific EAP characteristics.

Finally, we applied an input-output model to estimate the effect of the reduction in the occupational injury rate on the national employment and the gross domestic product (GDP). We estimate that declining occupational injury increased employment in 2002 by 550,000 jobs. Without the decline in occupational injuries, the unemployment rate in 2002 would have been 6.16% instead of 5.78%. The increase in GDP was $25.5 billion or 9% of the average annual GDP increase from 1993 to 2002.

SIGNIFICANT FINDINGS

The **specific aims** of our project and the related research are detailed below.

1. To analyze trends in 1987-1997 longitudinal (panel) data on occupational injury and illness and its work loss consequences within establishments and industries.

The results of our analysis are presented in a draft paper titled *"Workers' Compensation, the ADA and Injury Rates in the 1990s"*. As proposed, we constructed a longitudinal dataset of establishments from the 1987-1999 waves of the Bureau of Labor Statistics' (BLS) Annual Surveys of Occupational Injury and Illness. We merged these data with information on state workers' compensation systems, and changes in the laws, specifically the Americans with Disabilities Act. Due to concerns about the volume of data involved, we did not receive access to BLS establishment data on unionization, occupational and gender composition. Instead, we merged data from the Current Employment Statistics and the Occupational Employment Surveys for the period to get occupational and gender composition at the establishment's 3-digit industry.

Restrictions on the compensability of workers' compensation claims appear to uniformly depress the reported rate of all three types of injuries. The negative effects on reported rates of injury appear for both small and large firms. Anti-fraud measures had no consistent effects across firm size. Restrictions on the choice of doctor appear to increase the rate of cases with no lost work or restricted work while reducing reports of days-away cases but the effects are clearer in large firms.

As expected, the reasonable accommodations mandate of the ADA is linked to an increase in the rate of restricted work injuries for the full sample of establishments. The positive effects are evident for small and large firms, significantly so in the latter case. In addition, the rate of cases with no lost work is also associated with the accommodations mandate suggesting a possible mis-reporting of restricted work injuries as no-lost-work cases. Our results also indicate a reporting effect of the ADA's anti-firing provisions in small firms where injured workers may be more confident of claiming compensation for workplace injuries that might previously have gone unreported.

Unexpectedly, the ADA's accommodation provision also appears to increase the rate of days away from work cases though this effect appears to be limited to large firms. A possible explanation for this effect may lie in the considerable confusion surrounding the definition of "disability" under the ADA. According to the Equal Employment Opportunities Commission, the manner in which an employer treats an employee may turn a workers' compensation matter into a legal claim under the ADA. The increase in days-away cases may also imply that any ADA-related substitution of restricted work for days away from work may be more evident in its effects on the duration of these cases, which we did not analyze.

2. To perform cross-sectional analyses of how differences in health and safety programs between otherwise similar establishments affect injury rates. The evaluation targets include occupational safety and health training, drug testing, employee assistance programs, and wellness programs.

Two papers resulted from this line of inquiry.
2a..We merged 1993 data from the Annual Survey on Occupational Injuries and Illnesses with the 1993 Survey on Employer Provided Training (SEPT) conducted by the BLS. The results of our analysis are contained in the attached paper titled *"Does Safety Training Reduce Work Injury?"* This study offers a rare look at the effect of training, benefit packages, and workplace practices on work injury.
Our results suggest that safety training increases the reporting of injuries but also has real safety effects on days-away injuries, especially in smaller firms. Safety training appears to be more effective in preventing severe injuries in large firms than in small ones. While overexertion injuries were resistant to safety training, toxic exposure events were reduced in manufacturing establishments with a formal safety training program.
Wellness programs and EAPs were associated with lower injury rates in large firms where they are more common. There is some evidence to suggest that workplace innovations like total quality management significantly increase the reporting of injuries.

2b. In the second paper titled *"Drug Testing and Occupational Injury Rates", we* merge data from the 1989 wave of the Annual Survey with the Survey on Employer-Provided Anti-Drug Programs conducted by the BLS in 1988. Since the data were fairly dated, we ran into problems with data documentation and were forced to conduct unweighted analyses due to

lack of adequate information on weights. Nevertheless, we were able to correlate establishment information on drug testing, anti-drug policies, and employee assistance programs with rates of no-lost-work and days-away-from-work occupational injuries.

We find a 10% lower rate of injuries involving lost-work in the full sample of establishments that used drug testing though this relationship is not statistically significant when we consider firms separately by size and industry. Firms with drug testing have a 17% lower rate of minor injuries involving no lost work with the biggest difference (43%) occurring in the transportation and public utility industry. Controlling for other characteristics, the presence of an EAP was associated with a significant reduction in no-lost-work injuries across firms of different sizes and in the manufacturing industry while being only weakly associated with more serious lost-work cases. However, lost work injuries appear to be more responsive to specific EAP characteristics. Management sponsorship, especially in small firms, and on-site EAPs are both associated with significant reductions in lost-work cases. Telephone hotlines are associated with a lower lost-work rate especially in the transportation industry.

3. **To pilot test an input-output model that will estimate the effect of changing injury rates on the US economy and on specific industries.**

We detail our analysis in a paper titled *"The Impact of Occupational Injury Reduction on the US Economy"*. Reducing occupational injuries potentially could increase national economic activity significantly. This study is a first attempt to measure the impact of occupational injury reduction on national economic output, gross domestic product, national income, and employment by using an input-output model of the U.S. economy. We used 1993 occupational injury costs by industry *as a* baseline for the input-output model, then measured the impact of the 38% injury rate reduction between 1993 and 2002. All computations were in year 2000 dollars. We estimate that declining occupational injury increased employment in 2002 by 550,000 jobs. Without the decline in occupational injuries, the unemployment rate in 2002 would have been 6.16% instead of 5.78%. The increase in gross domestic product (GDP) was $25.5 billion or 9% of the average annual GDP increase from 1993 to 2002. These estimates represent the benefits of injury rate reduction but ignore associated prevention costs.

SCIENTIFIC REPORT

The section consists of four research papers listed below that present our methodology, data, and findings in detail. Full text may be found in the appendix.

1. The ADA, Workers' Compensation, and Injury rates in the 1990s
2. Does Safety Training Reduce Work Injury? (p 48)
3. Drug Testing and Occupational Injury Rates
4. The Impact of Occupational Injury Reduction on the US Economy

PUBLICATIONS

1: Employer costs of alcohol-involved injuries. Related Articles, LinkOut

Zaloshnja E, Miller TR, Hendrie D, Galvin D.
Am J Ind Med. 2007 Feb;50(2):136-42.
PMID: 17187380 [PubMed - indexed for MEDLINE]

2: The impact of occupational injury reduction on the U.S. economy. Related Articles, LinkOut

Zaloshnja E, Miller TR, Waehrer G.
Am J Ind Med. 2006 Sep;49(9):719-27.
PMID: 16917828 [PubMed - indexed for MEDLINE]

3: Costs of occupational injury and illness within the health services sector. Related Articles, Cited in PMC, LinkOut

Waehrer G, Leigh JP, Miller TR.
Int J Health Serv. 2005;35(2):343-59.
PMID: 15934169 [PubMed - indexed for MEDLINE]

4: Impact of a workplace peer-focused substance abuse prevention and early intervention program. Related Articles, Cited in PMC, LinkOut

Spicer RS, Miller TR.
Alcohol Clin Exp Res. 2005 Apr;29(4):609-11.
PMID: 15834226 [PubMed - indexed for MEDLINE]

5: Costs of occupational injury and illness across states. Related Articles, LinkOut

Waehrer G, Leigh JP, Cassady D, Miller TR.
J Occup Environ Med. 2004 Oct;46(10):1084-95.
PMID: 15602183 [PubMed - indexed for MEDLINE]

6: Costs of occupational injury and illness across industries. Related Articles, LinkOut

Leigh JP, Waehrer G, Miller TR, Keenan C.
Scand J Work Environ Health. 2004 Jun;30(3):199-205.
PMID: 15250648 [PubMed - indexed for MEDLINE]

7: Costs of large truck-involved crashes in the United States. Related Articles, LinkOut

Zaloshnja E, Miller TR.
Accid Anal Prev. 2004 Sep;36(5):801-8.
PMID: 15203357 [PubMed - indexed for MEDLINE]

8: An estimate of the U.S. Government's undercount of nonfatal occupational injuries. Related Articles, Cited in PMC, LinkOut

Leigh JP, Marcin JP, Miller TR.
J Occup Environ Med. 2004 Jan;46(1):10-8.
PMID: 14724473 [PubMed - indexed for MEDLINE]

9: Relative risk of injury and death in ambulances and other emergency vehicles. Related Articles, LinkOut

Becker LR, Zaloshnja E, Levick N, Li G, Miller TR.
Accid Anal Prev. 2003 Nov;35(6):941-8.
PMID: 12971929 [PubMed - indexed for MEDLINE]

10: Medical costs of fourteen occupational illnesses in the United States in 1999. Related Articles, LinkOut

Leigh JP, Yasmeen S, Miller TR.
Scand J Work Environ Health. 2003 Aug;29(4):304-13.
PMID: 12934724 [PubMed - indexed for MEDLINE]

11: Ambulance crashes: protect yourself and your patients. Related Articles, LinkOut

Becker LR.
JEMS. 2003 May;28(5):24-6. No abstract available.
PMID: 12748536 [PubMed - indexed for MEDLINE]

12: Costs of occupational injuries and illnesses in California. Related Articles, LinkOut

Leigh JP, Cone JE, Harrison R.
Prev Med. 2001 May;32(5):393-406.
PMID: 11330988 [PubMed - indexed for MEDLINE]

Appendix

The ADA, Workers' Compensation, and Injury rates in the 1990s

The ADA, Workers' Compensation, and Injury rates in the 1990s

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ABSTRACT

We examine the effects of the Americans with Disabilities Act and workers' compensation reforms on occupational injury rates using longitudinal establishment data from 1987–1999. As expected, the reasonable accommodations mandate of the ADA is linked to an increase in the rate of restricted-work injuries for the full sample of establishments. The rate of no-lost-work cases is also associated with the accommodations mandate suggesting a possible mis-reporting of restricted work injuries as no-lost-work cases. Unexpectedly, the ADA's accommodation provision appears to increase the rate of days away from work cases though this effect appears limited to large firms.

This research was conducted with restricted access to Bureau of Labor Statistics (BLS) data on-site at the BLS. The views expressed here are those of the authors and do not necessarily reflect the views of the BLS. This research was supported by grant R01 OH03750 from the National Institute for Occupational Safety and Health of the Centers for Disease Control and Prevention. All errors are our own.

Occupational injury rates in the US have been in steady decline through the 1990s. After an increase in the injury rate from 1983 to 1992, the rate of non-fatal injuries and illnesses in the US workplace declined from 8.9 cases per 100 full-time employees in 1992 to 6.3 cases in 1999, a 29% drop. The composition of occupational injuries also appears to have changed in the nineties. Specifically, the rate of cases involving only restricted work has risen by 50% (from 0.8 in 1992 to 1.2 in 1999) while those more serious injuries involving days away from work have declined by almost 30% (from 3 in 1992 to 1.9 in 1999). Since the injury rate is an important indicator of workplace safety, we need to understand the reasons for these changes both to identify factors that may have contributed to these changes and also to better target future prevention efforts.

Many factors could account for the apparent increase in worker safety including technological advances and the decline of the heavy manufacturing sector in the US. Also, in response to the runaway workers' compensation costs during the 1980s, many policy changes directed at the compensation and medical care of injured workers were initiated in the 1990s. As Ruser, Pergamit, and Krishnamurty (2004) points out, these measures reduce the benefits of filing workers' compensation claims and reporting injuries. In addition, return-to-work measures that provide light duty alternatives to injured workers may also change the composition of occupational injuries by shifting injuries from cases involving days away from work to cases with only restricted work.

At the same time that attempts were being made to reduce the costs of caring for injured workers, the 1990 Americans with Disabilities Act (ADA) mandated new safeguards for workers with disabilities, specifically the provision of reasonable accommodations for disabled workers. According to the Department of Labor, "reasonable accommodations are adjustments or modifications which range from making the physical work environment accessible to restructuring a job, providing assistive equipment, providing certain types of personal assistants (e.g., a reader for a person who is blind, an interpreter for a person who is deaf), transferring an employee to a different job or location, or providing flexible scheduling". While the ADA's definition of disability does not include occupational injuries, its mandated workplace adjustments can make it easier and cheaper for employers to offer restricted work (including special equipment, light duty, temporary transfers) as a cheaper alternative to days away from work for workers injured on the job.

In this paper, using longitudinal establishment data from 1987 to 1999, we examine whether the ADA could have altered the rate and composition of occupational injuries. We also examine whether workers' compensation reforms changed the rate of non-fatal workplace injuries. We focus on three reforms in particular - restrictions in doctor choice, anti-fraud measures, and restrictions on the compensability of workers' compensation claims. Our results indicate that the ADA's reasonable accommodation mandate has increased the rate of restricted work, as well as injuries involving no lost work. Unexpectedly, reasonable accommodations provisions also increased the rate of cases with days away from work suggesting that employers may be adapting their return to work strategies to deal with the threat of litigation under the ADA. Restrictions on compensability of compensation claims appears to have the intended effect of decreasing reported injury rates regardless of injury severity and for both small and large firms.

The Americans with Disabilities Act, 1990:

The ADA of 1990 was intended to expand opportunities for disabled people by preventing employment discrimination on the basis of disability. However, some studies have suggested that instead of expanding opportunities for the disabled, the ADA has reduced employment for disabled people by increasing their employment costs (see Acemoglu & Angrist [2001]; Jolls & Prescott [2004]). These costs are linked to two main provisions of the ADA. The first mandates that employers must provide "reasonable accommodations" to disabled workers unless such provisions imposed an undue burden on the employer. The second provision prohibits the discriminatory termination of employment for reasons of disability. This provision may increase the likelihood of litigation associated with even a lawful termination of disabled employment thus creating a "firing cost" associated with employing a disabled person.

The costs of workplace accommodations vary widely. Examples from the Job Accommodations Network range from $80 for lowering the wattage in overhead lights for a light-sensitive worker to $2,400 for a periscope attached to a microscope for a lab worker with a neck injury. According to the Job Accommodations Network, 70% of their users provided accommodations costing $500 or less, while 19% cost more than $1,000 (Job Accommodations Network [JAN], 1996).

What relationship could the ADA have with the rate of occupational injuries? The ADA's definition of disability requires (1) a physical or mental impairment that substantially limits a major life activity, (2) a record of such an impairment, or (3) being regarded as having such an impairment (Equal Employment Opportunities Commission [EEOC], 1996). Impairments resulting from occupational injury may not be severe enough to substantially limit a major life activity, or they may be only temporary, non-chronic, and have little or no long term impact. Still, by forcing employers to alter worksites or provide special equipment to reasonably accommodate disabled workers, the ADA makes it easier and cheaper for employers to offer restricted work as an option for workers injured on the job. Employers may use restricted work arrangements as a means of monitoring injured workers, to minimize both the productivity losses associated with injuries, and the effects of moral hazard due to workers' compensation benefits (Waehrer & Miller, 2003). Since the passage of the ADA, interest in providing workplace accommodations has greatly increased from 6,500 queries on this subject in 1990 to an annual average of 40,000 for the late 1990s (JAN, 2000). This suggests that the 1990s increase in restricted work injuries may be linked to the reasonable accommodations provisions of the ADA.

Apart from enabling restricted work arrangements for injured workers, the reasonable accommodations requirement could also increase the rate of no-lost-work (NLW) cases if employers mis-report the increased number of restricted-work-only cases as those involving no lost work. Providing accommodations should decrease the rate of days-away-from-work (DFW) cases by making it possible for some workers who might have taken days away from work to perform restricted work instead. In addition, alterations in the worksite or in equipment for the disabled can also make it possible for injured workers to return to work in a limited capacity earlier than they might otherwise have. Thus, the durations of cases with days away from work could also be shortened

(see Waehrer & Miller [2003] for evidence of the substitution of restricted work days for days away from work). However, this paper does not address that issue.[1]

Changes in the Workers' Compensation System:

Between the mid-1980s and early 1990s, workers' compensation costs grew faster than the covered payroll due to the rising cost of medical care for injured workers. In response, states passed a variety of reform packages aimed at controlling costs. Burton and Spieler (2001) provide a detailed description of the legislative changes in workers' compensation in the 1990s. The reforms included measures such as the increased use of managed care for utilization review of compensation claims and a focus on a timely return to work for the injured worker. In addition, states made other changes hoping to reduce the incidence of claims and their associated benefits. We focus on three types of reforms – anti-fraud measures, restrictions in doctor choice, and increased restrictions on the compensability of injuries.

Anti-fraud measures were passed by 22 states between 1990 and 1997. Primary targets for these programs were medical treatment and reporting fraud, claims fraud, employer and insurer fraud. In California, medical provider fraud and employer premium fraud are three to four times more costly than claimant fraud, yet claimants constitute 75% of people prosecuted for workers' compensation fraud (McBirnie, 2001).[2] As Ruser et al. (2004) point out, measures focused on claims fraud increase the burden of proof on workers and could deter legitimate claims for soft-tissue injuries like back sprains and carpal tunnel injuries that are harder to verify.[3]

The choice of medical doctor was also addressed in the reform packages. Medical doctors serve to both document the existence of a work-related injury and provide important input into deciding when a worker is fit enough to return to work either in his regular capacity or to perform some other restricted activity. Thus, they can affect both the legitimacy of a claim and the duration of benefits. The choice of medical doctor rests with workers in some states. Inn others, doctors are chosen by employers or from a restricted list of approved doctors. In the 1990s, eleven states transferred doctor choice from the worker to the employer either directly or by mandating that workers receive care from managed care organizations that had contracted with employers.

[1] Data on the duration and characteristics of cases with days away from work are available only from 1992 onwards. Thus, we cannot compare a post-ADA period to a pre-ADA period since the ADA went into effect in mid-1992.

[2] Claimant fraud cases may account for the majority of prosecutions since they may be easier to prosecute. Also, a single medical provider prosecution can include a large number of fraudulent claims.

[3] Prior research suggests that these injuries are also more responsive to changes in workers' compensation benefits suggesting moral hazard problems (e.g. Butler, Durbin, & Helvacian, 1996; Ruser, 1998).

Finally, 13 states attempted to restrict compensable injuries to those that were solely caused by work. In Kentucky for example, claims for on-the-job mental stress were barred unless the stress resulted from a physical job injury. According to Burton and Spieler (2001), this trend marked a departure from the past when the presence of other aggravating factors like lifestyle, pre-existing conditions, or aging did not prevent workers from receiving benefits. These restrictions are most binding for older workers and those with chronic conditions like back injuries and other musculoskeletal conditions that constitute the bulk of nonfatal occupational injuries and illnesses.

Related Literature: Conway and Svenson (1998) examine potential explanations for the decline in occupational injuries from 1992 to 1996 including the decline in the US manufacturing industry and technological advances. The decline in injury rates could also imply an increase in the underreporting of injuries rather than a truly safer workforce. They reject these explanations and instead suggest that the decline in injury rates correlates with reforms in state workers' compensation programs and industry efforts at promoting workplace safety and health. However, their paper is primarily a discussion of alternative explanations rather than a rigorous analysis of available data.

Boden and Ruser (2003) examine the effect of changes in doctor choice and compensability restrictions on the rate of injuries in the 1990s using aggregated injury data. Compensability restrictions accounted for between 7 – 9.4% of the fall in DFW injuries from 1991–1997. At the same time, these restrictions accounted for 6.8% of the rise in restricted work cases. Restricting the choice of medical provider had no significant effect on injuries of any severity.

Ruser et al. (2004) use individual data from the National Longitudinal Survey of Youth to examine whether changes in the workers' compensation system alter the probability of filing a claim and the duration and benefits associated with a claim. They do not find any effect of legislative changes in workers' compensation on injury incidence, claim duration or the receipt of benefits. However, more generous workers' compensation benefits lead to an increase in the filing of claims.

To our knowledge, no research has examined whether the ADA has affected the reported rate and composition of occupational injuries. Jolls and Prescott (2004) use the variation in pre-ADA state policies toward the disabled to identify the employment effects of the reasonable accommodation provisions of the ADA separately from the firing restrictions. Their analysis shows that the reasonable accommodations provisions are primarily responsible for the negative employment effects of the ADA, causing a 10% decline in disabled employment.

In this paper, we assemble a longitudinal dataset of establishments to examine whether the passage of the ADA and workers' compensation policy changes of the 1990s altered the trend in workplace injuries. The panel dataset allows us to estimate fixed - effects models that mitigate the biases which commonly occur in cross-sectional analyses due to unobserved heterogeneity across establishments. The long thirteen year time period allows us to identify effects of changes in workers' compensation systems that began in 1990 and also to identify changes as a result of the ADA.

We examine the same legislative changes in state workers' compensation policies as Ruser et al. (2004) and Boden and Ruser (2003), namely restrictions in doctor choice, restrictions on the compensability of certain injuries, and state anti-fraud measures. However, while these studies examined the effect of legislative changes on average injury rates and on the filing of workers compensation claims by individual workers, we focus on whether these policy changes can account for the declining trend in injuries using establishment data. The cross-state variation in the passage of workers' compensation reforms helps to identify the effects of the reforms separately from simple year effects.

Estimating Framework: We examine the effects of the ADA and workers' compensation changes on the rate of injuries of different severity – those minor injuries involving no lost work, restricted work only injuries that were more serious but did not require any time away from work, and the most serious category of injuries involving days away from work.

Since the ADA went into effect at the same time across the country, a simple comparison of pre- and post-ADA injury rates does not serve to identify its effect separately from general time effects. We also believe that its reasonable accommodation provision is likely to be more important than its anti-firing provisions in affecting reported occupational injury rates, especially for cases involving restricted work. To identify the effects of the reasonable accommodation provisions of the ADA on the reported injury rate, we follow Jolls and Prescott (2004) and use their information on pre-ADA variations in state laws regarding disabled employment.

Prior to the ADA's passage, twenty-nine states had already forbidden discrimination on the basis of disability in hiring, firing, and terms of employment (traditional anti-discrimination - TA). However, they did not require reasonable accommodations as the ADA subsequently did. Eighteen states already had ADA-like laws in effect requiring both protections against employment discrimination and reasonable accommodations (reasonable accommodations group-RA). Finally, a third group of three southern states had no laws governing the employment of disabled workers prior to the ADA (no protection group – NP).

Thus, the passage of the ADA caused no real change in the protections for disabled workers in the RA states, and only added the reasonable accommodation provision in the TA states. By comparing the change in the injury rate over time for establishments in TA states versus those in RA states, we can identify the effect of imposing a reasonable accommodations requirement on reported injuries.

We estimate separate fixed effects models of the log of the establishment injury rate per 10,000 full-time employees for the three injury types. The regression model is specified as follows:

$$\ln(I_{ejt}) = \alpha + \beta_1 \text{DistrictChoice}_{jt} + \beta_2 \text{Fraud}_{jt} + \beta_3 \text{NP}_{jt} + \beta_4 \text{RA}_{jt} + \gamma_1 \text{YY}_t + \gamma_2 \text{LnK}_{jt} + \delta_{jt} + \lambda_e + \varepsilon_{jt}$$

where e indexes the establishment, j identifies states, t indexes the years in the 13-year time period, u_e is the establishment-specific component of the error term and v_{jt} is the random component. I represents the injury rate per 10,000 full-time employees (FTEs)

and c denotes the year when the states made these changes in their workers' compensation policies.[4]

In our model, we do not define pre- and post-ADA periods but instead include interactions of time dummies with the RA and NP variables. Thus, we track the effect of the ADA's reasonable accommodations provisions through the time period under study. While not formally in effect, these provisions were widely anticipated in the run-up to the law's passage in 1990 and effective date in 1992. Since TA states with traditional protections for the disabled were more numerous, they form the base category of pre-ADA regimes. In the equation (1), the effect of imposing a reasonable accommodations mandate for any year t is measured by $-\beta_{2t}$. A similar difference-in-difference between establishments in NP and TA states, β_{3t}, measures the effect of barriers to firing the disabled on reported rates of occupational injury.

Our fixed effects models control for the possibility that even prior to the ADA's passage, firms in TA states were different in their approach to disabilities from those in the RA states. As Jolls and Prescott (2004) point out, the timing of the pre-ADA state laws suggests that RA states were in fact late converts to dealing with employment of the disabled, while TA states, in spite of having fewer pre-ADA protections, were concerned with the civil rights of the disabled at a much earlier date. Thus, firms in the latter states may have institutionalized the fair treatment of disabled workers to a much greater extent than those in RA states and may be better placed to extend accommodations to injured workers. The fixed effects models factor out those constant, firm-specific unobservables that may otherwise have muddied the estimates of the causal effect of the ADA's provisions with pre-ADA attitudes toward the disabled.

Because workers' compensation reforms were carried out in different states and at different times between 1987 and 1999, we follow Ruser et al. (2004) and contrast the reported injury rate in establishments in the reform states with that of establishments in non-reform states for the same time period. Since establishments and workers could take time to adjust to workers' compensation reforms, we allow for lagged effects of policy changes by creating four dummies for each reform state- one for the year of law change, for one year following the law change, for two years following, and for three or more years following the law change. To allow for firms adapting in anticipation of policy changes, we also create two dummies for one year and two years preceding the law change in the reform state. Our lead variables will also control for the law change coinciding with a period of high injury rates, and the subsequent reversion to the mean injury rate.

[4] Using logged injury rates omits establishments from the estimating sample when they have zero reported cases of a particular severity. However, in the case of DFW and NLW cases, almost all the firms have at least two years of positive reported cases, and thus they are included in the models. For RW cases, approximately 14% of the firms do not have two years of positive RW cases and thus they are excluded from the FE regressions.

Three vectors of reform dummies were created, one for each of the three workers' compensation reforms studied. Dummies were set to zero in states that did not enact a particular reform. The set of leads and lags for each reform allows us to track the progressive impact of the reforms as firms and workers adapt to the new workers' compensation environment.

States changing workers' compensation policies could be different from non-change states in unobservable ways that are correlated with the reported injury rate. For example, states that restricted doctor choice may also have been more likely to promote managed care organizations with utilization management of medical claims. The fixed effects models once again control for these firm-specific differences.

The vector *Xejt* includes the percentage of women workers and production workers in the establishment's three-digit industry, the logged earnings of production workers in that industry, and the average injury rate for that industry. These variables while not establishment-specific, will help to control for the riskiness of work at the firm. Finally, we use average annual employment at the establishment level to control for economic conditions facing the firms. Prior research (Smith, 1972) suggests that the injury rate is pro-cyclical. As the economy expands, more inexperienced workers are hired and the pace of work increases resulting in a higher rate of injuries. We also control for the percentage of full-time equivalent workers in the firm. A higher percentage of full-time workers suggests greater exposure to the risks of the workplace potentially increasing the injury rate. On the other hand, full-time workers are also likely to be more experienced and better prepared for job hazards than part-time workers.

Data: We assembled a panel dataset of establishment injury rates using data from the Annual Surveys of Occupational Injuries and Illnesses from 1987 to 1999. The Annual Survey is a federal/state program that has collected occupational injury and illness data on an annual basis since 1972, from logs that employers maintain according to Occupational Safety and Health Administration (OSHA) guidelines. Employer reports of worker injuries were collected from about 174,305 private industry establishments in 1999.[5] These establishments reported on the numbers of injuries and illnesses of various types - without lost work, with only restricted-work days, or with days away from work - that occurred in the previous year. In addition, the summary data include information on establishment characteristics like state, industry, average employment, and annual hours worked by all employees.

NLW cases require medical treatment other than first aid but do not involve any work loss beyond the day of injury. Restricted-work-only cases (RW cases) do not involve any days away from work except perhaps the day of injury. However, workers with these injuries cannot perform their regular job functions and instead may need reduced work hours, job modifications to avoid exacerbating their injuries, or temporary transfers to other jobs. While accommodation effects may vary across different types of restricted work, the data do not allow us to distinguish between them. Finally, DFW cases involve at least one day away from work after the day of injury. These cases may or may not involve some restricted work.

[5] The number of surveyed establishments has steadily decreased over the 13 year period. In 1987, the Annual Survey collected injury data from 251,483 establishments.

The Annual Survey is not designed as a longitudinal survey. Nevertheless, it samples establishments annually from the same BLS sampling frame. Hence a panel dataset hinges on finding enough establishments appearing more than once in the 13-year time period. Our task was complicated by a change in the unique establishment identifiers between pre-1992 and post-1991 periods. We created a bridge dataset that consisted of the matches between the 1991 and 1992 surveys using state, county, unemployment insurance number (UI number), and 4-digit Standard Industrial Classification (SIC) code as matching variables. We then matched pre- and post-1991 to this bridge 1991–92 data using the pre- and post-1991 establishment identifiers respectively. This resulted in a final panel of 727 establishments with all 13 years of data. The long time span allows us to examine the effects of workers' compensation reforms as well as the ADA, which was enacted in 1990 and became effective in 1992.

We used information presented in Ruser et al. (2004) on the timing of state reforms relating to fraud, restrictions in compensability, and doctor choice. Our information on the pre-ADA legal regimes in states is drawn from Jolls and Prescott (2004). We use the variation in pre-ADA disability laws across states to identify the effect of the ADA's reasonable accommodation provisions on the composition and rate of work injuries.

Since the Survey does not carry any information on workers' compensation benefits in different states, we added information on the state maximum weekly income replacement benefit and waiting period required by each state to qualify for compensation from the 1987–99 issues of Analysis of Workers' Compensation Laws (U.S. Chamber of Commerce, 1987–1999). We also merged information on the occupational composition of the 3-digit industry to which the establishment belonged from the 1988–98 Occupational Employment Surveys of the BLS. Data on gender composition and the earnings of production workers in the industry was also added from the annual Current Employment Surveys to further control for variation in injury rates that may be attributed to workforce composition.[6]

Because larger establishments have a greater probability of being selected for the Annual Survey in any given year, a balanced panel of establishments tends to be composed of a disproportionate number of large establishments. Table 1 compares the mean characteristics of the balanced panel with data from establishments surveyed in the 1995 round of the Annual Survey. As expected, the panel is composed of larger establishments with average reported employment of 1,777 compared with 19 workers for the 1995 data. Only 5% of the balanced panel is composed of very small firms with fewer than 50 workers, while this group constitutes 74% of the 1995 data. Conversely, 71% of the balanced panel is made up of very large establishments with over 1,000 workers, compared with 2% of the 1995 data.

[6] These data are from the 1988–1998 Occupational Employment Surveys of the BLS. The percentage of workers in seven major occupational groups was calculated at the most detailed industry level possible and then merged with the injury data Three years of survey data are needed to span all private industry. Thus the occupational data change at most every three years.

The panel data have a higher mean injury rate of 11.34 cases per 100 full-time employees compared with 8.4 injuries per 100 full-time workers for the 1995 data. This is not surprising given the inverted U-shape that describes the relationship between firm size and reported injuries in the BLS data.[7] A similar pattern is observed when we look at the rates of DFW and NLW cases. By contrast, RW cases are recorded at a higher rate in the balanced panel than in the master data, perhaps because restricted work is more prevalent among larger firms (see Waehrer & Miller [2003] for an analysis of the determinants of restricted work arrangements for injuries involving days away from work).

Establishments in the panel are more likely to be in the services sector relative to those in the 1995 data (48% versus 31%). Conversely, establishments from the mining industry are under-represented in the balanced panel (0.1%) versus the 1995 data (6%). These differences in industry composition could also account for the differences in the recorded injury rate between the two samples. In the empirical work that follows, we compensate for the disproportionate presence of large firms by also estimating separate models by size class. We also present results separately for the manufacturing and service industries. As seen below, manufacturing had the highest pre-ADA rate of RW cases while the services sector saw the sharpest increase in these cases.

Trends in Injury Rates: Figure 1 presents BLS estimates of injury rates from 1989 to 2001 for the three severity categories by industry. For all private industry, the rate of RW cases increased from 0.6 per 100 FTEs in 1989 to 0.7 in 1991, a 16% increase. After the ADA came into effect, the RW rate increased from 0.8 in 1992 to a steady rate of 1.2 cases per 100 FTEs in 1997, a 50% increase. The increase in RW cases appeared to be leveling off post-1997.

The change in the rate of RW cases was the strongest in the services sector which saw a 300% increase in restricted work rate from 0.2 per 100 full-time employees in 1989 to 0.8 cases in 2001. Manufacturing, which had the highest pre-ADA rate of RW cases, also had one of the smaller changes in the RW rate (50%). The mining industry saw the smallest (20%) increase in the RW rate.

While the changes in the injury rates appeared to be stronger in the post-ADA period, some increase in RW cases appeared prior to the law. These early changes are not inconsistent with ADA effects since the ADA was widely anticipated and employers may have already started altering their workplace policies. Similarly, since reasonable accommodation requirements have been in place for almost a decade, the tapering off in RW growth at the end of the 1990s is not surprising. Figure 1 also depicts the decline in NLW and DFW cases through the 1990s. Overall, the trend in DFW cases is consistent with the expected substitution of RW cases for DFW cases due to reasonable accommodations.

[7] Very small firms with fewer than 50 workers and very large firms with more than 1,000 workers report lower injury rates in the BLS surveys than medium-sized firms. However, many researchers (e.g. Leigh, 1989; Mendeloff & Kagey, 1990) see this as an artifact of poor recordkeeping in small establishments.

Regression Results: Regression estimates of the effects the ADA and workers' compensation reforms for the full panel are presented in Table 2 for the three types of injuries. Note that our fixed-effects models will only be able to identify the effects of those establishment characteristics that vary over the 13 year time period. Thus, stable differences between states with different pre-ADA laws, or between states that chose to change workers' compensation policies and those that did not, could not be separately identified.

Compensation Reforms: Restrictions on the compensability of claims had the largest and most significant effect on the rate of DFW cases, reducing the rate of injuries by almost 20% one year after the restrictions took effect in the reforming states with continued reductions thereafter. Significant reductions also occurred in the rate of NLW and RW cases after compensability restrictions went into effect in the reform states. Though stronger declines were seen post-reform especially for DFW cases, Table 1 shows that the rate of all three types of injuries also declined in the years prior to the change year suggesting that workers may have been adjusting their claims behavior in anticipation of the changes.

Restrictions on the choice of doctor had a delayed effect on DFW rates, reducing the rate by an average of 16% three or more years after the changes occurred in reform states. Post-reform increases in the rate of NLW cases suggest that more employer-friendly doctors may be causing a re-allocation of cases from the days-away category to the medically treated but no lost work group. Our establishment-based results contrast with Boden and Ruser (2003) whose analysis of mean injury rates found that the choice of medical provider has no significant relationship with the incidence of any nonfatal injuries.

Anti-fraud measures did not appear to affect the rate of DFW cases but did significantly reduce the rate of the less serious NLW cases by an average of 10% three or more years after the measures were put in place. These results suggest that anti-fraud measures may increase the burden of proof on workers sufficiently to make claim for minor injuries not worth the effort. However, this increase in the cost of filing a claim did not appear to be sufficient to deter compensation claims for more serious DFW injuries. Anti-fraud measures had a delayed positive effect on RW cases.

ADA effects: We expected that the ADA, especially its requirements for reasonable accommodations, would encourage more employers to offer restricted work options. The results in Table 2 show that this may in fact be happening though the effect is delayed. The results show that establishments in states where the ADA's accommodations requirements were new (ie. the TA states) had experienced a larger increase in the use of restricted work relative to establishments that were already dealing with accommodations prior to the ADA (ie. RA states). This difference is present even in pre-ADA years but is larger and more statistically significant from 1995 onwards.

We expected that the ADA's reasonable accommodations would reduce DFW cases with employers using restricted work options instead of days away from work for injured workers. Instead, our results show the opposite – establishments in TA states where accommodations were a new requirement of the law, saw a smaller drop in DFW rates than establishments in RA states. Thus, the ADA's reasonable accommodation

provision appeared to have slowed down rather than accelerated the decline in the rate of DFW cases.

This effect also appears to be delayed, starting in 1995 three years after the effective date of the ADA, and peaking in 1998. While DFW rates were 49% lower in TA establishments in 1998 compared to 1987, they were 66% lower in establishments in RA states that were already subject to reasonable accommodation requirements prior to the ADA. Thus, the decline in the rate of DFW cases in 1998 versus 1987 (the base year) was 17% lower in states where the ADA forced reasonable accommodations than for states where the ADA did not really change the laws governing disabled employment.

If the accommodations requirements increase the rate of restricted work only cases, it is also possible that some of these cases are mis-classified as not involving any lost work. Our results show that accommodations requirements increase the rate of NLW rates suggesting that this mis-classification may in fact be occurring. In contrast to DFW cases, the effects are not delayed but are significant starting in 1992 and increasing thereafter. The decline in the rate of NLW cases in 1998 versus 1987 (the base year) was 20% lower in states where the ADA's reasonable accommodations requirements were new relative to states that already had ADA-type laws prior to 1990.

Our results also show that firing costs (which were a new requirement for the three NP states with no employment protections for the disabled) did not significantly affect the rate of lost-work injuries. However, the decline in NLW cases was significantly greater in NP states relative to TA states which had pre-ADA protections against discrimination.

Results by Firm Size: Tables 3A–3C present regression results by size category for small establishments (100 or fewer workers); medium establishments (101–500 workers) and large establishments (greater than 500 workers). A priori, it is unclear whether small or large establishments should be more responsive to the ADA. Large firms can absorb the fixed administrative and infrastructure costs of complying with the ADA easier than small firms since they can spread those costs over a larger workforce. At the same time, the pre-ADA provision of restricted work was primarily in large firms – therefore, the marginal impact of the law may be greater in smaller firms.

Reasonable accommodations provisions are linked to large increases in the rate of RW cases in small firms from 1990 onwards. However, the estimates are not statistically significant, perhaps because of the small number of firms in this size category in our panel.

Accommodations are unexpectedly associated with a decrease in the RW rate for medium size firms. In large firms, accommodation provisions have their expected effects, increasing both RW and NLW rates significantly. On the other hand, firing cost provisions appear to have a greater impact on small firms, significantly increasing both the rate of DFW and NLW cases. Protections against firing may encourage workers in small firms to report injuries they might otherwise not have, and also to take time off work to recuperate.

Switching to workers' compensation policies, compensability restrictions significantly reduce the DFW rate in small and large establishments while effects were

mostly statistically insignificant and positive in medium-sized firms. NLW rates also fell in small firms after compensability restrictions are put in place and RW cases fell in large firms both prior to and after the restrictions were put in place. Restrictions in doctor choice actually increased both the rate of DFW and NLW cases in small firms while reducing the rate of RW cases in medium-sized establishments. Anti-fraud measures had a similar effect in medium-sized firms.

Results by Industry: Tables 4a and 4b report the results of separate regressions for the manufacturing and services industries. Compensability restrictions appears to have reduced the DFW rate in manufacturing firms though this effect peters out three or more years after the change. Larger and more sustained changes in the NLW rate are seen in response to both compensability restrictions and anti-fraud measures. The ADA appears to have had no significant effect on the rate of injuries in the manufacturing sector regardless of severity.

In the services industry, compensability restrictions caused significant and sustained reductions in the DFW rate from an average of 12% in the reform year to 28% three or more years later. The ADA's accommodations provisions were linked to significant increases in the NLW rate and somewhat weaker increases in the RW rate ranging from 41% to 44% from 1995 onward. Since service establishments dominate our balanced panel, it is not surprising that the reasonable accommodations mandate is estimated to slow the decline in DFW rates by 22%, similar to its full-sample effect.

Other Variables: Among other variables whose coefficients are not reported here, changes in establishment employment were not significantly related to DFW or NLW rates but were negatively and significantly related to RW rates.[8] Establishments with a higher percentage of full-time workers had lower rates for all severity categories suggesting that work experience was more important than exposure to workplace hazards in determining the risk of injury. An increase in the percentage of production workers in the establishment was positively related ($p=0.12$) to the injury rate for DFW injuries but did not affect the less severe injuries. Establishments with a higher percentage of women workers had a significantly lower rate of all types of injuries.

Summary: We examined the effect on recorded occupational injuries of two changes in the 1990s – the ADA and changes in state workers' compensation policies. Restrictions on the compensability of workers' compensation claims appear to uniformly depress the reported rate of injuries with no lost work, involving only restricted work, or that required days away from work to recover. The negative effects on reported rates of injury appear for both small and large firms. Anti-fraud measures had no consistent effects across firm size. Restrictions on the choice of doctor appear to increase the rate of cases with no lost work or restricted work while reducing reports of days-away cases but the effects are clearer in large firms.

As expected, the reasonable accommodations mandate of the ADA was linked to an increase in the rate of restricted work injuries for the full sample of establishments. The positive effects were evident for small and large firms, significantly so in the latter case. In addition, the rate of cases with no lost work was also associated with the

[8] A full set of results can be requested from the authors.

Accommodations mandate suggesting a possible mis-reporting of restricted work injuries as no-lost-work cases. Our results also indicated a reporting effect of the ADA's anti-firing provisions in small firms where injured workers may be more confident of claiming compensation for workplace injuries that might previously have gone unreported.

Unexpectedly, the ADA's accommodation provision also appeared to slow the 1990s decline in the rate of days away from work cases though this effect appears to be limited to large firms. This result implies that the ADA accommodations mandate has somehow increased employers' desire to ensure that workers take time away from work to completely recover from injury. A possible explanation for this effect may lie in the considerable confusion surrounding the definition of "disability" under the ADA.[9] According to the Equal Employment Opportunities Commission, the manner in which an employer treats an employee may turn a workers' compensation matter into a legal claim under the ADA. For example, if employers attempt to restrict workers from their pre-injury jobs for fear of a re-occurrence, the worker would be seen as "impaired" and could then litigate under the ADA. Given such a scenario, employers may be more focused on ensuring a complete recovery from injury even if it involves costly days away from work. The legal confusion surrounding "disability" is likely to be better resolved in states with a longer history of accommodation mandates prior to the ADA than in states where reasonable accommodations were newly introduced as a result of the ADA.

[9] In an example laid out by the Equal Employment Opportunities Commission (1996), consider an employee who has an occupational injury that has resulted in a temporary back impairment that does not substantially limit a major life activity. However, the employer views her as not being able to lift more than a few pounds and refuses to return her to her position. The employer regards her as having an impairment that substantially limits the major life activity of lifting. The employee has a disability as defined by the ADA.

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Table 1. Comparison of Establishment Panel with Survey Data from 1995

Characteristics	1995 Data	Panel
# establishments	248804	727
total injury rate	8.4	11.34
days-away rate	2.6	3.76
no-lost-work rate	4.6	6.02
restricted work rate	1.2	1.56
% firms by # of workers	19	1,777
<=49	0.74	0.047
50–99	0.11	0.061
100–500	0.117	0.102
500–1000	0.017	0.084
>1000	0.018	0.707
Reported Industry		
Agriculture	0.026	0.025
Mining	0.057	0.001
Construction	0.08	0.047
Manufacturing	0.141	0.179
Transp/Comm./Utilities	0.045	0.061
Wholesale Trade	0.06	0.022
Retail Trade	0.208	0.018
F.I.R.E.	0.077	0.025
Services	0.307	0.475

Table 2: Full Sample Effects of ADA and Workers' Compensation Changes in Injury Rates

	DFW			NLW			RWD		
Variables	**Coeff.**	**S.E.**	**t**	**Coeff.**	**S.E.**	**t**	**Coeff.**	**S.E.**	**t**
Reasonable Accommodation Effects ($-\beta_{2t}$)									
1988	0.060	0.059	1.020	0.027	0.090	0.300	0.156	0.151	1.030
1989	-0.020	0.058	-0.350	0.121	0.090	1.350	0.156	0.148	1.060
1990	0.038	0.059	0.650	0.088	0.090	0.980	0.070	0.146	0.480
1991	0.061	0.059	1.030	0.089	0.090	0.990	0.140	0.145	0.960
1992	0.055	0.059	0.930	0.174	0.091	1.920	0.149	0.145	1.030
1993	-0.001	0.059	-0.020	0.208	0.091	2.290	0.115	0.142	0.810
1994	0.045	0.060	0.760	0.176	0.091	1.920	0.158	0.142	1.110
1995	0.086	0.060	1.440	0.214	0.092	2.330	0.191	0.142	1.350
1996	0.121	0.059	2.030	0.224	0.091	2.480	0.241	0.140	1.730
1997	0.154	0.060	2.570	0.224	0.091	2.470	0.224	0.140	1.600
1998	0.170	0.060	2.830	0.200	0.091	2.200	0.301	0.140	2.160
1999	0.103	0.060	1.730	0.167	0.091	1.830	0.245	0.140	1.750
Firing Cost Effects (β_{3t})									
1988	0.037	0.141	0.260	-0.410	0.222	-1.850	0.320	0.356	0.900
1989	0.021	0.141	0.150	-0.541	0.220	-2.460	-0.015	0.338	-0.050
1990	-0.204	0.141	-1.450	-0.633	0.222	-2.850	-0.053	0.356	-0.150
1991	-0.013	0.145	-0.090	-0.713	0.228	-3.120	0.182	0.354	0.520
1992	0.109	0.145	0.750	-0.561	0.230	-2.440	0.263	0.349	0.750
1993	0.012	0.146	0.080	-0.534	0.227	-2.350	0.345	0.350	0.990

Table 2: Full Sample Effects of ADA and Workers' Compensation Changes in Injury Rates (continued)

	DFW			NLW			RWD		
Variables	**Coeff.**	**S.E.**	**t**	**Coeff.**	**S.E.**	**t**	**Coeff.**	**S.E.**	**t**
1994	0.046	0.146	0.310	-0.363	0.225	1.610	0.084	0.338	0.250
1995	0.134	0.147	0.910	-0.459	0.226	2.040	0.604	0.334	1.810
1996	0.014	0.143	0.090	-0.305	0.224	1.360	0.312	0.321	0.970
1997	0.016	0.143	0.110	0.078	0.222	0.350	0.108	0.322	0.340
1998	-0.040	0.143	0.280	-0.091	0.222	0.410	-0.150	0.322	-0.470
1999	0.033	0.143	0.230	-0.196	0.222	0.880	-0.149	0.319	-0.470
Provider Restrictions (Year minus Year of Law Change)									
-2	0.042	0.055	0.760	-0.099	0.085	1.170	-0.109	0.134	-0.820
-1	-0.015	0.056	0.260	0.015	0.085	0.180	0.040	0.133	0.300
0	-0.071	0.057	1.240	0.061	0.087	0.710	0.036	0.131	0.270
1	0.066	0.057	1.150	0.086	0.086	1.000	0.090	0.130	0.690
2	-0.010	0.055	0.170	0.199	0.082	2.420	0.038	0.126	0.300
>=3	-0.172	0.045	3.810	0.134	0.068	1.970	0.097	0.098	0.990
Anti-Fraud Initiatives (Year minus Year of Law Change)									
-2	0.046	0.036	1.270	-0.023	0.055	0.410	0.048	0.086	0.560
-1	0.003	0.041	0.060	-0.037	0.062	0.590	0.029	0.093	0.310
0	0.019	0.042	0.450	-0.138	0.062	2.220	0.066	0.092	0.720
1	0.033	0.042	0.790	-0.100	0.064	1.560	0.025	0.090	0.270
2	-0.025	0.042	0.600	-0.074	0.063	1.160	-0.071	0.089	-0.790

Table 2: Full Sample Effects of ADA and Workers' Compensation Changes in Injury Rates (continued)

	DFW			NLW			RWD		
Variables	**Coeff.**	**S.E.**	**t**	**Coeff.**	**S.E.**	**t**	**Coeff.**	**S.E.**	**t**
>=3	-0.034	0.031	-1.100	-0.109	0.046	-2.350	0.142	0.068	2.080
Compensability Restrictions (Year minus Year of Law Change)									
-2	-0.115	0.050	-2.310	0.077	0.075	1.020	-0.180	0.105	-1.720
-1	-0.092	0.051	-1.790	-0.023	0.078	-0.300	-0.180	0.108	-1.670
0	-0.147	0.052	-2.810	-0.081	0.079	-1.020	-0.223	0.107	-2.070
1	-0.199	0.052	-3.800	-0.155	0.078	-1.980	-0.190	0.107	-1.770
2	-0.181	0.052	-3.500	-0.076	0.078	-0.970	-0.203	0.103	-1.960
>=3	-0.107	0.038	-2.820	-0.144	0.057	-2.520	-0.309	0.081	-3.800

[1] Regressions also control for year effects, percentage of women and production workers, percentage full-time, reported employment, average injury rate and earnings of production workers at the 3-digit industry level, state waiting period and maximum weekly income replacement benefit from workers' compensation.

Table 3A: Effects on Injury Rates in Small Firms with 100 or Fewer Workers

Variables	DFW Coeff.	DFW S.E.	DFW t	NLW Coeff.	NLW S.E.	NLW t	RWD Coeff.	RWD S.E.	RWD t
Reasonable Accommodation Effects ($-\beta_{2t}$)									
1988	-0.147	0.215	-0.680	0.265	-0.2055	-1.040	-0.493	0.6072	-0.7330
1989	-0.234	0.212	-1.110	0.226	-0.2049	-0.910	-0.582	0.6008	-0.9660
1990	0.030	0.218	0.140	0.081	-0.2054	-0.320	0.787	0.6038	1.2330
1991	0.242	0.224	1.080	0.193	-0.2069	-0.720	0.153	0.6035	0.2540
1992	0.187	0.232	0.810	0.218	-0.2066	-0.820	-0.190	0.6087	-0.3180
1993	0.046	0.237	0.200	0.271	0.2083	0.960	0.263	0.6084	0.4380
1994	0.299	0.245	1.220	0.004	-0.2079	-0.010	0.107	0.6075	0.1760
1995	0.197	0.241	0.820	0.084	0.2079	0.300	0.508	0.6084	0.8340
1996	0.277	0.232	1.190	0.083	0.2075	0.300	0.552	0.6042	0.9130
1997	-0.098	0.242	-0.410	0.298	-0.2078	-1.070	0.047	0.6057	0.0770
1998	0.112	0.235	0.480	0.273	-0.2076	-0.990	0.332	0.6052	0.5480
1999	-0.084	0.239	-0.350	0.127	0.2078	0.460	-0.069	0.6063	-0.1100
Firing Cost Effects (β_{3t})									
1988	0.698	0.606	1.150	1.010	0.984	1.030	-		
1989	1.052	0.607	1.730	2.620	0.983	2.660	-		
1990	0.372	0.608	0.610	1.035	0.984	1.050	-		
1991	0.812	0.64	1.260	1.611	1.01	1.580	-		

		6			8		
			0.65				
1992		1.254	9	1.900	-		-
		0.65			0.93		
1993	1.393	8	2.120	1.788	0	1.920	-

Table 3A: Effects on Injury Rates in Small Firms with 100 or Fewer Workers (continued)

Variables	DFW Coeff.	S.E.	t	NLW Coeff.	S.E.	t	RWD Coeff.	S.E.	t
		0.665						1.115	0.320
1994	1.549		2.330	2.332	0.924	2.520	0.370		
				2.910		0.932	3.570		
1995	1.915	0.658			3.325		-		
				3.070		1.012	3.240		
1996	1.978	0.645			3.280		-		
		0.645						1.523	1.220
1997	1.433		2.220	4.198	0.911	4.610	1.859		
		0.641						1.521	1.050
1998	1.150		1.790	4.092	0.907	4.510	1.592		
		0.641						1.512	1.600
1999	0.984		1.540	2.726	0.906	3.010	2.413		
Provider Restrictions (Year minus Year of Law Change)									
	-	0.193	-					0.559	0.250
-2	0.109		0.560	-0.033	0.230	-0.140	0.141		
	-	0.185	-					0.425	0.790
-1	0.157		0.850	-0.055	0.213	-0.260	-0.338		
		0.262						0.593	0.030
0	0.210		0.800	0.260	0.302	0.860	-0.018		
		0.266						0.587	0.250
1	0.408		1.530	0.413	0.311	1.330	0.145		
		0.280						0.621	0.560
2	0.313		1.120	0.572	0.323	1.770	0.348		
		0.237						0.564	0.050
>=3	0.501		2.110	0.571	0.276	2.070	0.025		
Anti-Fraud Initiatives (Year minus Year of Law Change)									
	-	0.137	-					0.497	0.680
-2	0.057		0.420	-0.004	0.163	-0.020	-0.338		
		0.135						0.405	1.270
-1	0.044		0.320	-0.184	0.160	-1.150	-0.515		
	-	0.155	-					0.417	2.170
0	0.135		0.890	-0.197	0.172	-1.140	-0.907		
	-	0.158	-					0.435	1.070
1	0.030		0.190	-0.115	0.188	-0.610	-0.468		

2	-0.136	0.156	-0.870	0.108	0.181	0.590	-0.610	-0.422	-1.440
>=3	0.135	0.127	1.070	0.032	0.148	0.220	-0.483	-0.405	-1.190

Table 3A: Effects on Injury Rates in Small Firms with 100 or Fewer Workers (continued)

	DFW			NLW			RWD		
Variables	**Coeff.**	**S.E.**	**t**	**Coeff.**	**S.E.**	**t**	**Coeff.**	**S.E.**	**t**
Compensability Restrictions (Year minus Year of Law Change)									
-2	-0.444	0.243	-1.830	-0.101	0.294	-0.350	-0.359	0.550	-0.650
-1	-0.533	0.216	-2.470	-0.041	0.260	-0.160	-0.060	0.475	-0.130
0	-0.403	0.261	-1.550	-0.363	0.317	-1.150	-0.062	0.572	-0.110
1	-0.921	0.266	-3.460	-0.833	0.311	-2.680	-1.370	0.619	-2.210
2	-0.909	0.266	-3.420	-0.526	0.311	-1.690	-0.475	0.575	-0.830
>=3	-0.683	0.233	-2.930	-0.708	0.266	-2.660	-0.299	0.528	-0.560

[1] See Footnote 1 in Table 2A. [2] Coefficients cannot be estimated due to collinearity.

Table 3B: Effects on Injury Rates in Medium Firms with 100 to 500 Workers

Variables	DFW Coeff.	DFW S.E.	DFW t	NLW Coeff.	NLW S.E.	NLW t	RWD Coeff.	RWD S.E.	RWD t
Reasonable Accommodation Effects ($-\beta_{2t}$)									
1988	0.176	0.189	0.930	-0.213	0.253	-0.840	-0.380	0.481	-0.790
1989	-0.003	0.189	-0.020	-0.330	0.254	-1.300	-0.527	0.479	-1.100
1990	0.044	0.190	0.230	-0.418	0.256	-1.640	-0.808	0.465	-1.740
1991	-0.072	0.191	-0.380	-0.348	0.256	-1.360	-0.427	0.455	-0.940
1992	-0.128	0.196	-0.650	-0.270	0.265	-1.020	-0.241	0.468	-0.510
1993	-0.183	0.197	-0.930	-0.237	0.265	-0.890	-0.502	0.473	-1.060
1994	-0.173	0.199	-0.870	-0.062	0.267	-0.230	-0.869	0.489	-1.780
1995	-0.016	0.198	-0.080	0.118	0.268	0.440	-0.728	0.470	-1.550
1996	0.050	0.198	0.250	-0.030	0.268	-0.110	-0.602	0.475	-1.270
1997	-0.043	0.197	-0.220	-0.090	0.266	-0.340	-0.298	0.464	-0.640
1998	0.000	0.198	0.000	0.231	0.264	0.880	-0.945	0.457	-2.070
1999	-0.172	0.201	-0.860	0.419	0.272	1.540	-0.915	0.471	-1.940

Firing Cost Effects (β_{3t})

1988	0.073	0.455	0.160	-0.311	0.603	-0.520	0.380	1.084	-0.350
1989	0.189	0.455	0.420	-0.450	0.604	-0.750	-2.022	0.983	-2.060
1990	-0.270	0.457	-0.590	-0.283	0.676	-0.420	-0.911	1.083	-0.840
1991	-0.467	0.491	-0.950	0.196	0.715	-0.270	-0.971	1.130	-0.860
1992	0.287	0.494	-0.580	0.011	0.654	-0.020	-1.489	1.148	-1.300
1993	0.349	0.495	-0.710	0.315	0.654	-0.480	-1.374	1.046	-1.310

Table 3B: Effects on Injury Rates in Medium Firms with 100 to 500 Workers (continued)

	DFW			NLW			RWD		
Variables	**Coeff.**	**S.E.**	**t**	**Coeff.**	**S.E.**	**t**	**Coeff.**	**S.E.**	**t**
1994	-0.653	0.494	-1.320	0.101	0.653	0.160	-2.526	1.139	-2.220
1995	-0.149	0.493	-0.300	0.212	0.651	0.330	-2.697	1.033	-2.610
1996	-0.390	0.482	-0.810	0.336	0.638	0.530	-3.400	1.022	-3.330
1997	0.283	0.479	0.590	0.576	0.634	0.910	-2.615	1.013	-2.580
1998	-0.138	0.477	-0.290	0.334	0.631	0.530	-1.413	0.966	-1.460
1999	0.244	0.478	0.510	-0.454	0.632	-0.720	-1.412	0.971	-1.450
Provider Restrictions (Year minus Year of Law Change)									
-2	-0.040	0.172	-0.230	0.125	0.235	0.530	-0.376	0.322	-1.170
-1	0.073	0.157	0.470	-0.104	0.208	-0.500	-0.165	0.287	-0.580
0	-0.407	0.183	-2.230	0.066	0.241	0.280	-0.695	0.318	-2.180
1	-0.064	0.189	-0.340	0.244	0.246	0.990	-0.814	0.319	-2.550
2	-0.213	0.187	-1.140	0.251	0.242	1.040	-0.883	0.332	-2.660
>=3	-0.464	0.148	-3.140	0.147	0.193	0.760	-0.746	0.267	-2.800
Anti-Fraud Initiatives (Year minus Year of Law Change)									
-2	0.002	0.127	0.020	-0.143	0.172	-0.830	-0.142	0.295	-0.480
-1	0.177	0.121	1.470	-0.107	0.158	-0.680	-0.345	0.261	-1.320
0	0.188	0.132	1.430	-0.280	0.175	-1.600	0.313	0.300	1.040
1	0.376	0.133	2.820	-0.368	0.177	-2.080	0.202	0.276	0.730
2	0.200	0.136	1.470	-0.266	0.179	-1.490	0.043	0.270	0.160
>=3	0.241	0.103	2.350	-0.351	0.136	-2.570	0.542	0.216	2.510

Table 3B: Effects on Injury Rates in Medium Firms with 100 to 500 Workers (continued)

	DFW			NLW			RWD		
Variables	**Coeff.**	**S.E.**	**t**	**Coeff.**	**S.E.**	**t**	**Coeff.**	**S.E.**	**t**
Compensability Restrictions (Year minus Year of Law Change)									
-2	0.124	0.164	0.760	-0.232	0.214	-1.080	0.649	0.294	2.210
-1	0.125	0.157	0.790	-0.075	0.201	-0.380	0.260	0.268	0.970
0	-0.091	0.178	-0.510	-0.281	0.231	-1.220	0.420	0.320	1.310
1	0.181	0.175	1.030	-0.293	0.228	-1.290	0.316	0.322	0.980
2	0.202	0.171	1.180	-0.302	0.226	-1.340	0.630	0.322	1.960
>=3	0.294	0.151	1.940	-0.239	0.201	-1.190	0.252	0.310	0.810

[1] See Footnote 1 in Table 2A.

Table 3C: Effects on Injury Rates in Large Firms with More than 500 Workers

Variables	DFW Coeff.	DFW S.E.	DFW t	NLW Coeff.	NLW S.E.	NLW t	RWD Coeff.	RWD S.E.	RWD t
Reasonable Accommodation Effects ($-\beta_{2t}$)									
1988	0.063	0.064	0.990	0.099	0.103	0.960	0.226	0.164	1.380
1989	0.014	0.064	0.210	0.207	0.102	2.020	0.236	0.161	1.470
1990	0.040	0.064	0.630	0.146	0.102	1.430	0.104	0.159	0.650
1991	0.032	0.064	0.510	0.147	0.103	1.430	0.180	0.158	1.140
1992	0.053	0.064	0.820	0.245	0.103	2.380	0.195	0.157	1.240
1993	-0.002	0.064	-0.030	0.211	0.103	2.060	0.138	0.154	0.900
1994	0.038	0.065	0.590	0.184	0.103	1.780	0.222	0.154	1.440
1995	0.066	0.065	1.010	0.171	0.103	1.650	0.212	0.154	1.380
1996	0.079	0.065	1.220	0.226	0.103	2.200	0.276	0.151	1.820
1997	0.172	0.065	2.660	0.283	0.103	2.740	0.246	0.151	1.620
1998	0.181	0.065	2.780	0.214	0.103	2.070	0.380	0.151	2.500
1999	0.119	0.065	1.850	0.099	0.103	0.960	0.333	0.151	2.200
Firing Cost Effects (β_{3t})									
1988	-0.029	0.150	-0.200	-0.506	0.245	-2.070	0.304	0.378	0.810
1989	-0.094	0.150	-0.620	-0.725	0.242	-2.990	0.198	0.362	0.550
1990	-0.235	0.150	-1.570	-0.773	0.242	-3.190	0.058	0.377	0.150
1991	-0.026	0.150	-0.170	-0.937	0.242	-3.870	0.311	0.375	0.830

		4	0.170		9	3.770		5	0
		0.154	0.140		0.251	-2.920		0.369	1.070
1992	0.022			-0.733			0.395		
		0.154	-0.950		0.251	-2.860		0.375	1.100
1993	-0.146			-0.717			0.414		

Table 3C: Effects on Injury Rates in Large Firms with More than 500 Workers (continued)

	DFW			NLW			RWD		
Variables	**Coeff.**	**S.E.**	**t**	**Coeff.**	**S.E.**	**t**	**Coeff.**	**S.E.**	**t**
1994	0.022	0.154	0.140	-0.504	0.249	-2.030	0.324	0.362	0.900
1995	0.032	0.156	0.210	-0.739	0.249	-2.970	0.890	0.356	2.500
1996	-0.087	0.153	-0.570	-0.549	0.246	-2.230	0.606	0.340	1.780
1997	-0.116	0.152	-0.760	-0.202	0.246	-0.820	0.276	0.344	0.800
1998	-0.126	0.152	-0.830	-0.389	0.246	-1.580	-0.149	0.346	-0.430
1999	-0.080	0.152	-0.530	-0.267	0.245	-1.090	-0.215	0.343	-0.630
Provider Restrictions (Year minus Year of Law Change)									
-2	0.010	0.066	0.150	0.039	0.105	0.370	0.052	0.158	0.330
-1	0.020	0.066	0.300	-0.068	0.106	-0.640	-0.121	0.163	-0.740
0	0.015	0.066	0.220	0.069	0.105	0.650	0.155	0.156	0.990
1	0.030	0.066	0.460	0.084	0.105	0.800	0.206	0.156	1.320
2	0.031	0.061	0.520	0.225	0.096	2.350	0.150	0.147	1.020
>=3	-0.166	0.051	-3.240	0.172	0.081	2.120	0.267	0.115	2.320
Anti-Fraud Initiatives (Year minus Year of Law Change)									
-2	0.040	0.048	0.830	-0.027	0.076	-0.360	0.094	0.103	0.910
-1	0.029	0.040	0.720	0.014	0.064	0.210	0.111	0.095	1.180
0	0.027	0.048	0.550	-0.112	0.076	-1.470	0.115	0.104	1.100
1	-0.009	0.049	-0.190	-0.065	0.077	-0.850	0.017	0.103	0.170
2	-0.004	0.049	-0.070	-0.069	0.077	-0.900	-0.041	0.101	-0.400
>=3	-0.085	0.034	-2.480	-0.083	0.055	-1.520	0.108	0.076	1.420

Table 3C: Effects on Injury Rates in Large Firms with More than 500 Workers (continued)

	DFW			NLW			RWD		
Variables	**Coeff.**	**S.E.**	**t**	**Coeff.**	**S.E.**	**t**	**Coeff.**	**S.E.**	**t**
Compensability Restrictions (Year minus Year of Law Change)									
-2	-0.121	0.057	-2.110	0.006	0.091	0.070	-0.263	0.124	-2.120
-1	-0.084	0.056	-1.510	0.111	0.089	1.250	-0.239	0.120	-1.990
0	-0.141	0.058	-2.440	-0.060	0.091	-0.660	-0.258	0.122	-2.110
1	-0.201	0.058	-3.460	-0.116	0.092	-1.270	-0.113	0.122	-0.930
2	-0.197	0.057	-3.430	-0.040	0.091	-0.440	-0.254	0.118	-2.160
>=3	-0.109	0.040	-2.690	-0.144	0.064	-2.240	-0.316	0.090	-3.520

[1] See Footnote 1 in Table 2A.

Table 4A: Effects on Injury Rates in Manufacturing Firms

Variables	DFW			NLW			RWD		
	Coeff.	S.E.	t	Coeff.	S.E.	t	Coeff.	S.E.	t
Reasonable Accommodation Effects ($-\beta_{2t}$)									
1988	0.032	0.112	0.280	-0.143	0.120	1.190	-0.128	0.188	0.680
1989	-0.082	0.112	-0.730	0.088	0.120	0.730	0.123	0.189	0.650
1990	-0.020	0.113	-0.180	-0.161	0.121	1.340	-0.141	0.187	-0.750
1991	-0.012	0.113	-0.110	-0.291	0.122	2.390	-0.046	0.187	-0.250
1992	-0.084	0.114	-0.740	-0.129	0.122	1.050	0.000	0.189	0.000
1993	-0.162	0.114	-1.420	-0.114	0.122	0.940	0.018	0.187	0.100
1994	-0.142	0.115	-1.230	-0.006	0.123	0.050	-0.142	0.188	-0.760
1995	-0.072	0.115	-0.620	-0.072	0.123	0.590	-0.281	0.187	-1.510
1996	-0.035	0.114	-0.310	-0.053	0.121	0.440	-0.045	0.185	-0.240
1997	0.067	0.114	0.590	0.151	0.122	1.240	0.013	0.185	0.070
1998	0.045	0.115	0.390	0.136	0.122	1.110	-0.054	0.185	-0.290
1999	-0.032	0.115	-0.280	0.132	0.123	1.070	-0.166	0.187	-0.890
Firing Cost Effects (β_{3t})									
1988	0.179	0.199	0.900	-0.318	0.214	1.480	0.315	0.372	0.850
1989	0.037	0.199	0.190	-0.286	0.214	1.340	-0.201	0.348	-0.58

									80
									-
			-			-		0.35	0.9
1990	-0.084	0.200	0.420	-0.249	0.214	1.160	-0.327	4	20
		0.21			0.22	-			
1991	0.010	0	0.050	-0.180	5	0.800	0.128		0.370
0.350						-		0.36	0.1
1992	0.302	0.210	1.430	-0.084	0.228	0.370	0.065	7	80
								0.37	0.4
1993	0.150	0.211	0.710	0.071	0.226	0.310	0.173	3	60

Table 4A: Effects on Injury Rates in Manufacturing Firms (continued)

	DFW			NLW			RWD		
Variables	**Coeff.**	**S.E.**	**t**	**Coeff.**	**S.E.**	**t**	**Coeff.**	**S.E.**	**t**
1994	0.095	0.211	0.450	0.057	0.226	0.250	0.104	0.358	0.290
1995	0.229	0.213	1.070	0.039	0.226	0.170	0.448	0.361	1.240
1996	0.063	0.206	0.310	0.133	0.221	0.600	0.022	0.339	0.060
1997	-0.058	0.205	-0.280	0.323	0.220	1.470	-0.180	0.343	-0.530
1998	-0.051	0.205	-0.250	0.283	0.220	1.290	-0.041	0.339	-0.120
1999	0.051	0.205	0.250	0.111	0.219	0.510	-0.103	0.338	-0.310
Provider Restrictions (Year minus Year of Law Change)									
-2	-0.015	0.117	-0.130	0.112	0.125	0.890	0.184	0.186	0.990
-1	0.097	0.114	0.850	-0.147	0.122	-1.200	-0.026	0.183	-0.140
0	-0.107	0.119	-0.900	0.075	0.128	0.590	-0.087	0.181	-0.480
1	-0.107	0.121	-0.880	0.139	0.128	1.090	-0.072	0.182	-0.400
2	-0.035	0.118	-0.300	0.148	0.125	1.180	-0.109	0.178	-0.610
>=3	-0.268	0.086	-3.100	0.015	0.092	0.160	-0.264	0.136	-1.940
Anti-Fraud Initiatives (Year minus Year of Law Change)									
-2	-0.015	0.074	-0.200	-0.057	0.080	-0.720	0.033	0.120	0.270
-1	0.071	0.069	1.030	0.028	0.074	0.380	0.124	0.114	1.080
0	0.066	0.076	0.870	-0.151	0.080	-1.880	0.170	0.124	1.360
1	-0.015	0.077	-0.190	-0.082	0.081	-1.010	0.052	0.122	0.420
2	-0.053	0.077	-0.680	-0.167	0.081	-2.060	-0.042	0.120	-0.350
>=3	-0.066	0.058	-1.140	-0.218	0.061	-3.570	0.254	0.092	2.760

Table 4A: Effects on Injury Rates in Manufacturing Firms (continued)

	DFW			NLW			RWD		
Variables	**Coeff.**	**S.E.**	**t**	**Coeff.**	**S.E.**	**t**	**Coeff.**	**S.E.**	**t**
Compensability Restrictions (Year minus Year of Law Change)									
-2	-0.090	0.098	-0.920	-0.175	0.104	-1.680	-0.081	0.155	-0.530
-1	-0.112	0.097	-1.160	-0.023	0.102	-0.220	-0.325	0.153	-2.130
0	-0.247	0.101	-2.440	-0.301	0.107	-2.810	-0.273	0.159	-1.720
1	-0.093	0.101	-0.920	-0.431	0.106	-4.080	-0.158	0.154	-1.020
2	-0.183	0.098	-1.870	-0.295	0.104	-2.820	0.078	0.149	0.530
>=3	-0.018	0.072	-0.250	-0.338	0.076	-4.450	-0.212	0.114	-1.860

[1] See Footnote 1 in Table 2A.

Table 4B: Effects on Injury Rates in Services Industry

Variables	DFW Coeff.	DFW S.E.	DFW t	NLW Coeff.	NLW S.E.	NLW t	RWD Coeff.	RWD S.E.	RWD t
Reasonable Accommodation Effects ($-\beta_{2t}$)									
1988	0.081	0.073	1.110	0.216	0.156	1.380	0.238	0.286	0.830
1989	0.083	0.073	1.140	0.109	0.155	0.700	0.221	0.270	0.820
1990	0.176	0.074	2.400	0.185	0.155	1.200	0.041	0.271	0.150
1991	0.091	0.074	1.230	0.318	0.156	2.040	0.294	0.264	1.110
1992	0.080	0.074	1.080	0.325	0.156	2.080	0.176	0.261	0.670
1993	0.082	0.074	1.100	0.299	0.156	1.910	0.212	0.256	0.830
1994	0.130	0.075	1.740	0.260	0.157	1.650	0.348	0.256	1.360
1995	0.103	0.075	1.370	0.268	0.159	1.690	0.408	0.255	1.600
1996	0.130	0.075	1.750	0.214	0.157	1.360	0.380	0.250	1.520
1997	0.195	0.075	2.610	0.184	0.157	1.170	0.351	0.251	1.400
1998	0.219	0.075	2.930	0.039	0.157	0.250	0.424	0.250	1.690
1999	0.167	0.075	2.240	0.024	0.157	0.150	0.439	0.249	1.760
Firing Cost Effects (β_{3t})									
1988	-0.338	0.203	-1.660	-0.601	0.488	-1.230	0.570	0.821	0.690
1989	-0.015	0.203	-0.070	-0.978	0.475	-2.060	0.334	0.830	0.400
1990	-0.448	0.203	-2.200	-1.107	0.491	-2.250	2.052	1.097	1.870
1991	-0.169	0.207	-0.810	-1.511	0.498	-3.040	0.449	0.925	0.480

			0			0			
			-			-			
		0.20	1.05		0.49	2.15		0.89	0.64
1992	-0.219	8	0	-1.065	5	0	0.574	8	0
			-			-			
		0.20	0.69		0.48	2.89		0.86	0.83
1993	-0.143	9	0	-1.402	5	0	0.713	2	0

Table 4B: Effects on Injury Rates in Services Industry (continued)

	DFW			NLW			RWD		
Variables	**Coeff.**	**S.E.**	**t**	**Coeff.**	**S.E.**	**t**	**Coeff.**	**S.E.**	**t**
1994	0.063	0.208	0.300	-0.788	0.474	-1.660	-0.169	0.834	-0.200
1995	0.214	0.208	1.030	-0.974	0.475	-2.050	0.699	0.774	0.900
1996	0.140	0.206	0.680	-0.483	0.479	-1.010	0.618	0.776	0.800
1997	0.255	0.205	1.240	-0.103	0.470	-0.220	0.230	0.768	0.300
1998	-0.019	0.206	-0.090	-0.558	0.471	-1.180	-0.324	0.779	-0.420
1999	0.030	0.205	0.150	-0.368	0.470	-0.780	-0.331	0.761	-0.430
Provider Restrictions (Year minus Year of Law Change)									
-2	0.090	0.072	1.240	-0.051	0.149	-0.340	-0.001	0.219	0.000
-1	-0.004	0.072	-0.050	-0.213	0.150	-1.420	-0.389	0.242	-1.610
0	0.039	0.073	0.530	0.005	0.154	0.030	0.258	0.217	1.190
1	0.179	0.074	2.440	0.081	0.150	0.540	0.296	0.218	1.350
2	0.070	0.065	1.080	0.120	0.134	0.900	0.154	0.207	0.740
>=3	-0.107	0.057	-1.880	0.272	0.118	2.310	0.404	0.166	2.430
Anti-Fraud Initiatives (Year minus Year of Law Change)									
-2	0.065	0.057	1.130	0.054	0.119	0.450	0.303	0.162	1.870
-1	0.029	0.045	0.650	0.041	0.093	0.440	0.138	0.147	0.940
0	-0.020	0.058	-0.350	-0.019	0.118	-0.160	0.191	0.152	1.260
1	0.099	0.058	1.710	-0.045	0.123	-0.360	0.191	0.156	1.220
2	0.058	0.058	0.990	0.001	0.120	0.000	0.101	0.152	0.660
>=3	0.088	0.040	2.190	0.098	0.084	1.170	0.202	0.117	1.720

Table 4B: Effects on Injury Rates in Services Industry (continued)

	DFW			NLW			RWD		
Variables	**Coeff.**	**S.E.**	**t**	**Coeff.**	**S.E.**	**t**	**Coeff.**	**S.E.**	**t**
Compensability Restrictions (Year minus Year of Law Change)									
-2	-0.072	0.063	-1.140	0.045	0.131	0.340	-0.182	0.172	-1.050
-1	-0.025	0.060	-0.420	0.115	0.124	0.920	-0.044	0.170	-0.260
0	-0.124	0.063	-1.960	-0.018	0.131	-0.130	-0.204	0.168	-1.210
1	-0.306	0.064	-4.800	-0.001	0.131	-0.010	-0.167	0.171	-0.980
2	-0.252	0.063	-3.990	0.043	0.129	0.330	-0.270	0.164	-1.650
>=3	-0.280	0.045	-6.210	-0.029	0.093	-0.310	-0.117	0.132	-0.880

[1] See Footnote 1 in Table 2A.

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APPENDIX

Does Safety Training Reduce Work Injury?

DOES SAFETY TRAINING REDUCE WORK INJURY?

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access to Bureau of Labor Statistics (BLS) data on-site at the BLS. The views expressed here are those of the authors and do not necessarily reflect the views of the BLS. This research was supported by grant R01 OH03750 from the National Institute for Occupational Safety and Health of the Centers for Disease Control and Prevention.

ABSTRACT

We use establishment-level data to provide a rare look at the effect of training, benefit packages, and workplace practices on occupational injury rates. Our results suggest that safety training increases the reporting of injuries but also has real safety effects on days-away injuries, especially in smaller firms. While overexertion injuries were resistant to safety training, toxic exposure events were reduced in manufacturing establishments with a formal safety training program. Wellness programs and EAPs were associated with lower injury rates in large firms where they are more common. Workplace innovations like total quality management significantly increase the reporting of injuries.

Occupational injuries affect workers, employers and society at large through their impact on medical costs, workplace productivity and pain and suffering associated with injuries. For employers, workplace injuries create disruptions in the work cycle, and in some cases, may call for hiring replacement workers. To achieve productivity goals with a minimum of injuries, employers frequently train workers in the proper and safe use of equipment, invest in ergonomic equipment, and experiment with a variety of work practices designed to reduce injuries. In this paper, we examine the effects of formal safety training programs on workplace injury, focusing on the costliest injuries with days away from work.

The Occupational Safety and Health Administration (OSHA) strongly promotes safety and health training as an essential component of employers' efforts to provide a safe workplace. Hundreds of requirements for safety and health training are found in occupational safety and health standards promulgated by OSHA (Cohen and Colligan 1998). OSHA also limits certain jobs to persons receiving specialized training. In addition to OSHA requirements, firms receive worker's compensation premium discounts for their efforts in injury prevention including safety initiatives.

Safety training can be given via a highly structured formal training program or through more informal ways of providing workers with job-related skills. A survey by the Bureau of Labor Statistics (BLS) indicates that US employers spend a considerable amount of time and resources on both formal and informal training including safety training. For example, establishments with 50 or more employees paid $7.7 billion to in-house training staff and $5.5 billion to outside trainers in 1994, $139 and $98 per employee respectively (Frazis et al. 1998). Workers spend roughly 4% of their work

hours in some kind of training resulting in additional wage costs. Safety and health training accounts for a quarter of the total hours spent in formal training.

BACKGROUND AND RELATED LITERATURE

OSHA training requirements are specific to different hazards and therefore vary widely in their instructions about content, frequency and duration, documentation of training, trainer qualifications, and training methods. The most explicit training requirements are found in the Hazardous Waste Operations and Emergency Response standards and the OSHA adoption of the EPA asbestos abatement work rule (Cohen and Colligan 1998). In most workplaces, OS&H training is likely to be a natural part of job skills training. In occupations such as logging, for example, "poor technique" is widely reported as a cause of injury resulting from inadequate training and a failure to learn the proper work methods.

The bulk of training activities involve fundamentals programs that instruct workers to avoid known hazards through the proper use and maintenance of equipment and materials. However, training can also be proactive, teaching workers to recognize and head off potential problems through teamwork, via union or management efforts, and encouraging workers and supervisors to be jointly accountable for injury control.

A large-scale review of the literature on safety and health training interventions to reduce work-related injury and disease was undertaken by NIOSH in 1998 (Cohen and Colligan 1998). Most safety training interventions were undertaken in response to site-specific hazards and involved small non-random samples of workers. While most training interventions studied did not address OSHA training requirements per se, the review provided support for training as an important part of a firm's hazard control activities.

The extent to which safety training can be transferred to actual jobsite demands, and the employer's commitment to promote training as well as improve post-training productivity and injury outcomes can affect the success of training efforts. These factors can also complicate attempts to evaluate the effects of safety training separately from other workplace factors. Training effects may be easier to detect in more immediate indicators of an establishment's injury record like changes in toxic exposure levels or increased compliance with safe work practices than in effects on ultimate measures of workplace injury. Thus, most studies examine outcomes like worker knowledge and safe behavior rather than direct measures of injury.

Some studies have found training to be ineffective in reducing work-related disabilities (Tan et al. 1991; Heath 1981). Linnemann et al. (1991) studied three intervention efforts directed at reducing needle-stick injuries for 3,100 nurses in a university hospital. Pre- and post measures of injuries showed a rise in needle-sticks from 51 cases per 1000 employees to 67 cases possibly due to increased reporting.

On the other hand, hazardous waste site workers and emergency responders reported a better ability to handle chemical spills after taking the required OSHA training (McQuiston et al. 1994). Hunt et al. (1993) studied 220 Michigan establishments and found that a 10% higher self-reported level of safety training was associated with a 6.5% lower incidence of lost workday cases. Habeck et al. (1988) in their pilot study of Michigan firms showed that firms with low workers' compensation claim rates engaged in safety and prevention activities more frequently.

Saari and Nasanen (1989) find that training directed at problematic housekeeping conditions at a shipyard (32 workers) accounted for only 25% of the large reduction in

injury rate that followed. The authors speculate that the improved housekeeping allowed workers to notice other potential hazards as well. Sulzer-Azaroff et al. (1990) conducted a pre-post evaluation of training for 225 employees in three high-injury departments of a telecommunications manufacturer. Training resulted in a decline in OSHA-recordable injuries in two of the three departments, and a decrease in lost-time cases in all three with an estimated savings of $55,000.

Most of these studies do not account for whether those who provide safety training are more safety conscious to begin with. The provision of safety training is not likely to be randomly distributed among firms. For example, "good actors" may provide safety training but may also have other establishment-wide policies in place that reduce injury rates. Such a scenario would lead to a biased estimate of training effects.

This paper measures the effect of formal occupational safety and health training on days-away-from-work injuries using matched establishment data from two BLS surveys, one on occupational injuries and the other on employer provided training. The latter survey is rich in detail about both training and establishment practices like workplace innovations and employee benefits that could affect injury rates and may also be associated with a greater concern for health and safety. Thus, we expect that our data will help to control for endogeneity in the provision of safety training, resulting in a cleaner estimate of safety effects.

Besides analyzing injury rates, we examine whether safety training reduces the per worker average cost of days-away-from-work injuries. We analyze the distribution of days away from work to check whether safety training has a differential effect on injuries of varying severity. We also examine the event underlying the injury (e.g. falls, exertion)

to determine if safety training is more effective in preventing certain types of injuries. We expect events such as exposures to toxic hazards that are specifically targeted by OSHA training requirements to be responsive to safety training. Section II describes the data used, followed by the estimating framework in Section III and results in Section IV.

DATA

We examine the effects of safety training on injury outcomes using a unique dataset created by matching BLS data on training and injury at the establishment level. For training information, we use the 1993 BLS Survey on Employer-Provided Training (SEPT) which gathered information on the existence of formal training programs provided or financed by a sample of private non-agricultural establishments (see Frazis et al. 1995, for discussion of the SEPT93). Surveys were mailed to approximately 12,000 establishments and viable data were received from 7,895 establishments, a response rate of 71%. The SEPT questioned establishments about the provision of workplace orientation, safety and health training, formal apprenticeship programs, basic skills training including language skills, and job skills training.

In addition to formal training data, the SEPT93 questioned establishments about their use of flexible workplace practices like worker teams, total quality management, quality circles, job rotations, and just-in-time inventories. Establishments were also asked about the provision of employee benefits including health insurance, employee assistance programs, and wellness programs. The data includes information on the number of employees: (1) on payroll in 1993, (2) covered by a collective bargaining agreement, (3) who had worked less than a year, or (4) were working part-time. This allows us to calculate the percentage of new workers, the percentage of part-time workers and the

percentage unionized. While our main focus is on training effects, these other establishment characteristics are also likely to affect the workplace injury record.

We match the training data to summary data on the injury and illness records of establishments using the 1993 Annual Survey of Occupational Injuries and Illnesses (SOII, BLS 1996) collected by the BLS. The SOII is a federal/state program that has collected occupational injury and illness data on an annual basis since 1972, from logs that employers maintain according to Occupational Safety and Health Administration (OSHA) guidelines. In 1993, employer reports of worker injuries were collected from about 250,000 private industry establishments. The establishments reported on the numbers of injuries and illnesses of various types (without lost work, with only restricted-work days, or with days away from work) that occurred during the year. They also report on the total annual hours worked by all employees, the annual average number of employees and the establishment's industry. (In the rest of the paper, we refer to injury and illness cases as "injuries" and days-away-from-work cases as "days-away cases" for the sake of brevity.)

Starting in 1992, the summary reports of injuries were supplemented by microdata on cases with days away from work. Those establishments expected to have large numbers of these cases were instructed to sample them while those with 20 or fewer cases reported information on the age, race, gender, tenure, and occupation of each worker with a days-away-from-work injury. In addition, data on the nature, event and source of injury was collected along with an estimate of the number of days away from work involved in each case. In 1993, the SOII microdata consisted of 603,936 cases with one or more days away from work. Approximately 475,000 of these cases were used to

estimate the mean days away from work and associated wage, medical, and pain and suffering costs associated with each reported injury (see Leigh et al 2004 for a discussion on the costs of occupational injuries). In 1993, there were 2.25 million such injuries estimated to cost approximately $80 billion (Leigh et al. 2004). A weighted average of these costs was calculated by establishment and then merged with the summary data. The weighted frequency of different injury events and the number of cases in five severity categories were also calculated from the microdata and merged with the summary data.

Matching the SOII to the SEPT93 resulted in a final sample of 2,358 establishments with data on training and human resource practices combined with injury counts, costs, event, and severity data. The matched sample has a larger proportion of large firms than the original surveys since large firms tended to appear in both surveys with higher probability than smaller firms do. Establishment weights were calculated for the matched data based on the initial SEPT weights.[1]

Table 1 shows that our merged data with rescaled weights has a somewhat higher provision of safety training (39%) than the original weighted SEPT survey (32%). Of the other types of formal training surveyed – workplace, orientation, basic skills training in English and mathematics, apprenticeship, safety, and job skills training – formal job skills training was most prevalent with 62% of establishments offering training in managerial, technical, sales, computer, cleaning, or production-related skills. This was followed by workplace training (48%), formal orientation programs (42%), formal apprenticeships (24%), and basic skills training (2%).

Insert Table 1 about here

[1] Weighted frequencies in 40 industry-firmsize cells from the matched data were scaled up to match the corresponding frequencies in the original SEPT data.

The provision of formal safety training varies across industries and establishments of different sizes.[2] Safety training is barely offered among establishments in the finance, insurance and real estate sectors, but is much more prevalent in mining, construction, manufacturing, and transportation and utilities industries.[3] This pattern is not surprising since we would expect that jobs in these industries are riskier and require more attention to safety.

The larger the establishment, the more likely it was to offer training – only 35% of establishments with fewer than 50 employees provide safety training compared with 91% of the largest establishments with more than 1000 employees. Larger firms may have a greater incentive to provide safety training to prevent occupational injuries because of the experience rating system. Under this system, large firms' premiums track their own injury records more closely than in small firms where premiums depend more on the average injury experience of their industry.

Establishments providing safety training had a higher proportion of employees covered by union contracts, and fewer part-time or new workers. Establishments with a high level of union involvement may be more sensitive to safety and training considerations. New and inexperienced workers, especially those with under a year of service, have higher injury rates and may require more attention to safety training. However, the incentive to provide general safety training will also be lower for workers with looser ties to the establishment.

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[2] The agricultural establishments in Table 1 are in the agricultural services sector, primarily landscaping.
[3] Over half of mining establishments offer formal safety training in our merged data, a similar percentage as in the original SEPT. However, we expected a much higher percentage in the mining industry which is subject to some of the more stringent safety and health regulations in the workplace. One possible explanation may be that training is offered in informal, on-the-job ways not captured by our variable or by the union rather than the employer.

As Gittleman et al. (1998) show, adoption of flexible workplace practices and formal training practices tend to go together. Flexible workplace strategies like worker teams, and total quality management were adopted at a higher rate in firms with a formal safety training program than without, as were production practices like just-in-time inventory controls. These have created a production process that can adjust more rapidly to fluctuations in demand or respond to troublespots in the production process. Establishments with workplace innovations that require more decision-making from individual workers may find it in their interests to provide these workers with all the tools needed to perform well. Many safety training programs encourage workers to reduce hazards through education of co-workers and supervisors, an approach consistent with the "total quality management" philosophy where workers and supervisors are jointly responsible for addressing safety needs.

Establishments with safety training provide benefits like health care, employee assistance programs, and wellness programs at a higher rate than those without safety training. This is not surprising given the correlation between benefits and firm size. In addition, benefits like EAPs and wellness programs may be seen as part of a disability management strategy that seeks not only to prevent injuries but also to minimize the disruptions arising from injuries (Hunt and Habeck 1993).

Table 1 shows that days-away cases are a bigger problem for establishments with safety training than without. The rate of days-away injuries in our matched sample is 1.2 per 100 full-time equivalents (FTEs) for establishments without a formal safety program,

versus 2.1 cases per 100 FTEs for establishments with one.[4] Days-away cases also appear more severe in establishments with safety training, costing $29,000 per case compared with $18,000 per case in establishments without safety training. Our data suggest that firms may employ safety training in a bid to improve their injury records.

ESTIMATING FRAMEWORK

Since 15% of our sample reports a zero days-away injury rate, we estimate the following two-part model of injury rates.

$$y_{1i}^{*} = X\beta_{1i} + u_{1i}$$
$$y_1 = 1 \quad if \quad y_{1i}^{*} >= 0$$
$$y_1 = 0 \quad if \quad y_{1i}^{*} < 0$$
$$y_{2i} = X\beta_{2i} + u_{2i} \quad when \quad y_1 = 1$$

In the first stage, we analyze y_1, a dummy for the positive reporting of days-away injuries, with a univariate probit. In the second stage, we estimate an OLS regression for those establishments with injuries using y_2, the log of the days-away injury rate as the dependent variable. Thus, the model allows the process underlying the reporting of injuries to be different between establishments with no injuries and those with a positive number of days-away injuries.[5]

The coefficient on safety training in a simple regression of the injury rate on establishment characteristics may not reflect the causal effect of safety training. Rather, an establishment decision to provide training may be indicative of other observable and unobservable factors which themselves may affect the injury rate. For example, Habeck

[4] The overall mean days-away rate is 1.6 per 100 FTEs, lower than the 2.9 rate reported by the BLS for 1993 (BLS 1996). This difference is not surprising since our weights were rescaled to match the industry-size composition of the SEPT survey rather than the injury survey.

[5] While the data could also be analysed using a tobit, the two-part model has the advantage of allowing the covariates to have different effects in the two stages of estimation. Manning et al. (1987) use Monte Carlo simulations to show that the two-part model which ignores the correlation between the two stages dominates a model that accounts for the correlation.

et al. (1988) found that firms with an open managerial style and a corporate culture with an "obvious human resource orientation" had lower claim rates than average. Failing to control for these other policies can result in an upward biased estimate of the extent to which safety training reduces injury rates. Conversely, those firms with hazardous jobs and high rates of injury may also be more inclined to offer training as a remedial practice, resulting in a positive relationship between training and injury rates in a simple regression.

We use an instrumental variables approach to control for the potential endogeneity of safety training. Specifically, we write the model as

$$z_i^* = T_i\gamma + v_i$$
$$z_i = 1 \quad if \quad z_i^* >= 0$$
$$z_i = 0 \quad otherwise$$
$$\ln y_i = X_i\beta + \alpha z_i + w_i$$

In the above model, z_i represents the provision of safety training, and y_i is the days-away rate. We estimate the coefficient on safety training using a two-stage procedure – in the first stage we predict safety training using a univariate probit and use the predicted value as an instrument in the second-stage injury equation. Identification of the model depends on locating elements in T_i that affect the provision of safety training but are uncorrelated with the injury rate. We use the provision of formal orientation programs to identify the model. Our IV model purges the training coefficient of any unobserved correlation between the process generating injuries and the decision to provide safety training and thus, should provide cleaner estimates of the causal effect of safety training on the rate of days-away injuries.[6]

[6] All analyses were run using STATA software.

We examine the relationship between safety training and the probability of cases in five categories of days away from work (1–3, 4–6, 7–20, 20–60, and greater than 60 days) using grouped ordered logits. We use two-part models to analyze the rate of different underlying injury events (contact, falls, exertion, transportation, exposure, assaults and explosions, and other events) in establishments with and without formal safety training programs. Our results will provide more detail on the kinds of days-away injuries (shorter versus longer duration injuries, or falls versus overexertion) that may be most responsive to safety training programs.

EXPLANATORY FACTORS

Safety training and the rate of days-away cases depend on the characteristics of the establishment workforce, the injury record of the industry, and workplace characteristics like innovativeness and generosity of employee benefits.

Establishment Workforce

We control for establishment size, the percentage of new workers, part-time workers, and workers covered by a union contract in both training and injury equations. Prior research suggests an inverted-U relationship between firm size and injury rates (Ruser 1985), a pattern that is repeated in our data. We merge information on the occupational composition of the 3-digit industry to which the establishment belongs and the earnings of production workers in the industry to further control for variation in injury rates that may be attributed to workforce composition.[7]

[7] These data are from the 1992–1994 Occupational Employment Surveys of the BLS. The percentage of workers in seven major occupational groups was calculated at the most detailed industry level possible and then merged with the matched SEPT-SOII data.

In the injury equation, we include the rate of days-away-from-work cases at the three-digit industry level to control for the variation in riskiness of work across establishments. For both injury and training equations, we control for whether restricted work was used at all, shifting injured workers from the days-away category to the restricted-work-only category (see Ruser 1999, for a discussion of the expanded use of restricted work in the 1990s).[8] We include two-digit industry dummies where possible to further control for unobserved differences across industries.

Employee Benefits

Establishments providing health insurance, sick leave and related benefits may be more attuned to their workers' health and safety concerns. Workers in establishments that provide paid leave for sickness or personal reasons may be less inclined to use the workers' compensation system which requires a waiting period before qualifying for partial income replacement. Finally, EAPs and wellness programs may improve safety by reducing workplace substance use and encouraging a healthful lifestyle. In Washington state, workers' compensation premia are discounted if firms put an injury prevention plan into place that includes EAPs. While a survey of 50 companies credited EAPs with a 17% reduction in occupational injury, no large-scale research exists on this topic (see Blum and Roman 1995, for a review of EAP evaluations). In the training and injury equations, we control separately for different benefits like flexible work schedules, health insurance, paid leave, EAP programs and wellness programs, since we are interested in their individual effects on the injury rate and the provision of safety training.

[8] Prior research suggests that firms may use restricted work offerings to reduce days away from work, especially for hard-to-observe injuries (Waehrer and Miller 2003). Such firms may also be more committed to preventing injuries through the provision of safety training.

Innovative Workplace

Critics of innovative work practices charge that they have reduced worker autonomy on the shop floor and endangered worker safety and health by speeding up the production process (e.g. Parker 1985). Brenner et al. (2004) show that quality circles and just-in-time production in particular, have a sizeable, positive and statistically significant effect on the rate of cumulative trauma disorders including carpal tunnel syndrome. We use dummy variables to control for the use of just-in-time inventories and innovative work practices like worker teams, TQM, quality circles, employee involvement, and job rotation in both the safety and injury equations.

State OSHA Plans , Workers' Compensation

As of 1993, twenty states had obtained federal approval to operate their own occupational safety and health programs (SOSHA) rather than remain under the Federal Occupational Safety and Health Administration.[9] According to Finkin et al. (2002) state plans employ more compliance officers and undertake more inspections than the federal plan but also impose lower fines for violations. While the majority of SOSHA programs are similar to the federal program, five states (California, Hawaii, Michigan, Oregon, and Washington) have different, generally tougher requirements.

In addition to the state safety and health programs, we include the state waiting period to qualify for workers' compensation and the average income replacement rate faced by a firm to control for any incentive effects on the days-away rate.

[9] Under the OSHA Act of 1970, states are encouraged to develop their own safety and health plans containing necessary elements for worker protection. Once the federal OSHA has determined the state plan has the necessary elements and will give workers protection "at least as effective" as that provided by the federal government, it will certify a state plan give it final approval. Final approval results in an infusion of federal funds to cover up to half the costs of the state OSHA plan. We exclude NY, NJ, CT from the state OSHA group because their state plans only cover public employees.

Other Formal Training

The data include information on five distinct types of formal training provided besides safety training – workplace training, formal orientation, basic skills training in English or math, apprenticeships, and formal job skills training. Teaching basic language skills or training a worker in production-related skills such as how to operate or repair machinery can have positive safety consequences over and above their immediate effects on worker productivity. Likewise, formal training in workplace practices (equal opportunity, environmental, or collective bargaining provisions; policies on sexual harassment and diversity; how to work in groups; time management, leadership; communication skills) may also affect the reported injury rate by informing workers about the remedies available to them in the event of a workplace injury. The motivations for providing formal job skills training also are included to explain both safety training and the injury rate. The requirement of bargaining contracts, having workers lacking in skill or needing special skills, upgrading or introducing new technology, or providing training to meet legal requirements are all possible motivations.

In contrast, formal orientation training defined as providing "information on personnel and workplace practices and overall company policies" may be reasonably expected to have no effect on injuries. However, establishments that conduct orientation programs may also have the training facilities needed to provide formal safety and health training. In our IV models, we restrict formal orientation to affect only the safety training decision and not injury outcomes, helping to identify the injury equation. We test the validity of this restriction in our models.

RESULTS

Tables 2–7 present estimates of safety training effects on the injury outcomes. Models are estimated for the full sample and by establishment size (less than or greater than 250 workers). We analyze four dependent variables – the log of the rate of days-away-from-work cases per 10,000 full-time employees (FTEs); the logged total cost of days-away cases per 10,000 FTEs; the probability of cases in five categories of days away from work; and the probability of different underlying injury events.[10] The latter two variables are analyzed using grouped ordered logits and two-part models respectively.[11]

The Rate of Days-Away-from Work Injuries

Table 2 reports the estimated difference in the mean rate of days-away injuries for the average establishment in the full sample and by size class using coefficients from the two-part model. [12] Controlling for other characteristics, establishments with safety training have approximately 27 more days-away cases per 10,000 FTEs than those with no training, a statistically significant difference. Since the mean rate of days-away cases (per 10,000 FTEs) is 160 for all establishments, this amounts to a 17% higher rate for the establishment with safety training.

Insert Table 2 about here

[10] The median number of days away from work in BLS data is 6 days (BLS 1993).
[11] Robust standard errors allow for clustering of observations within 40 industry-size groups.
[12] The marginal effect of a change in the variable of interest on the mean injury rate I is evaluated at the sample mean $\bar{x}$ and calculated as

$$\frac{dI}{dX_j} = \left(\Delta F(X\beta_1) + \beta_{2j} F(X\beta_1)\right) \cdot \exp\left(X\beta_2 + \frac{\sigma^2}{2}\right)$$ where B_1 and B_2 are the coefficients from the first and second stages of the two-part model and j indexes the variables. For dummy variables, $\Delta F(X\beta_1)$ is calculated as the discrete change in the standard normal distribution function as the variable changes from 0 to 1, holding the other variables at their means. For continuous variables, $\Delta F(X\beta_1)$ is calculated as the derivative of the standard normal distribution function with respect to the variable X_j. Standard errors are calculated using the delta method (Goldberger 1991).

The result is similar when we consider establishments separately by size - those with safety training have a 13% and 43% higher rate of days-away injuries respectively for the average small and large establishment, and the relationships are statistically significant. Similarly, training correlated with a higher mean days-away rate for the average establishment in the manufacturing and construction industries (industry results can be requested from the authors).

It seems unreasonable that safety and health training would cause an increase in the injury rate. Instead, we interpret these results as an indication of either a greater incentive for firms with costly days-away injuries to adopt palliative safety training programs or a greater tendency to report injuries in establishments with formal safety training programs. The reporting effects of workplace innovations on injury rates were previously noticed by Brenner et al. (2004) in their study of cumulative trauma disorders. To distinguish between these competing explanations, we examine the coefficients from the two-part model in Table 3.

Insert Table 3 about here

Formal safety training is positively and significantly associated with a higher probability of a positive number of days-away injuries but also is associated with a significant 24% reduction in the injury rate for the subset of establishments with injuries according to column (1) of Table 3.[13] The results are similar when we examine small firms separately in column (2). Conversely, safety training significantly reduces the probability of days-away injuries in large establishments but is positively and significantly associated with the rate of injury for large establishments with days-away cases.

[13] The percentage change in injury rates in the second-stage of the two-part model is calculated as e^{β}-1.

Underreporting of days-away injuries may be a bigger problem for those firms reporting no cases at all than among those firms already reporting a positive number. If safety training increases the reporting of injuries then we expect this effect to be stronger in the first stage of the two-part model rather than the second stage. This occurs in our model for both the full sample and for small establishments - safety training is positively related to the probability of a non-zero number of days-away cases while reducing the days-away rate for those establishments already reporting these cases.[14]

These results suggest that the increase in the mean rate of days-away cases for establishments with safety training is consistent with a reporting effect especially in smaller establishments. However, these reporting effects are not present for large establishments whose safety training appears to be a response to a poor injury record. It is also possible that small firms that have formal safety training programs are generally more careful in other unobservable ways resulting in a lower injury rate. We examine this potential endogeneity of safety training below.

Endogenous Safety Training

Table 4 reports IV estimates that are purged of any unobserved correlation between safety training and the days-away rate. The data are restricted to establishments reporting a positive days-away rate. As stated earlier, the model is identified using the difference across establishments in the provision of formal orientation training, which is restricted to affect only the provision of safety training and not the injury rate.[15]

Insert Table 4 about here

[14] Two-part coefficients by industry reveal a similar story.
[15] We tested our identifying assumption by including orientation training in a regression of logged rate on predicted safety training and the other covariates. Orientation training has an insignificant effect on the logged days-away rate.

The estimated safety effects are slightly larger than the two-part coefficients for the full sample and for smaller establishments. We tested for the exogeneity of safety training using an augmented regression (Davidson and Mackinnon 1993). We cannot reject the hypothesis that safety training is exogenous in the models for the full sample and for the smaller size category (p=0.72, and 0.98 respectively). The wide range of establishment variables that are available in our data appear to help control for underlying characteristics that influence both the provision of training and the injury rate.[16] On the other hand, for large establishments, the IV model suggests that there are no real training effects and we should treat safety training as endogenous (p=0.16). The IV results for large firms indicate an upward bias in the two-part coefficient on safety training.

The results support our conjecture that the estimated higher mean injury rate reported in Table 2 for small firms with formal safety training is due more to a positive reporting effect of safety training than due to any remedial safety actions by establishments with poorer injury records. In fact, to the extent that there are remedial actions among small firms, our coefficient on formal safety training would be a conservative estimate of training effects on days-away cases. The reporting effects of safety training are not unexpected given that many safety programs also have a strong reporting component to facilitate treatment for injuries. For example, an intervention to prevent needle stick injuries also encouraged reporting and follow-up laboratory work to test for HIV (Linneman et al. 1991).

[16] The exogeneity test for safety training yielded a much smaller p-value of 0.21 for a sparse model that excluded other training, workplace innovation, and benefit. A sparse IV model of logged days-away rates implied a 42% lower reported injury rate due to safety training. (Results can be obtained from authors upon request).

Table 4 also provides information about those establishment characteristics that are consistent with a formal safety training program. Worker teams were negatively associated with formal safety programs while job rotation was positively related. Total quality management was insignificantly related to safety training.[17]

State-run safety and health plans increased the probability of safety training in small firms but in states where the OSH program differed from the federal program, the probability of formal safety and health training was lower. For large firms, state OSH plans had positive but statistically insignificant effects on safety and health training.

The provision of orientation training was a strong predictor of a formal safety training program. Establishments offering other types of formal training like basic skills training, or workplace training were also significantly more likely to provide formal safety training. Controlling for other training, benefit provisions were generally unrelated to safety training. The existence of an EAP program did not significantly alter the provision of safety and health training.

Finally, among results not reported in the tables, a longer state waiting period decreases the probability of safety training in small firms suggesting that safety training may be a response to compensation costs. The average replacement rate facing the firm is negatively related to safety training, possibly reflecting workforce composition.[18] The average industry days-away rate strongly increases (decreases) the probability of safety training in large (small) firms. Controlling for riskiness of work, workers' compensation variables have no significant effect on training in large firms.

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[17] Since innovative work practices are likely to be put in place as a group, we also experimented with using the number of workplace innovations in our models. These surprisingly, were negatively associated with formal safety training while the number of benefits were positively related to training.

[18] Since weekly income replacement is capped, low wage workers have higher replacement rates but may also be less likely to receive formal training.

Cost of Injuries

To assess the injury cost differential associated with safety training programs, we report safety coefficients from simple OLS models of logged total costs of days-away injuries per 10,000 FTEs in Table 5. Safety training is associated with a statistically insignificant reduction in total days-away costs per employee, both for the full sample (-5%) and for smaller establishments. For larger establishments with more than 500 employees, safety training is associated with a significant 68% increase in the costs per employee suggesting again that establishments with a greater number and severity of days-away injuries tend to adopt such programs.[19]

Insert Table 5 about here

Severity of Injuries

To further analyze safety effects on the severity of injuries we model the distribution of injury durations using grouped ordered logits in Table 6a. The results show that for the full sample and larger establishments, a formal safety training program increases (reduces) the likelihood of the least (most) severe injuries with between 1 and 3 (over 60) days away from work. The increased reporting of days-away cases in small establishments should especially affect short-duration cases that may otherwise have gone unreported in the absence of formal training. However, the opposite result holds with training positively related to severity in small firms though the coefficient is statistically insignificant.

Insert Table 6a about here

A more straightforward look at the effect of safety training on the probability of injuries of different durations can be seen from Table 6b where we predict the probability

[19] We also estimated IV models with qualitatively similar results (available upon request).

of each severity category with and without safety training, holding all other variables constant. For larger establishments, formal safety training is associated with a significantly increased probability of shorter duration injuries with fewer than 6 days away while reducing the probability of injuries with 7 or more days away from work. The results for small firms are reversed and safety training does not seem to have a significant relationship with injury severity.

Insert Table 6b about here

Injury Events

We examine the responsiveness of different injury events to safety training using two-part models of the event rate per 10K FTEs. Establishments with safety training have a significantly lower rate of contact injuries and falls where these occur. However, safety training is associated with a higher probability of overexertion injuries.[20] The resistance of overexertion injuries to safety training is not surprising given the complexity of back disorders. As Carlton (1987) shows, even when workers are trained in proper ergonomic techniques, these may not be readily implemented due to other considerations like the worksite layout.

Workers in different industries are not equally exposed to different injury events – for example, the majority of injuries resulting from toxic exposure to chemicals occur in manufacturing.[21] We re-examined the distribution of injury events after restricting the data to manufacturing establishments. Manufacturing establishments with safety training

[20] Contact injuries include being struck or compressed by objects or equipment or being crushed in collapsing materials (e.g. trench cave-in).
[21] The majority of exposure injuries are exposures to caustic, noxious, or allergenic substances (primarily chemicals).

have a significantly lower rate of injuries resulting from toxic exposure, a gratifying result since such incidents are the explicit target of many OSHA training requirements.

Insert Table 7 about here

Other Results

Table 2 presents the relationship between other characteristics and the mean days-away rate in the average establishment. Training in basic skills like English and mathematics was associated with an increase in the mean injury rate. The coefficients in Table 3 suggest that this increase was primarily due to improved reporting of days-away cases. Other types of training were not significantly associated with improved safety in the average establishment.[22]

State OSHA plans that were different (i.e. stricter) than federal OSHA plans were positively and significantly related to the mean injury rate for small firms. Table 3 shows that for small firms facing these stricter plans, there was both increased reporting of injuries as well as a higher injury rate for establishments with days-away cases. These results are consistent with offsetting behavior among small firms in these states (Klick and Stratmann 2003) or with stricter enforcement leading to more careful reporting of injuries.

Workplace innovations like total quality management, worker teams and peer review were associated with large and statistically significant increases in the mean rate for the full sample and smaller establishments, primarily reporting effects. Brenner et al. (2004) found JIT and quality circles to be positively and significantly associated with the

[22] These results were relatively unchanged in models where the different training variables were entered one at a time. We also interacted job skills and safety training. The interaction variable had a negative effect on the days-away rate in the two-part model suggesting that the two types of training complemented each other – however, the coefficient was statistically insignificant.

rate of carpal tunnel disorders. However, these innovations have insignificant effects on the days-away rate in our models. Controlling for other innovative practices, quality circles and in some cases, job rotation were associated with a significantly lower reporting of days-away injuries.

Employee benefits like health insurance increase the reporting of days-away cases in small firms. Similarly, EAP programs are associated with 144 more cases (per 10k FTEs) in the minority of small establishments that provide them, primarily a reporting phenomenon. The results are reversed for large firms where EAPs are more prevalent. EAPs are associated with 87 fewer days-away cases per 10K FTEs in the average large establishment. The cost-per-worker of days-away cases was 18% lower for large establishments with EAPs. Wellness programs are associated with a lower injury rate in large firms where they are more common.[23]

SUMMARY

This study offers a rare look at the effect of training, benefit packages, and workplace practices on work injury. Our results suggest that safety training increases the reporting of injuries but also has real safety effects on days-away injuries, especially in smaller firms. Safety training appears to be more effective in preventing severe injuries in large firms than in small ones. While overexertion injuries were resistant to safety training, toxic exposure events were reduced in manufacturing establishments with a formal safety training program.

By combining data with detailed information on training and other establishment characteristics with data on injury, we are able to control more fully for any underlying

[23] Controlling for other characteristics, the percentage of new workers, part-time workers and union coverage are significantly linked to increases in the days-away rate for the average large establishment (results can be obtained from the authors).

correlation between the training decision and an establishment's injury record. Our data on work organization helps to more fully characterize the post-training environment that will affect the ease with which training lessons are implemented in the regular workday.

Wellness programs and EAPs are associated with lower injury rates in large firms where they are more common. There is some evidence to suggest that workplace innovations like total quality management significantly increase the reporting of injuries. Quality circles, previously implicated in poor injury outcomes (Brenner et al. 2004), are also shown to depress the reporting of injuries in our data.

Our study does not refer to specific OSHA safety training requirements and our safety training variable may include a range of activities from general safety admonitions to more specific workplace instructions. Also, we cannot tell how many workers received formal safety training, or whether the training was concentrated among workers in hazardous occupations. Still, our results do point to some real safety training effects on days-away cases with the possibility that rigorously designed training interventions could have even larger beneficial effects on workplace safety.

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Table 1. Summary Statistics-Weighted

Percent of Establishments Providing Formal Training

	Safety	Apprentice	Basic	Workplace	Job Skills	Orientation	Injury Rate
Original SEPT	0.32	0.19	0.02	0.36	0.49	0.32	--
Merged SEPT-SOII	0.39	0.24	0.02	0.48	0.62	0.42	1.58
By establishment size							
<=49 employees	0.35	0.23	0.01	0.46	0.60	0.38	1.37
50–49 employees	0.81	0.29	0.02	0.86	0.87	0.80	4.55
100–499 employees	0.80	0.38	0.11	0.84	0.88	0.87	4.03
500–999 employees	0.95	0.39	0.18	0.93	0.98	0.94	3.03
>=1000 employees	0.91	0.53	0.44	0.95	0.95	0.91	2.96
By Major Industry							
Agriculture[1]	1.00	0.66	0.00	0.99	0.99	0.67	0.14
Mining	0.56	0.03	0.18	0.40	0.55	0.20	5.42
Construction	0.64	0.32	0.00	0.42	0.47	0.37	13.36
Manufacturing	0.56	0.10	0.14	0.47	0.57	0.45	3.64
Transp/Comm/Utilities	0.61	0.44	0.11	0.69	0.70	0.47	1.13
Wholesale Trade	0.31	0.10	0.00	0.24	0.43	0.52	1.81
Retail Trade	0.41	0.37	0.00	0.60	0.77	0.52	0.26
F.I.R.E	0.03	0.03	0.01	0.06	0.07	0.04	0.07
Services	0.17	0.02	0.00	0.52	0.58	0.41	0.23

Establishment Characteristics by Safety Training

	Safety=0	Safety=1
Percent - part-time	0.29	0.13
Percent - new	0.25	0.17
Percent - covered	0.09	0.23
Cost of DAW cases/FTE	$86	$555
Cost/DAW case	$18,027	$28,851
Rate of DAW cases/100 FTEs	1.24	2.12
Paid leave	0.44	0.78
Health insurance	0.3	0.74
EAP pgm	0.01	0.13
Wellness pgm	0.004	0.04
Just-in-time inventories	0.14	0.15
Worker teams	0.06	0.17
Total quality management	0.18	0.38
Quality Circles	0.02	0.06

[1] Establishments are in the agricultural services sector.

Table 2. Estimated Marginal Effects on Mean Rate of Days-Away-From-Work Cases: Weighted

Variables	All establishments: N=2358			Size<=250: N=902			Size>250: N=1456		
	dRate/dx	S.E	t	dRate/dx	S.E	t	dRate/dx	S.E	t
Formal safety training	26.61	11.12	2.39	20.32	8.21	2.47	154.48	71.50	2.16
Basic training	118.36	28.29	4.18	114.26	22.15	5.16	40.07	51.25	0.78
Formal apprenticeship	-3.88	11.81	-0.33	-3.47	8.76	-0.40	34.24	24.97	1.37
Formal workplace training	-6.09	8.95	-0.68	-7.16	6.94	-1.03	39.53	45.69	0.87
Formal jobskill training	-6.36	11.12	-0.57	-8.43	8.98	-0.94	67.46	112.39	0.60
Just-in-time	1.08	9.08	0.12	1.96	6.76	0.29	25.46	26.53	0.96
Work teams	34.18	8.46	4.04	22.31	6.26	3.57	10.83	31.13	0.35
Total quality management	56.83	16.70	3.40	48.16	13.01	3.70	27.97	21.93	1.28
Quality circles	-15.71	20.20	-0.78	-8.47	14.66	-0.58	-34.26	44.17	-0.78
Peer review	111.69	23.75	4.70	91.19	17.27	5.28	60.86	54.23	1.12
Employee involvement	-8.31	5.13	-1.62	-4.37	4.01	-1.09	-97.55	29.34	-3.32
Job rotation	-16.52	14.24	-1.16	-12.73	12.32	-1.03	22.76	32.75	0.69
Flex. work schedule	-3.02	6.99	-0.43	-0.87	5.26	-0.16	-38.16	27.71	-1.38
Paid leave	-41.55	14.30	-2.91	-30.07	10.03	-3.00			
Health care [1]	30.92	22.21	1.39	25.87	16.51	1.57	522.37	130.05	4.02
EAP pgm.	172.43	23.85	7.23	144.40	17.96	8.04	-86.78	46.13	-1.88
Wellness pgm.	-16.64	25.16	-0.66	-11.61	19.92	-0.58	-55.76	19.51	-2.86
State OSHA Plan	-17.44	17.96	-0.97	-11.44	12.47	-0.92	78.17	52.23	1.50
State Plan differs from Federal OSHA	63.04	21.01	3.00	54.16	16.97	3.19	-48.37	54.13	-0.89

[1] Healthcare and paid leave are combined in the models for large firms.

* Marginal effects evaluated at the average X using two-part coefficients; standard errors calculated using the delta method. The mean number of days-away cases per 10K FTEs is 160 for the full sample, 156 in small firms and 357 in large firms.

Table 3. Two-Part Model of Rate of Days-Away Cases – Weighted

Prob. (# Cases >0)	All establishments: N=2358			Size<=250: N=902			Size>250: N=1456		
Variables	**Coefficient**	**S.E.**	**t**	**Coefficient**	**S.E.**	**t**	**Coefficient**	**S.E.**	**t**
Basic training	1.09	0.60	1.81	1.23	0.64	1.93	-0.02	0.26	-0.07
Formal apprenticeship	-0.18	0.25	-0.70	-0.22	0.26	-0.82	0.21	0.20	1.08
Formal workplace training	-0.02	0.28	-0.09	-0.10	0.29	-0.33	0.52	0.43	1.22
Formal jobskill training	-0.28	0.29	-0.95	-0.36	0.31	-1.17	-2.60	0.92	-2.84
Just-in-time	0.03	0.31	0.09	0.04	0.32	0.13	0.20	0.27	0.74
Work teams	0.54	0.31	1.72	0.52	0.32	1.61	-0.08	0.27	-0.29
Total quality mgmnt.	0.87	0.27	3.16	0.96	0.29	3.28	0.20	0.26	0.76
Quality circles	-1.15	0.47	-2.48	-1.19	0.49	-2.42	-0.64	0.30	-2.15
Peer review	1.12	0.46	2.41	1.18	0.47	2.51	-0.15	0.27	-0.57
Employee involvement	-0.27	0.32	-0.83	-0.25	0.34	-0.72	-0.02	0.22	-0.11
Job rotation	-0.78	0.34	-2.30	-0.89	0.36	-2.43	1.04	0.32	3.22
Flex. work schedule	-0.08	0.25	-0.32	-0.06	0.27	-0.24	-0.90	0.22	-4.11
Paid leave	-0.68	0.37	-1.85	-0.69	0.37	-1.85			
Health care [1]	0.75	0.28	2.68	0.83	0.30	2.81	-6.60	1.64	-4.03
EAP pgm.	1.39	0.35	3.96	1.45	0.37	3.87	0.18	0.24	0.74
Wellness pgm.	-0.62	0.47	-1.31	-0.53	0.54	-0.99	0.12	0.27	0.44
Formal safety training	0.62	0.23	2.66	0.66	0.25	2.66	-1.04	0.41	-2.56
State OSHA Plan	-0.44	0.25	-1.74	-0.42	0.26	-1.60	-0.18	0.20	-0.91
State OSHA Plan differs from Federal OSHA	0.73	0.32	2.31	0.81	0.33	2.48	1.02	0.41	2.46
Ln(Days-Away-Rate)	**All estabs. : N=2013**			**Size<=250: N=631**			**Size>250 : N=1382**		
Basic training	-0.14	0.16	-0.87	-0.05	0.22	-0.23	0.11	0.13	0.84
Formal apprenticeship	0.17	0.15	1.12	0.19	0.16	1.14	0.09	0.08	1.11
Formal workplace training	-0.28	0.16	-1.72	-0.36	0.16	-2.18	0.11	0.15	0.71
Formal jobskill training	0.36	0.23	1.57	0.29	0.25	1.17	0.19	0.27	0.70
Just-in-time	-0.01	0.14	-0.06	0.06	0.16	0.36	0.07	0.09	0.74
Work teams	-0.08	0.11	-0.67	-0.15	0.13	-1.15	0.03	0.09	0.34
Total quality mgmnt.	-0.11	0.11	-0.95	-0.11	0.13	-0.87	0.08	0.09	0.87
Quality circles	0.20	0.18	1.14	0.38	0.20	1.87	-0.09	0.11	-0.80
Peer review	-0.06	0.17	-0.38	-0.08	0.19	-0.41	0.17	0.11	1.52
Employee involvement	0.09	0.14	0.65	0.17	0.17	1.02	-0.27	0.10	-2.73
Job rotation	0.19	0.14	1.35	0.14	0.15	0.96	0.06	0.11	0.57
Flex. work schedule	0.02	0.14	0.13	0.08	0.16	0.49	-0.10	0.08	-1.19
Paid leave	-0.43	0.22	-1.96	-0.47	0.22	-2.17			
Health care [1]	-0.27	0.18	-1.48	-0.23	0.21	-1.08	1.47	0.35	4.16
EAP pgm.	-0.18	0.14	-1.36	-0.19	0.16	-1.21	-0.24	0.10	-2.36
Wellness pgm.	-0.09	0.16	-0.55	-0.18	0.22	-0.81	-0.15	0.09	-1.71
Formal safety training	-0.28	0.17	-1.63	-0.32	0.18	-1.78	0.43	0.18	2.32
State OSHA Plan	0.00	0.11	0.02	0.02	0.13	0.18	0.22	0.09	2.43
State OSHA Plan differs from Federal OSHA	0.41	0.15	2.72	0.52	0.17	3.11	-0.14	0.14	-0.99
R2	0.55			0.57			0.32		

[1] Healthcare and paid leave are combined in the models for large firms.

* Robust standard errors allow for correlation within industry-size groups. Other controls include percentage new, part-time and union, reasons for job skills training, whether establishment had restricted work cases, size categories, 2-digit

SIC dummies, occupational/gender composition of industry, state waiting period, average income replacement rate faced by establishment, and log average annual earnings for production workers in industry.

Table 4. Log Rate of Days-Away Injuries with Endogenous Safety Training (2SLS) – Weighted

Safety training=1	All estabs.: N=2013			Size<=250: N=631			Size>250: N=1382		
	Coefficient	S.E.	t	Coefficient	S.E.	t	Coefficient	S.E.	t
Basic training	0.85	0.45	1.89	1.59	0.71	2.25	0.32	0.28	1.15
Formal apprenticeship	0.04	0.26	0.17	-0.14	0.34	-0.42	0.47	0.22	2.09
Formal workplace training	0.78	0.25	3.09	0.86	0.29	2.94	-0.65	0.44	-1.48
Formal jobskill training	-0.02	0.29	-0.06	0.05	0.35	0.15	1.60	0.56	2.86
Just-in-time	-0.30	0.33	-0.91	-0.39	0.42	-0.93	0.22	0.31	0.71
Work teams	-1.29	0.32	-4.10	-1.82	0.42	-4.35	-0.23	0.21	-1.09
Total quality mgmnt.	-0.07	0.28	-0.25	0.12	0.32	0.37	0.49	0.35	1.41
Quality circles	-0.04	0.39	-0.11	0.07	0.49	0.14	-0.90	0.27	-3.32
Peer review	-0.49	0.35	-1.41	-0.42	0.45	-0.95	-0.30	0.30	-0.99
Employee involvement	-0.46	0.33	-1.39	-0.69	0.39	-1.76	0.59	0.31	1.87
Job rotation	0.76	0.32	2.41	0.69	0.39	1.77	1.15	0.31	3.78
Flex. work schedule	0.24	0.30	0.80	0.24	0.36	0.66	-0.41	0.25	-1.61
Paid leave	-0.25	0.47	-0.53	-0.50	0.52	-0.96			
Health care[1]	0.48	0.39	1.21	0.70	0.49	1.43	-2.78	1.83	-1.52
EAP pgm.	0.02	0.30	0.07	-0.13	0.39	-0.32	0.22	0.30	0.71
Wellness pgm.	-0.17	0.36	-0.47	-0.58	0.50	-1.18	0.26	0.24	1.06
State OSHA Plan	1.44	0.43	3.39	1.74	0.46	3.79	0.46	0.35	1.32
State OSHA Plan differs from Federal OSHA	-1.29	0.47	-2.71	-1.57	0.57	-2.76	0.51	0.50	1.01
Formal orientation training	2.68	0.28	9.72	3.42	0.37	9.33	1.23	0.37	3.34
Ln(Days-Away-Rate)	**All estabs.: N=2013**			**Size<=250: N=631**			**Size>250: N=1382**		
	Coefficient	**S.E.**	**t**	**Coefficient**	**S.E.**	**t**	**Coefficient**	**S.E.**	**t**
Basic training	-0.13	0.16	-0.80	-0.04	0.22	-0.18	0.11	0.13	0.87
Formal apprenticeship	0.18	0.15	1.17	0.19	0.17	1.16	0.11	0.09	1.32
Formal workplace training	-0.25	0.16	-1.57	-0.34	0.17	-2.05	0.09	0.15	0.63
Formal jobskill training	0.35	0.23	1.52	0.29	0.25	1.14	0.25	0.28	0.87
Just-in-time	-0.02	0.14	-0.12	0.04	0.16	0.28	0.06	0.10	0.61
Work teams	-0.08	0.12	-0.68	-0.15	0.13	-1.12	0.08	0.09	0.84
Total quality mgmnt.	-0.11	0.12	-0.92	-0.11	0.13	-0.85	-0.09	0.11	-0.77
Quality circles	0.21	0.18	1.15	0.38	0.21	1.86	-0.01	0.10	-0.07
Peer review	-0.08	0.18	-0.47	-0.09	0.19	-0.49	0.17	0.11	1.56
Employee involvement	0.09	0.15	0.61	0.16	0.17	0.97	-0.25	0.10	-2.41
Job rotation	0.20	0.14	1.39	0.15	0.15	1.01	0.09	0.11	0.84
Flex. work schedule	0.02	0.14	0.15	0.08	0.17	0.51	-0.10	0.09	-1.17
Paid leave	-0.42	0.22	-1.92	-0.47	0.21	-2.18			
Health care	-0.27	0.18	-1.48	-0.23	0.21	-1.08	1.46	0.35	4.21
EAP pgm.	-0.18	0.13	-1.36	-0.19	0.16	-1.17	-0.22	0.11	-2.08
Wellness pgm.	-0.10	0.16	-0.61	-0.19	0.22	-0.85	-0.17	0.09	-1.80
State OSHA Plan	0.01	0.12	0.11	0.03	0.13	0.24	0.23	0.09	2.52
State OSHA Plan differs from Federal OSHA	0.40	0.15	2.60	0.51	0.17	2.98	-0.11	0.13	-0.88
Formal safety training	-0.36	0.23	-1.59	-0.37	0.22	-1.67	0.10	0.39	0.25
R2	0.55			0.56			0.31		
Safety training is exogenous			0.72			0.86			0.16

* See footnotes in Table 3 for other relevant details. Sample is restricted to establishments reporting a positive number of days-away cases.

Table 5. Regression Model of Logged Costs of Days-Away Injuries per 10K FTEs

Variables	All establishments N=1921			Small establishments N=594			Large establishments N=1327		
	Coefficient	S.E	t	Coefficient	S.E	t	Coefficient	S.E	t
Basic training	-0.02	0.21	-0.08	0.03	0.30	0.11	0.00	0.10	0.02
Formal apprenticeship	0.40	0.18	2.24	0.47	0.22	2.15	0.05	0.09	0.50
Formal workplace training	-0.08	0.27	-0.29	-0.05	0.29	-0.18	0.26	0.15	1.72
Formal jobskill training	0.13	0.35	0.37	0.16	0.39	0.40	0.42	0.26	1.59
Just-in-time	0.29	0.19	1.51	0.33	0.24	1.39	0.04	0.10	0.37
Work teams	-0.02	0.18	-0.11	-0.03	0.23	-0.11	0.07	0.09	0.74
Total quality mgmnt.	-0.11	0.16	-0.71	-0.17	0.19	-0.92	0.03	0.09	0.36
Quality circles	0.46	0.23	1.98	0.70	0.30	2.32	0.01	0.11	0.05
Peer review	-0.14	0.21	-0.67	-0.14	0.24	-0.57	-0.07	0.13	-0.54
Employee involvement	0.02	0.18	0.10	0.01	0.22	0.04	-0.18	0.10	-1.78
Job rotation	0.42	0.21	1.96	0.47	0.26	1.80	0.06	0.11	0.54
Flex. work schedule	-0.21	0.19	-1.07	-0.18	0.24	-0.79	-0.11	0.09	-1.25
Paid leave	-0.45	0.38	-1.19	-0.50	0.41	-1.21			
Health care [1]	-0.31	0.35	-0.88	-0.29	0.44	-0.66	0.30	0.32	0.92
EAP pgm.	0.23	0.14	1.62	0.25	0.17	1.50	-0.20	0.11	-1.79
Wellness pgm.	-0.42	0.18	-2.27	-0.64	0.27	-2.40	-0.12	0.09	-1.26
State OSHA Plan	-0.23	0.18	-1.29	-0.31	0.22	-1.37	0.10	0.09	1.03
State OSHA Plan differs from Federal OSHA	0.67	0.24	2.81	0.75	0.29	2.61	0.03	0.13	0.26
Formal safety training	-0.05	0.23	-0.21	-0.02	0.26	-0.09	0.52	0.16	3.35
R2	0.43			0.45			0.35		

* See footnotes in Table 3 for other relevant details. Sample is restricted to establishments reporting a positive number of days-away cases and with cost information.

Table 6A. Grouped Ordered Logit Model of Severity of Days-Away Injuries

Variables	All establishments N=1950			Small establishments N=603			Large establishments N=1347		
	Coefficient	S.E	z	Coefficient	S.E	z	Coefficient	S.E	z
Formal safety training	-0.40	0.04	-9.71	0.08	0.07	1.27	-0.81	0.06	-13.67
Basic training	0.06	0.02	3.89	0.22	0.10	2.23	0.07	0.02	4.26
Formal apprenticeship	-0.04	0.02	-2.62	0.20	0.05	3.90	-0.08	0.02	-4.86
Formal workplace training	0.34	0.03	10.27	0.14	0.07	2.10	0.45	0.04	11.14
Formal jobskill training	-0.35	0.04	-8.65	-0.68	0.08	-8.39	-0.10	0.05	-1.99
Just-in-time	-0.13	0.02	-7.04	0.17	0.07	2.57	-0.12	0.02	-6.21
Work teams	0.02	0.02	0.85	0.09	0.06	1.41	0.05	0.02	2.32
Total quality mgmnt.	-0.07	0.02	-3.89	-0.05	0.06	-0.95	-0.08	0.02	-4.15
Quality circles	0.24	0.02	13.02	0.28	0.08	3.68	0.27	0.02	13.63
Peer review	-0.02	0.02	-0.86	-0.15	0.08	-1.92	0.01	0.02	0.48
Employee involvement	0.05	0.02	2.91	-0.15	0.08	-2.04	0.06	0.02	3.09
Job rotation	-0.07	0.02	-3.77	-0.03	0.07	-0.41	-0.09	0.02	-4.96
Flex. work schedule	0.04	0.02	2.29	-0.01	0.06	-0.14	0.04	0.02	2.06
Paid leave	-0.15	0.07	-2.10	0.04	0.11	0.39			
Health care	0.23	0.06	4.02	-0.14	0.10	-1.48	-1.00	0.30	-3.31
EAP pgm.	0.04	0.02	2.03	0.27	0.06	4.52	-0.05	0.02	-2.08
Wellness pgm.	0.13	0.02	7.66	-0.24	0.08	-3.00	0.16	0.02	9.30
State OSHA Plan	-0.26	0.02	-14.93	-0.36	0.06	-6.31	-0.25	0.02	-13.66
State OSHA Plan differs from Federal OSHA	0.27	0.02	11.14	0.69	0.08	8.69	0.24	0.03	9.31

* See footnotes in Table 3 for other relevant details. Sample is restricted to establishments reporting a positive number of days-away cases with non-missing data for the counts in different severity categories. Five severity categories are modeled - 1–3 days, 4–6 days, 7–20 days, 21–60 days, and >=60 days.

Table 6B. Predicted Severity Distribution by Safety Training (Standard deviations in parentheses)

Full sample	<= 3 days		4–6 days		7–20 days		21–60 days		>= 60 days	
	Prob.	95% C.I.	Prob.	95% C.I.	Prob.	95% C.I.	Prob.	95% C.I.	Prob.	95% C.I.
Safety=0	0.267 (0.086)	[0.263,0.271]	0.134 (0.020)	[0.133,0.135]	0.239 (0.016)	[0.239,0.240]	0.203 (0.042)	[0.201,0.204]	0.157 (0.062)	[0.154,0.159]
Safety=1	0.347 (0.099)	[0.343,0.351]	0.147 (0.014)	[0.146,0.148]	0.228 (0.023)	[0.227,0.229]	0.165 (0.044)	[0.163,0.167]	0.112 (0.048)	[0.110,0.114]

Small firms	<= 3 days		4–6 days		7–20 days		21–60 days		>= 60 days	
	Prob.	95% C.I.	Prob.	95% C.I.	Prob.	95% C.I.	Prob.	95% C.I.	Prob.	95% C.I.
Safety=0	0.377 (0.149)	[0.366,0.389]	0.149 (0.020)	[0.148,0.151]	0.214 (0.041)	[0.210,0.217]	0.145 (0.057)	[0.141,0.149]	0.114 (0.069)	[0.109,0.119]
Safety=1	0.359 (0.147)	[0.348,0.371]	0.148 (0.022)	[0.146,0.149]	0.217 (0.038)	[0.214,0.220]	0.152 (0.057)	[0.147,0.157]	0.123 (0.073)	[0.117,0.129]

Large firms	<= 3 days		4–6 days		7–20 days		21–60 days		>= 60 days	
	Prob.	95% C.I.	Prob.	95% C.I.	Prob.	95% C.I.	Prob.	95% C.I.	Prob.	95% C.I.
Safety=0	0.194 (0.070)	[0.190,0.198]	0.114 (0.025)	[0.113,0.115]	0.237 (0.021)	[0.236,0.238]	0.241 (0.035)	[0.239,0.243]	0.215 (0.078)	[0.210,0.219]
Safety=1	0.343 (0.099)	[0.338,0.348]	0.147 (0.014)	[0.146,0.147]	0.231 (0.024)	[0.229,0.232]	0.168 (0.045)	[0.166,0.171]	0.111 (0.048)	[0.109,0.114]

Table 7. Safety Training and the Rate of Injury by Event

Outcome	Coefficient	S.E.	t
Contact Injury			
Change in Prob(Inj.>0)	-0.085	0.099	0.86
Log(Rate)	-0.548	0.263	2.09
Falls			
Change in Prob(Inj.>0)	-0.059	0.075	0.82
Log(Rate)	-0.694	0.312	2.22
Over-Exertion			
Change in Prob(Inj.>0)	0.252	0.102	2.57
Log(Rate)	0.205	0.301	0.68
Transportation			
Change in Prob(Inj.>0)	0.019	0.008	1.57
Log(Rate)	-0.664	0.414	1.61
Exposure			
Change in Prob(Inj.>0)	0.034	0.014	1.99
Log(Rate)	-0.465	0.484	0.96
Exposure - Manufacturing			
Change in Prob(Inj.>0)	0.006	0.003	2.60
Log(Rate)	-1.208	0.465	2.60

[1] The average number of day-away cases per 10k FTEs is establishments with a positive number of days-away cases is 1,069 for contact injuries; 1,174 for falls; 3,285 for over-exertion; 84 for exposure; 161 for transportation; 50 for exposure injuries in manufacturing.

* See footnote in Table 3 for other relevant details. Sample is restricted to establishments reporting a positive number of days-away cases.

Appendix

Anti-Drug Programs and Occupational Injury

Drug Testing, Employee Assistance Programs and Workplace Injury

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ABSTRACT

We correlate establishment information workplace anti-drug programs in 1988 with occupational injury rates. We find a 10 percent lower rate of injuries involving lost-work in establishments using drug testing, though this relationship is statistically insignificant when we consider firms separately by size and industry. Firms with drug testing have a 17 percent lower rate of minor injuries without work loss. Employee assistance programs (EAPs) were associated with a significant reduction in no-lost-work injuries but only weakly associated with more serious lost-work cases. However, the latter were more responsive to specific EAP characteristics like management sponsorship, onsite locations, and telephone hotlines.

Illicit drug use has risen dramatically in the U.S. over the past few decades. The increase is uniformly observed for several different categories of people. Intuitively, drug and alcohol use among employed persons should affect on-the-job performance, but conflicting studies exist on this issue. Anti-drug policies in the workplace are assumed to prevent and deter drug use and thus improve job performance and safety. However, very few studies have examined this question. In this paper, we focus on the relationship between anti-drug policies and workplace safety. Specifically, we examine whether firms with drug testing, written policies on drug use in the workplace, and employee assistance programs (EAPs) have lower occupational injury rates than firms without such programs.

Illicit drug use in the workplace is believed to result in higher rates of occupational injury because of impaired performance. (See Spicer (1)) for a review of the relationship between substance use and occupational injury. However, drugs and alcohol are less involved in occupational injuries than in other unintentional injuries (2). Data on drug involvement in occupational injuries is limited and, according to the National Academy of Sciences (3), a causal linkage is hard to find (see Hingson et al. (4), for positive associations between drug use and injury risk; see Hoffman and Larison (5), for no relationship between drug use and work injury and Holcom et al. (6) for a similar result in low-risk occupations.)

Notwithstanding the lack of a clear causal connection between drug use and work accidents, the U.S. has embarked on an extensive program to reduce substance use in the workplace. Several high-profile transportation accidents involving alcohol or drugs (e.g., the Exxon Valdez) have increased the pressure for drug-testing in the workplace. The 1988 Drug-Free Workplace Act requires recipients of Federal grants and contracts to certify that they maintain a drug-free workplace and subsequent executive orders similarly direct Federal

agencies. Safety-sensitive transportation workers have been subject to random drug testing since January 1990 for most modes and since January 1992 for trucks and buses.

The American Management Association (AMA) reports that as of 2001, 66 percent of firms tested employees for drug use, down from 80 percent in 1996 (7, 8). The majority of employers conduct pre-employment drug tests on new hires -- tests are rarely given as part of the application process. Instead, job offers are conditioned on passing a drug test. For-cause testing is also used. Here, testing is triggered upon suspicion of drug use or after as part of an incident investigation. Random drug testing tends to be focused on employees in safety-sensitive positions.

Testing workers for drug use can be expensive. Between 1989 and 1990, 153 employees out of 28,872 in 38 executive branch agencies tested positive for drugs. On average, the tests cost $400 per tested employee or approximately $77,000 per employee testing positive for drugs (9). Over the years, the test positive rate has also fallen, information treated as evidence of a deterrent effect by proponents of testing, or as a result of an expansion of testing by opponents. Notably, the positive test rate also has fallen for random testing, despite unchanged testing intensity (3, 10, 11), which suggests that testing either shifts drug abusers out of safety-sensitive jobs or discourages drug use.

In addition, many firms have established employee assistance programs (EAPs) that provide employees with services to prevent or eliminate work-related or family-related problems including substance abuse. EAPs vary widely in the range of services, but usually they provide access to drug treatment and follow-up services and protect the confidentiality of employees. EAPs can be internal (i.e., run by company employees and be located at or near the company) or

external to the company (outside contractors provide EAP services and the locations are outside the company).

Related Literature: The majority of drug-testing studies does not explicitly relate a firm's performance to its adoption of testing programs, but rather relate a positive drug test result (i.e., drug use) to subsequent worker behavior. Thus, workers testing positive on pre-employment drug tests have been found to have a higher risk of injury (12), more absenteeism, and a greater risk of being fired (13, 14). The few studies of for-cause drug testing similarly related a positive drug test result with a greater use of sick leave and a higher risk of vehicle crashes (15, 16).

Two studies explicitly link the use of drug testing programs with a firm's productivity and costs. Shepard and Clifton (1998) examined the relationship between productivity (measured by net sales per employee) and drug testing in 63 high-tech firms (17). Productivity was significantly lower in testing firms, compared with non-testers, for both pre-employment and random drug testing. More recently, Ozminkowski (2003) saw a deterrent effect of drug testing in his analysis of data from 15 sites of a U.S. manufacturing company (18). Doubling the testing rate reduced the odds of injury by half, and reduced medical expenditures as well. The study suggested that employees be subject to 1.68 random drug tests a year in order to minimize medical expenditures. Wickizer et al. (2004) examined Washington State's 1996 Drug-Free Workplace program's effect on the incidence of occupational injuries using workers' compensation claims data from 1994 to 1999 (19). They find that the program had a statistically significant effect in three industries – construction, manufacturing, and services. Overall, the program was estimated to result in 3.3 fewer injuries and one less lost-work injury per 100

person-years. However, their study could not control for other establishment characteristics besides industry that may have differentially affected the decline in injury rates.

All of these studies fail to account for the real possibility that firms that employ drug testing (or use different rates of drug testing) may differ in unobservable ways that are related to the outcomes from firms that do not use drug testing. This endogeneity in drug testing can result in biased estimates of its true effect. Thus, if safety conscious firms that pay attention to occupational safety in ways that are not observed in the data also employ drug testing, then we may see a negative "effect" of drug testing on injury rates. This scenario is only partially consistent with the Ozminkowski (2003) results, even though the firm under study had a very low injury rate to begin with. Conversely, if firms with poor injury records attempt to use drug testing as a remedial device, then we may see a positive "effect" of drug testing on injury or a negative relationship with productivity as seen in Shepard and Clifton (1998).

Similar concerns are raised by EAP studies, many of which are descriptive. Kurtz et al. (1984) reviewed the sparse literature on EAP effectiveness and found that EAPs were associated with improvements in job performance (20). Goss and Mearns (1997) saw a significant cost savings due to a reduction in absenteeism that they attribute to EAP counseling (21). Goetzel et al. (1996) found that participation in an EAP was associated with a reduced number of workers at risk in several health areas including cholesterol, exercise, tobacco use, alcohol use, vehicle safety, nutrition, stress, and general well-being (22). Hanlon et al. (1998) found that almost half of the 868 workers participating in an EAP program reported at least one desired behavior change (quit smoking, increased exercise, reduced drinking, improved diet) (23). In research on the effectiveness of specific EAP services, Foote and Erfut (1991) randomly assigned workers

with substance abuse problems to followup services, and found they did not have a significant effect on absenteeism but did reduce substance abuse-related health benefit claims (24).

In this paper, we match establishment information on anti-drug programs with data on their injury rates to assess whether workers are safer in firms with such programs. Anti-drug programs are justified on the grounds of improved productivity and safer work environments but not much research has examined this question. Our data will allow us to assess the relative importance of different anti-drug strategies like a firm policy on drug use, drug testing, and EAPs, as well as whether anti-drug programs relate differently with minor injuries versus those that are serious enough to involve some work loss. We also examine the relationship between the reported injury rate and specific EAP characteristics (type of sponsorship, onsite/offsite) and services (hotline, counseling/followup). Finally, we present results for different firm sizes and for the manufacturing and transportation/utilities industries where anti-drug programs are the most prevalent.

Data: We examine the effects of anti-drug programs on injury outcomes using a unique dataset created by matching Bureau of Labor Statistics (BLS) data on anti-drug programs with injury data at the establishment level. For drug policy information, we use the 1988 BLS Survey on Employer Anti-Drug Programs (SEADB), a quick response survey that gathered information on the extent and characteristics of employer-instituted anti-drug programs in a sample of 7,502 non-agricultural establishments. The SEADB questioned establishments about the use of drug testing, formal policies on drug use in the workplace, and EAPs and their characteristics.

We match the anti-drug program data to summary data on the injury and illness records of establishments using the 1989 Annual Survey of Occupational Injuries and Illnesses (SOII) collected by the BLS. The SOII is a Federal/State program that has collected occupational injury

and illness data on an annual basis since 1972, from logs that employers maintain according to Occupational Safety and Health Administration (OSHA) guidelines. In 1989, employer reports of worker injuries were collected from about 250,000 private industry establishments. The establishments reported on the numbers of injuries and illnesses of various types (without lost work, with only restricted-work days, or with days away from work) that occurred during the year. They also reported the total annual hours worked by all employees, the annual average number of employees and the establishment's industry.

Workplace injury rates will be affected by firm characteristics like the percentage of women workers and the occupational composition of the workforce. We add data on the percentage of women workers at the most detailed industry level possible using data from the 1988 Current Employment Statistics. Data on the percentage of workers in seven large occupational categories are also merged at the detailed industry level using data from the 1989–91 Occupational Employment Statistics.[24] The average injury rate for the firm's 3-digit industry is used as a proxy for the inherent riskiness of work in the establishment. Finally, we add data on maximum weekly workers' compensation benefit and waiting period in the State to control for any incentive effects on reporting occupational injuries.

In the results that follow, we focus on non-fatal workplace injuries of two types – those severe cases involving some lost work, and less severe injuries that require medical treatment but do not involve any lost work. In doing so, we are implicitly allowing substance use to have a different relationship with injuries of different severity. We do not include illnesses in our analysis because they are the result of cumulative exposure to the workplace instead of a traumatic event.

[24] Three year of OES data are needed to span the entire industry spectrum. Earlier data were unavailable but our estimate of the occupational distribution should not be measurably different from that in 1988.

Matching the SOII to the SEADP resulted in a final sample of 1,405 non-agricultural establishments with valid data on anti-drug programs and workplace injuries.[25] About half of the firms in the matched sample have over 1,000 employees, a larger proportion of large firms than the original surveys (large firms tended to appear in both surveys with higher probability than smaller firms did). Thus, our results will be more pertinent to large establishments than to all firms generally.

Table 1 provides information on the use of anti-drug programs in our data. In the matched sample, 65 percent of firms used a formal written policy regarding drug use, 62 percent had EAPs, and 41 percent used drug testing.[26] Drug testing generally coexisted with a drug policy — only 14 percent of the establishments without a formal drug policy used drug testing in the workplace. More testing establishments reported testing applicants for jobs (89 percent) than testing employees (72 percent). The majority of establishments conducted employee drug tests (69 percent) if they were suspected of drug use.

Companies in the transportation, communications, and public utilities industries (TCPU) used anti-drug programs most frequently (87 percent), followed by manufacturing (84 percent). The construction industry had the highest injury rate (17.2 injuries per 100 full-time employees [FTEs]) and used anti-drug programs less frequently than other industries – only 51 percent had a formal policy on drug use, 28 percent of construction establishments had EAPs and 21 percent used drug testing. Drug testing was most common in TCPU, with 62 percent of establishments testing.

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[25] The establishments were matched by comparing their State, county, 4-digit SIC code, and Unemployment Insurance identification number.

[26] . In the original SEADP, a formal drug policy was used by 16 percent of firms, followed by EAPs (4 percent), and drug testing (3 percent) (unpublished BLS memo). Weighted statistics were not possible in this paper because the weights in the SEADP were not available to the researchers.

Anti-drug programs were more prevalent in large establishments with over 500 employees in 1988 – almost half these firms used drug testing. By contrast, drug testing was used in only 8 percent of workplaces with fewer than 50 workers. Similar variation by firm size was seen for EAPs. Formal drug policies, though also more prevalent in larger firms, were not infrequently used in small establishments as well. Larger firms may have a greater incentive to provide safety training to prevent occupational injuries because of the experience rating system. This places greater weight on the frequency of injuries rather than their severity when determining workers' compensation premiums. Thus, large firms' premiums track their own injury records more closely than in small firms where premiums depend more on the average injury experience of their industry.

Table 1 also reports the characteristics of EAPs by industry and firm size in 1988. 62 percent of EAPs used a telephone hotline, with the highest use in the finance, insurance and real estate industry (71 percent). Not surprisingly, the vast majority of EAPs offered drug education, counseling, referral or followup services. Management sponsorship of EAPs appears to be dominant, especially in the retail, financial/real estate, and services sectors. Union-management collaborations were more common in manufacturing and TCPU, two industries with a higher proportion of union workers. Two-thirds of EAPs were staffed by outside contractors. We examine the efficacy of different EAP types and services in our models.

Methods: The injury data report the counts of workplace injuries involving lost workdays (LWD), and those involving no lost work (NLW). Of the 1,407 establishments in our matched sample, 8percent reported zero counts of LWD cases and 12 percent report no NLW injuries. Because of the nature of the data and the number of establishments with zero injury counts, we used a count-data model to analyze the injury rate, with a negative binomial

distribution generating the injury counts. Count-data models are preferable to OLS regressions of the injury rate that can result in negative predictions of the injury rate. [27] Coefficients on anti-drug programs in the negative binomial regressions represent the natural log of the mean injury rate ratio for establishments with and without the programs, holding all other variables constant. We present results for different establishment size categories and for the manufacturing and transportation, communications, and public utilities industry. All models are estimated using Stata software with standard errors that are robust to heteroskedasticity in the error term. [28]

Results: Table 2 presents coefficients of anti-drug programs in the negative binomial models on the rate of LWD injuries per 10,000 full-time employee equivalents (FTEs) in the matched sample. Column 1 shows that firms with one or more of the three anti-drug programs under study did not report different rates of LWD injuries from firms that did not employ any anti-drug strategies. A formal drug policy was not significantly related to the lost-workday rate in column 2. Controlling for the existence of a drug policy, firms with drug testing had almost 10 percent fewer lost workday cases per 10,000 FTEs; this relationship became smaller and slightly less significant when we also controlled for the presence of an EAP.

In the bottom panels of Table 2 we present results for establishments by size and industry. In columns (1) to (4), none of the anti-drug programs have a statistically significant relationship with the lost-work injury rate except when we focus on the very large establishments with more than 500 workers. Establishments in this size group with a formal drug policy have a statistically significant 12-14 percent reduction in the rate of lost-work injuries.

[27] Using the natural logarithm of the injury rate would yield positive predictions but require excluding the large number of firms with zero injury counts in the sample.
[28] We checked the robustness of our results by also estimating simple linear regression models of the injury rate. Results were qualitatively similar to those reported here.

Drug policies are positively related to the lost-work rate in manufacturing establishments. Controlling for a formal drug policy and drug testing, manufacturing firms with EAPs have a significant 16 percent lower lost-work rate. EAPs are also associated with significantly lower lost-work injuries in the transportation and utilities industry.

Table 3 presents estimates from models of the rate of minor injuries involving no lost work. Anti-drug programs are related to improvements in the rate of NLW injuries. Establishments with drug testing have 17 percent fewer NLW injuries in the full sample and a statistically significant 43 percent reduction in the NLW rate in the transportation and utilities industry. However, manufacturing firms with drug testing do not record fewer no-lost-work cases. Drug testing programs appear to have a weaker relationship with no-lost-work injuries as firms get larger, with an insignificant coefficient in the estimates for very large establishments with over 500 employees.

Formal policies on drug use do not appear to be related to the NLW rate. Large establishments with formal drug policies appear to have a significantly lower rate of no-lost-work injuries but this relationship becomes less important when we include smaller firms in the sample. Transportation firms with a written drug policy have significantly more cases of injuries with no lost work.

Finally, establishments with EAPs record statistically significant reductions in no-lost-work cases in the full sample, for different firm size groups, and in the manufacturing industry. While transportation EAPs are associated with a large 24 percent reduction in NLW cases, the coefficient is not statistically significant perhaps due to the small sample of such firms.

EAP Characteristics and the Injury Rate: Table 4 presents coefficients from negative binomial regressions of the rate of lost-work and no-lost work injuries on different EAP

characteristics for firms with an EAP. Specifically, we examine whether the EAP sponsorship (management, union, a union-management collaboration) affects the relationship between the EAP and the reported injury rate. We also examine whether staffing by an outside contractor versus company employees makes a difference. Finally we examine the relationship between services like a telephone hotline and drug services (these include drug education and awareness programs, counseling, referrals for drug treatment, and followup services for identified drug users) and changes in the reported rate of lost-work and no-lost-work injuries. Columns 1–4 analyze each of these characteristics separately and column 5 reports the marginal change in the injury rate controlling for other EAP characteristics.

Surprisingly, whereas Table 2 showed a relatively weak relationship between the presence of an EAP and the lost-work injury rate, Table 3 shows that the organization of an EAP does matter. Sole sponsorship by management is associated with a lower reported lost-work rate, though this relationship is much weaker when we restrict the sample to very large establishments or to the manufacturing or transportation industries. The results are consistent with several explanations – small companies that sponsor EAPs may be more proactive towards worker safety to begin with; management-sponsored EAPs may be more effective in mitigating worker problems and thus reducing lost work injuries; or more troubling, small companies with management-sponsored EAPs may discourage the reporting of lost-work injuries.

EAPs staffed by an outside contractor are also associated with a higher reported lost-work injury rate with statistically significant coefficients for the full sample and for very large establishments. Because such EAPs also tend to be offsite, the results may indicate that on-premises EAPs may be more useful in providing employee services.

Among the EAP services, a telephone hotline that puts employees in touch with a counselor for crises brought on by drugs or alcohol is strongly related to a lower lost-work rate in the transportation and utilities industry and just falls short of statistical significance ($p=0.11$) in the full sample when we control for other EAP characteristics in column 5. Finally, services like drug education, short- or long-term counseling, and followup services for drug or other problems are positively associated with the lost-work rate for the full sample and in TCPU.

The bottom half of Table 4 suggests that although EAPs were significantly associated with reductions in minor no-lost-work injuries, the characteristics of EAPs do not matter so much. Exceptions are the EAP sponsorship and outside staffing, which show similar relationships with minor injuries as with lost-work injuries.

Summary and discussion: Safety concerns have been a powerful force behind the use of drug testing in the workplace. Despite the attention given to workplace anti-drug programs, very little research has examined whether establishments with such programs have better safety records than firms without. This study sheds light on the safety effects of the components of a drug-free workplace program, namely formal workplace drug policies, drug testing, and EAPs.

We find a 10 percent lower rate of injuries involving lost-work in the full sample of establishments that used drug testing, though this relationship is not statistically significant when we consider firms separately by size and industry. Firms with drug testing have a 17 percent lower rate of minor injuries involving no lost work, with the biggest difference (43 percent) occurring in the transportation and public utility industry.

Controlling for other characteristics, the presence of an EAP was associated with a significant reduction in no-lost-work injuries across firms of different sizes and in the manufacturing industry, though being only weakly associated with more serious lost-work cases.

However, lost work injuries appear to be more responsive to specific EAP characteristics. Management sponsorship, especially in small firms, and onsite EAPs are both associated with significant reductions in lost-work cases. EAP telephone hotlines are associated with a lower lost-work rate, especially in the transportation industry.

This study has several strengths. Existing studies of the associations between anti-drug programs and workplace outcomes including injury often rely on data from a single company, making them unrepresentative. Instead, our study uses nationally representative survey data on anti-drug programs in establishments in different industries and of different sizes. The data allows us to separately estimate the association between workplace injury and three different components of an anti-drug program, namely a written policy, drug testing, and an EAP. This study provides valuable information on which types of EAPs and which specific EAP services may be more useful for injury reduction.

A limitation of this study is the age of the data used. Workplace drug testing has become much more prevalent in recent years. EAPs that initially were focused on substance abuse have now expanded their mission to include an array of family services and other work-life issues. More recent data would show whether these changes have diluted substance abuse prevention efforts and reduced their impact on workplace injury.

Our results neither establish that drug testing deters drug use nor can we infer causal effects of drug testing or use on workplace injury. Our results are consistent with two hypotheses. Drug testing may screen out problem employees resulting in a safer workforce (because more establishments tested job applicants rather than employees). Further, if establishments performing risky operations are more likely to employ drug testing, then the 10 percent lower injury rate may even underestimate the true safety effects of a drug-testing

program. On the other hand, testing firms may be more safety conscious in their work operations than non-testing firms in ways that are not measured in our data, resulting in the apparent "effect" on injury rates.

As the National Academy of Sciences (3) pointed out, the predictive validity and cost-effectiveness of drug testing will depend on the prevalence of illicit drug use in the underlying population and the use of stringent drug-testing procedures. Small businesses using less stringent testing procedures increase their risk of false positive results and thus reduce the potential gain from screening job applicants in this way. Although drug testing may serve to screen out problem employees, focusing on problem behaviors like absenteeism may provide a less invasive and cheaper way to accomplish the same goals.

Table 1: Distribution of Anti-Drug Programs in Matched Data (%)

	Any Program	Drug Policy	Drug Testing	EAP	Injury Rate	EAP Sponsorship[a]				Other EAP Characteristics		
						Mgmnt.	Union	Union-Mgmnt.	Other	Outside Staff	Phone Hotline	Drug Services
All	0.81	0.65	0.41	0.62	11.90	0.68	0	0.24	0.03	0.61	0.62	0.93
By establishment size												
<=49 employees	0.49	0.37	0.08	0.20	10.08	0.79	0	0.07	0.14	0.64	0.64	1
50-49 employees	0.67	0.57	0.19	0.32	16.21	0.78	0	0.15	0	0.7	0.44	0.93
100-499 employees	0.68	0.53	0.31	0.45	13.87	0.74	0	0.15	0.04	0.64	0.46	0.93
500-999 employees	0.83	0.67	0.45	0.63	13.01	0.74	0	0.16	0.04	0.68	0.59	0.93
>=1000 employees	0.92	0.75	0.51	0.79	10.30	0.69	0.01	0.21	0.03	0.5	0.61	0.93
By Major Industry												
Mining	0.80	0.78	0.54	0.56	6.40	0.70	0	0.043	0.043	0.48	0.43	0.78
Construction	0.61	0.51	0.21	0.28	17.50	0.59	0.037	0.15	0.11	0.56	0.41	0.89
Manufacturing	0.84	0.69	0.53	0.70	14.08	0.68	0	0.24	0.03	0.55	0.58	0.94
Transp/Comm/Utilities	0.87	0.78	0.62	0.72	11.53	0.66	0	0.26	0.02	0.61	0.62	0.93
Wholesale Trade	0.82	0.71	0.44	0.55	14.79	0.56	0	0.2	0.08	0.6	0.64	0.84
Retail Trade	0.77	0.66	0.13	0.41	12.84	0.81	0.02	0.08	0.02	0.69	0.54	0.94
F.I.R.E	0.81	0.57	0.21	0.71	2.78	0.80	0	0.1	0.1	0.76	0.71	1
Services	0.79	0.52	0.20	0.61	7.57	0.83	0.01	0.06	0.04	0.43	0.53	0.93

Excludes Private agricultural establishments.
Sponsorship does not sum to one because of missing values.

Table 2: Regression Coefficients in Model of Logged Rate of Lost-Work Injuries
(Std. Error in parentheses)

Sample	Program	(1)	(2)	(3)	(4)	(5)
	Any Program	-0.005 (0.068)				
	Drug Policy		-0.004 (0.052)	0.031 (0.055)		0.042 (0.056)
	Drug Testing			-0.095* (0.058)		-0.081 (0.059)
All:N=1,405	EAP				-0.091 (0.058)	-0.080 (0.061)
	Any Program	-0.065 (0.068)				
	Drug Policy		-0.038 (0.052)	-0.009 (0.055)		0.006 (0.057)
	Drug Testing			-0.079 (0.058)		-0.069 (0.059)
Emp >=50; N=1,334	EAP				-0.091 (0.058)	-0.078 (0.060)
	Any Program	-0.099 (0.071)				
	Drug Policy		-0.061 (0.053)	-0.033 (0.056)		0.020 (0.058)
	Drug Testing			-0.074 (0.059)		-0.067 (0.059)
Emp>=100 ; N=1,251	EAP				-0.084 (0.059)	-0.066 (0.062)
	Any Program	-0.189** (0.085)				
	Drug Policy		-0.129** (0.055)	-0.139** (0.057)		-0.122** (0.057)
	Drug Testing			0.025 (0.062)		0.027 (0.062)
Emp>=500; N=897	EAP				-0.109 (0.069)	-0.083 (0.071)
	Any Program	-0.056 (0.104)				
	Drug Policy		0.058 (0.078)	0.105 (0.091)		0.134 (0.093)
	Drug Testing			-0.094 (0.088)		-0.069 (0.087)
Manuf=1; N=565	EAP				-0.139 (0.089)	-0.158* (0.092)
	Any Program	0.152 (0.263)				
	Drug Policy		0.225 (0.179)	0.176 (0.202)		0.262 (0.197)
	Drug Testing			0.084 (0.181)		0.116 (0.177)
TCPU=1; N=212	EAP				-0.388** (0.188)	-0.468*** (0.183)

* statistically significant at the 90% level; ** - significant at 95%; *** significant at 99% level.

Models also control for 2-digit industry, 3-digit industry injury rate, workers' compensation benefits, occupational composition of 3-digit industry, percentage women and log earnings of production workers in industry.

Table 3: Regression Coefficients in Model of Logged Rate of No-Lost-Work Injuries (Std. errors in parentheses)

Sample	Program	(1)	(2)	(3)	(4)	(5)
All:N=1,405	Any Program	-0.028 (0.081)				
	Drug Policy		-0.022 (0.066)	0.043 (0.069)		0.064 (0.070)
	Drug Testing			-0.168** (0.071)		-0.151** (0.072)
	EAP				-0.155** (0.068)	-0.143** (0.073)
Emp >=50; N=1,334	Any Program	-0.065 (0.082)				
	Drug Policy		-0.027 (0.067)	0.033 (0.069)		0.059 (0.072)
	Drug Testing			-0.155** (0.071)		-0.132* (0.072)
	EAP				-0.185*** (0.069)	-0.172** (0.073)
Emp>=100 ; N=1,251	Any Program	-0.089 (0.087)				
	Drug Policy		-0.040 (0.069)	0.017 (0.072)		0.042 (0.074)
	Drug Testing			-0.142* (0.073)		-0.128* (0.073)
	EAP				-0.152** (0.071)	-0.14* (0.076)
Emp>=500; N=897	Any Program	-0.291** (0.117)				
	Drug Policy		-0.139* (0.085)	-0.104 (0.088)		-0.075 (0.092)
	Drug Testing			-0.096 (0.085)		-0.094 (0.085)
	EAP				-0.166* (0.086)	-0.139 (0.091)
Manuf=1; N=565	Any Program	-0.129 (0.111)				
	Drug Policy		-0.079 (0.086)	-0.077 (0.102)		-0.044 (0.104)
	Drug Testing			-0.006 (0.099)		0.009 (0.099)
	EAP				-0.179* (0.095)	-0.169* (0.102)
TCPU=1; N=212	Any Program	0.350 (0.308)				
	Drug Policy		0.279 (0.204)	0.583*** (0.209)		0.601*** (0.206)
	Drug Testing			-0.480** (0.213)		-0.433** (0.207)
	EAP				-0.239 (0.211)	-0.239 (0.205)

See footnote in Table 2.

Table 4: Regression Coefficents of EAP Characteristics in Models for Logged Injury Rate in Establishments with EAPs (Std. Errors in parentheses)

	EAP Characteristics	(1)	(2)	(3)	(4)	(5)
Lost Work Injury Rate						
EAP=1; N=876	Union-Management	0.164** (0.083)				0.181** (0.082)
	Other	0.229* (0.121)				0.235* (0.124)
	Outside Staffing		0.114** (0.058)			0.189***(0.063)
	Telephone Hotline			-0.061 (0.059)		-0.101 (0.063)
	No Drug Services				0.118 (0.108)	0.069 (0.292)
>=500 employees & EAP=1; N=675	Union-Management	0.072 (0.089)				0.067 (0.089)
	Other	0.157 (0.144)				0.171 (0.153)
	Outside Staffing		0.126** (0.062)			0.182***(0.068)
	Telephone Hotline			-0.035 (0.060)		-0.077 (0.065)
	No Drug Services				0.063 (0.116)	-0.003 (0.476)
Manufacturing & EAP=1; N=395	Union-Management	-0.044 (0.099)				0.0002 (0.099)
	Other	0.029 (0.257)				-0.012 (0.265)
	Outside Staffing		0.088 (0.082)			0.137 (0.087)
	Telephone Hotline			-0.105 (0.084)		-0.181** (0.090)
	No Drug Services				-0.073 (0.129)	0.472** (0.236)
TCPU & EAP=1; N=152	Union-Management	0.301** (0.143)				0.287** (0.140)
	Other	-0.359 (0.343)				-0.388 (0.344)
	Outside Staffing		-0.054 (0.139)			0.175 (0.156)
	Telephone Hotline			-0.322** (0.158)		-0.212 (0.166)
	No Drug Services				0.737***(0.214)	--
No-Lost-Work Injury Rate						
All with EAP=1; N=876	Union-Management	0.174* (0.091)				0.179** (0.092)
	Other	0.152 (0.282)				0.204 (0.301)
	Outside Staffing		0.108 (0.072)			0.129* (0.075)
	Telephone Hotline			0.041 (0.076)		0.012 (0.078)
	No Drug Services				0.012 (0.136)	-0.505 (0.759)
>=500 employees & EAP=1; N=675	Union-Management	0.189* (0.105)				0.231** (0.106)
	Other	0.255 (0.337)				0.326 (0.364)
	Outside Staffing		0.177** (0.079)			0.198** (0.083)
	Telephone Hotline			0.069 (0.086)		0.023 (0.085)
	No Drug Services				-0.029 (0.148)	-0.328 (0.762)
Manufacturing & EAP=1; N=395	Union-Management	0.108 (0.109)				0.126 (0.113)
	Other	0.116 (0.369)				0.131 (0.442)
	Outside Staffing		0.034 (0.087)			0.061 (0.093)
	Telephone Hotline			-0.015 (0.097)		-0.047 (0.101)
	No Drug Services				-0.046 (0.173)	-0.079 (0.892)
TCPU & EAP=1; N=152	Union-Management	-0.129 (0.184)				-0.137 (0.181)
	Other	0.187 (0.249)				0.067 (0.258)
	Outside Staffing		0.224 (0.173)			0.263 (0.186)
	Telephone Hotline			0.065 (0.163)		0.042 (0.177)
	No Drug Services				0.157 (0.294)	--

See Footntoe in Table 2.

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Appendix

The Impact of Occupational Injury Reduction on the US Economy

The impact of occupational injury reduction on the U.S. economy. Related Articles, LinkOut

Zaloshnja E, Miller TR, Waehrer G.
Am J Ind Med. 2006 Sep;49(9):719-27.
PMID: 16917828 [PubMed - indexed for MEDLINE]

Pacific Institute

FOR RESEARCH AND EVALUATION

October 30, 2004

Final Report Office
Attn: Mary Ann P. Monroe
Acquisition and Assistance
Field Branch, PGO Centers for
Disease Control and Prevention
626 Cochrans Mill Road
Pittsburgh, PA 15236-0070
Re: Final Performance Report for RO1 OH 03750

Dear Ms. Monroe:

Please find enclosed our final performance report for NIOSH grant RO1 OH 03750. As requested, the document includes a final progress report, a final financial status report, and a final invention statement and certification.

This report presents our findings on the relationships between occupational injury rates and establishment practices like safety training, drug testing and employee assistance programs. We examine the effects of workers compensation changes and the passage of the Americans with Disabilities Act on reported injury rates using establishment data. Finally, we examine the effect of the decline in occupational injury rates on job creation and the US GDP using an input-output model.

Our results are presented in greater detail in the four papers that are attached to the summary document. In addition to these four papers, we have also disseminated results on the costs of occupational injury using peer-reviewed journal articles that are listed in the report.

We hope you find this report to be a useful contribution to the field. If you have any questions, please feel free to contact me at (301) 755-2727.

Sincerely,

Ted R. Miller

Calverton Office Park

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