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OCCASIONAL
PAPER

The Effects of Substance Use on Workplace Injuries

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Sponsored by the Commonwealth of Pennsylvania and
the Allegheny County Department of Human Services

CENTER FOR HEALTH AND SAFETY IN THE WORKPLACE

A study by the RAND Institute for Civil Justice and RAND Health

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Preface

Occupational injuries are a serious public-health issue and cause significant morbidity and mortality in the United States. In 2004, there were 3.4 million admissions to emergency rooms for job-related injuries and illnesses, a number that reflects an estimated rate of 2.5 admissions per 100 full-time equivalent (FTE) workers aged 15 and older (CDC, 2007b). In 2005, private industry employers reported 1.2 million injuries and illnesses that required days away from work, representing 135.7 per 10,000 FTE workers (IIF, 2007). The same year, data from the Census of Fatal Occupational Injuries (CFOI) estimated that there were approximately four occupational-injury deaths per 100,000 employed workers, which represented a total of 5,702 such deaths that year (CDC, 2007a). The costs of occupational injuries and illnesses in the United States exceed $100 billion annually and entail both direct (e.g., medical expenses) and indirect (e.g., loss of wages, loss of home, workplace disruption) costs borne by injured workers, their families, other workers through lower wages, firms through lower profits, and consumers through higher prices (Leigh, 2000).

In this paper, we review the literature that has examined the impact of substance use on occupational injuries. We begin briefly by describing the so-called obvious associations between using on the job and occupational injuries and propose alternative reasons that substance use may be linked to work-related accidents. We then review the most-recent empirical literature that has attempted to document the relationship between substance use and occupational injuries. We highlight findings that are consistent across studies and address the limitations that most of these studies confront. We then proceed to examine the policies that attempt to address substance use at the workplace and, often without empirical analysis, hypothesize why each initiative may or may not influence rates of occupational injuries. We conclude by discussing what remains unknown about the relationship between substance use and occupational injuries and identify future avenues for research that could help fill some of these research gaps.

The research reported in this paper was sponsored by the Commonwealth of Pennsylvania and the Allegheny County Department of Human Services. The paper should be of interest to policymakers interested in workers' compensation, industry drug testing, and injury prevention; clinicians, particularly those who work in emergency departments and trauma centers; researchers interested in injury epidemiology and substance use; and executives interested in learning the role that substance use might play in the injuries experienced by their employees and in policies and initiatives that may minimize these injuries.

The RAND Center for Health and Safety in the Workplace

The RAND Center for Health and Safety in the Workplace is dedicated to reducing workplace injuries and illnesses. The center provides objective, innovative, cross-cutting research to improve understanding of the complex network of issues that affect occupational safety, health, and workers' compensation. Its vision is to become the nation's leader in improving workers' health and safety policy.

The center is housed at the RAND Corporation, an international nonprofit research organization with a reputation for rigorous and objective analysis on the leading policy issues of our time. It draws on the expertise within three RAND research units:

- RAND Institute for Civil Justice, a national leader in research on workers' compensation
- RAND Health, the most trusted source of objective health-policy research in the world
- RAND Infrastructure, Safety, and Environment, a national leader in research on occupational safety.

The center's work is supported by funds from federal, state, and private sources. For additional information about the center, please contact

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Abbreviations

ADA	Americans with Disabilities Act
CFOI	Census of Fatal Occupational Injuries
CI	confidence interval
DSM-III-R	*Diagnostic and Statistical Manual of Mental Disorders: DSM-III-R* (APA, 1987)
EAP	employee-assistance program
ED	emergency department
FTE	full-time equivalent
ICD-9	International Classification of Diseases, 9th rev. (WHO, 1977–1978)
IOM	Institute of Medicine
ME	medical examiner
MOD	modification factor
NAIC	National Association of Insurance Commissioners
NCOIL	National Conference of Insurance Legislators
NHIS	National Health Interview Survey
NHSDA	National Household Survey on Drug Abuse
NLSY	National Longitudinal Survey of Youth
NSDUH	National Survey on Drug Use and Health
NTOF	National Traumatic Occupational Fatalities
OR	odds ratio
OSHA	Occupational Safety and Health Administration
UPPL	Uniform Accident and Sickness Policy Provision Law
USCG	U.S. Coast Guard
USPS	United States Postal Service

CHAPTER ONE

Introduction: Epidemiology of Occupational Injury and Employee Substance Use

Occupational injuries are a serious public-health issue that cause significant morbidity and mortality in the United States. In 2004, there were 3.4 million admissions to emergency rooms for job-related injuries and illnesses, a number that reflects an estimated rate of 2.5 admissions per 100 full-time equivalent (FTE) workers aged 15 and older (CDC, 2007b). In 2005, private industry employers reported 1.2 million injuries and illnesses that required days away from work, representing 135.7 per 10,000 FTE workers (IIF, 2006). The same year, data from the Census of Fatal Occupational Injuries (CFOI) estimated that there were approximately four occupational-injury deaths per 100,000 employed workers, which represented a total of 5,702 such deaths that year (CDC, 2007a). The costs of occupational injuries and illnesses in the United States exceed $100 billion annually and entail both direct (e.g., medical expenses) and indirect (e.g., loss of wages, loss of home, workplace disruption) costs borne by injured workers, their families, other workers through lower wages, firms through lower profits, and consumers through higher prices (Leigh, 2000).

Injury is one of many adverse consequences of substance use and misuse, and substance use and misuse are therefore often suspected to contribute to occupational injuries. A significant share of full-time workers report heavy alcohol use or illegal drug use and meet criteria for substance-use disorders, which make these conjectures even more salient. For instance, according to the 2002, 2003, and 2004 National Surveys on Drug Use and Health, approximately 9 percent of 18- to 64-year-old full-time workers met criteria for heavy alcohol use and 9 percent met criteria for past-year alcohol dependence or abuse. With respect to drug use, 8 percent of 18- to 64-year-old workers reported any illicit drug use in the past month, and 3 percent met criteria for past-year drug dependence or abuse (Larson et al., 2007). A survey of U.S. workers conducted in 2002–2003 indicated that, in the preceding 12 months, 7 percent had drunk during the workday, 1.7 percent had worked under the influence of alcohol, and just over 9 percent had worked with a hangover (Frone, 2006a) while 3 percent had used illicit drugs when at work (Frone, 2006b).

Although the relationship between substance use and occupational injuries has been deemed seemingly obvious, researchers often encounter difficulty in their attempts to quantify this association (Normand, Lempert, and O'Brien, 1994). This is due in large part to the methodological complexities inherent in these types of investigations, and, as a result, research findings are generally mixed. However, fueled in large part by increased media scrutiny on work-related accidents attributed to substance use on the job, often with grave consequences, employers and policymakers have designed and implemented workplace programs and policies, such as drug testing and employee-assistance programs (EAPs), to help minimize the burden that substance use and misuse may have in terms of adverse work-related outcomes and

behaviors. Although the relationship between substance use and occupational injuries is poorly understood, reducing such injuries is often one of the primary justifications for implementing these programs (Roman and Blum, 2002).

In this paper, we review the literature that has examined the impact of substance use on occupational injuries. We begin briefly by describing the so-called obvious associations between using on the job and occupational injuries and propose alternative reasons that substance use may be linked with work-related accidents. We then review the most-recent empirical literature that has attempted to document the relationship between substance use and occupational injuries. We highlight findings that are consistent across studies and address the limitations that most of these studies confront. We then proceed to examine the policies that attempt to address substance use in the workplace and, often without empirical analysis, hypothesize why each initiative may or may not influence rates of occupational injuries. We conclude by discussing what remains unknown about the relationship between substance use and occupational injuries and identify future avenues for research that could help fill some of these research gaps.

CHAPTER TWO

Mechanisms Linking Substance Use to Injuries at Work

Almost half of all fatal occupational injuries are transportation incidents, and the remainder are generally grouped into being struck by an object, falling to a lower level, or being the victim of a homicide (CDC, 2007a). In many of these instances, findings from experimental studies on the impact of substance use, particularly alcohol and sedative use, on impairments in reaction time, reasoning, coordination, care, and judgment may explain why even minimal amounts of substance use while working may increase a worker's risk of being injured on the job (Normand, Lempert, and O'Brien, 1994). On the other hand, laboratory studies have indicated that moderate levels of drug use may not affect a worker's ability to perform certain work-related tasks, particularly those that are simple and repetitive (Fischman and Schuster, 1980; Holcom, Lehman, and Simpson, 1993). Studies have also consistently shown that homicide victims often have elevated levels of alcohol in their bodies, which may be attributed to the alcohol and other drugs' suppression of the central nervous system, which could lead to an increase in provocative behavior. Alternatively, people who are intoxicated may be more likely to be targeted for other crimes (e.g., robbery) that result in homicide (Goodman et al., 1986). In these cases, the substances' acute intoxication effects are considered the primary causal mechanisms linking substance use to injury, though risk of injury is certainly influenced by environmental conditions (e.g., driving a car, noise and lighting, victimization).

In addition to the acute effects of alcohol and other drug use on judgment and psychomotor skills, substance use that occurs hours before a worker begins his or her shift can cause spillover effects, such as fatigue and hangovers, that may independently increase injury risk. Hangovers exist not only for alcohol use but for drug use as well (Chait, Fischman, and Schuster, 1985). While experimental research on the effects of hangovers and spillover effects of substance use is scant, some studies have shown that hangovers affect cognitive skills, including tasks related to driving or piloting aircraft, which may therefore influence the risk of injury in a manner similar to the influences of acute alcohol intoxication (Lemon, 1993; Yesavage and Leirer, 1986).

An alternative explanation linking substance misuse to occupational injuries is based on the hypothesis that persons more likely to misuse alcohol and other substances may be more likely to be engaged in other behaviors that increase the risk of injury, a concept termed *deviance proneness* (Dawson, 1994; Lehman et al., 1995; Newcomb, 1994; Spicer, Miller, and Smith, 2003). As we report later, rather than examining intoxication's acute effects on injuries, researchers often use self-reports of drinking patterns in some past interval and, in many cases, have found that reports of heavy use or misuse increase the risk of occupational injuries during a corresponding period of time (Dawson, 1994; Stallones and Xiang, 2003). The concept of deviance proneness hypothesizes that, among workers, heavy substance use or misuse is one

of a constellation of deviant behaviors that may also include increased risk taking, sensation seeking, and noncompliance with workplace safety policies (Spicer, Miller, and Smith, 2003). In other words, substance use may be a symptom of an underlying construct that increases individuals' risk of being injured on the job while not independently causing the injury. In fact, empirical research that has accounted for other risk-taking dispositions has found that positive relationships between substance use and injury are often attenuated when controlling for these other behaviors, lending support to this theory (Cherpitel, 1999; Spicer, Miller, and Smith, 2003).

Economics provides a final explanation for why substance use may be associated with occupational injuries. In their study on the effect of drugs on workplace accidents, which we describe in more detail later, Kaestner and Grossman (1995) hypothesize that, because workplace accidents result in loss of income (i.e., forgone earnings minus any workers' compensation benefits), a negative relationship between wages and drug use (i.e., people are less likely to use drugs as the "cost" of missing work increases) and positive relationship between workers' compensation benefits and drug use (i.e., compensation for lost wages associated with missing work) would signal that drug use affects injury risk. We can extend this logic to hypothesize that, if heavy substance use or misuse is associated with lower wages (Buchmueller and Zuvekas, 1998), the "cost" of being injured in terms of forgone earnings may be lower, which could therefore increase a worker's risk of injury. Of course, it is difficult in analyses of wages and substance use to determine the direction of causality.

CHAPTER THREE

Substance Use and Misuse and Occupational Injuries: Empirical Evidence

In 1993 and 1994, two reviews synthesized the empirical literature that aimed to investigate the relationship between substance use and misuse and occupational injuries. In the first of these, Stallones and Kraus (1993) conclude that there was not enough evidence to establish a causal relationship between alcohol use and workplace injuries. A year later, the Institute of Medicine (IOM) released its own review of drugs and the American workforce (Normand, Lempert, and O'Brien, 1994). In the IOM report, the Committee on Drug Use in the Workplace conducted a wider review of the impact of alcohol and other drug use on a range of occupational outcomes, including absenteeism, turnover, job satisfaction, and accidents. With respect to occupational injuries, the committee concludes that, while there was evidence that substance use negatively affected job behaviors and occupational outcomes, including injury, substance use's influence on these injuries was small. More importantly, however, the IOM study highlights the lack of rigorous analytic approaches in most studies, which limited their ability to say anything definitive about the relationship. For example, although many researchers had hypothesized that deviance proneness could be an important omitted factor causing spurious correlation between substance use and workplace injuries in the absence of a causal effect, many studies lacked controls for personality traits and other risk-taking dispositions in multivariate models. In addition, both reviews note that very few studies employed a control group, which limited their ability to estimate differential risk between substance-using and nonusing groups.

In the current study, we review selected studies that have been conducted since the previous review (i.e., 1993–1994), though we highlight findings from earlier studies where relevant. Studies conducted since 1994 were located using PubMed® and Google Scholar™ searches using the terms "occupational injuries" and "workplace injuries" in conjunction with "substance use," "alcohol," and "drug"; additional studies were identified using cited-reference searches. Studies were selected that provided empirical evidence linking any measure of substance-using behaviors with any measure of occupational injury. While many follow the same methodology of the previous studies mentioned in the earlier reviews, some have advanced the research field by using multivariate analysis to control for other related behaviors (e.g., Hoffman and Larison, 1999), a control group for comparison (e.g., Lapham, McMillan, and Gregory, 2003), or alternative identification strategies (e.g., Kaestner and Grossman, 1998) in their attempts to parse out the causal effect of substance abuse on occupational injuries.

We identified a total of 33 studies. Studies varied widely with respect to methods of measuring substance use and injuries, using both subjective (e.g., survey responses) and objective (e.g., diagnostic tests, hospital-chart reviews) measures. We discuss the results from these

studies, presented in categories defined generally by the measurement strategy that each study employed.

Self-Reports of Substance Use and Injury

Studies that used workers' own reports of both injuries and substance use (n = 11) are presented in Table 3.1.

Alcohol Use and Occupational Injuries

Several studies found large, positive effects of self-reported alcohol use on occupational injuries. Stallones and Xiang (2003) examined the relationship between alcohol use and work-related injuries among Colorado farm residents between 1993 and 1995. Drinking had a significant effect on reporting a work-related injury: Those who drank alcohol on average three or more times per week had about 3.2 injuries per 10,000 person-work-days, compared with 1.9 injuries per 10,000 person-work-days for nondrinkers, representing a 70-percent increase in risk.[1] Dawson (1994) showed a positive relationship between drinking five or more drinks daily in the past year and having an on-the-job injury among respondents in the 1998 National Health Interview Survey (NHIS) (odds ratio [OR] = 1.74, 95-percent confidence interval [CI] = 1.38–2.21). Shipp et al. (2005) examined rates of drinking in the past 30 days and self-reported injuries while working for pay among high school–aged workers in Texas. These researchers found that the likelihood of occupational injuries increased from an OR of 1.56 for light users, who reported drinking 1–19 days in the past 30 days, to an OR of 10.55 for heavy users, who reported drinking every day. In a telephone survey of the Canadian population, Wells and Macdonald (1999) found that increased drinking was associated with increased self-reports of accidents for younger adults (15–24) but not for older age categories, though those who drank more than 14 drinks per week were more likely to report having been involved in an accident at work. Mangione et al. (1999) found a parabolic relationship between alcohol use and injury in their multivariate analysis of survey data from several work sites of seven corporations, in which abstainers and heavy drinkers reported roughly the same mean number of injuries on the job (0.30 in the previous 12 months) while very light to moderate-heavy drinkers reported almost half that number.

These positive results are matched by a nearly equal number of studies that used self-reports and found *no* effects of alcohol use on injury. Ames, Grube, and Moore (1997) found no effect of any of their measures of drinking behavior (i.e., drinking before work, drinking at work, being hung over at work, usual drinking, and heavy drinking, which they defined as 10 or more drinks on one occasion in the past year) on workplace injuries in a small sample of manufacturing workers, though they do note a significant effect of drinking on other behavioral problems in the workplace, such as sleeping on the job or arguments with coworkers. Veazie and Smith (2000) and Hoffman and Larison (1999) also found no significant relationship between drinking and traumatic injuries at work in two different nationally representative samples: Veazie and Smith (2000) used various levels of drinking over the past year in the

[1] Ten thousand person-days is about 40 years of work. So 3.2 injuries per 10,000 person-days is an annual rate of 8.0 injuries per 100 workers. The rate for nondrinkers would be 4.8 per 100 workers. If 10 million workers are drinkers (out of 140 million), that would be an excess of 320,000 injuries due to drinking each year.

Table 3.1
Studies Using Self-Reports of Injury and Substance Use

Author	Sample	Analysis	Measure of Substance Use	Measure of Injury	Findings
Ames, Grube, and Moore (1997)	832 hourly employees at a manufacturing facility in the U.S, collected over 5 years	Observational, cross-sectional	Self-report: Alcohol use (during and prior to work, frequency of working while hung over)	Self-report: Work injury in past year	Alcohol use was not associated with injury but was associated with sleeping on the job and arguments with coworkers.
Dawson (1994)	29,192 adults in the 1988 NHIS	Observational, cross-sectional	Self-report: Alcohol use (number of days drank ≥5 drinks in past 12 months)	Self-report: Work injury in past year	Daily heavy drinkers and less frequent heavy drinkers were more likely to report an on-the-job injury.
Frone (1998)	319 working adolescents in New York State, 1996	Observational, cross-sectional	Self-report: Alcohol and marijuana (frequency of use, on-the-job frequency of use)	Self-report: 7 types of work injuries during past 9 months	On-the-job (but not general) substance use was associated with work injuries.
Hoffman and Larison (1999)	9,097 workers in the 1994 NHSDA	Observational, cross-sectional	Self-report: Past-year alcohol use (10-item scale of DSM-III-R alcohol-use disorders); past-year use of cocaine/marijuana	Self-report: Work injury in past year	No association was found between drinking, marijuana or cocaine use, and work- related accidents.
Holcom, Lehman, and Simpson (1993)	1,325 municipal workers in southwestern U.S.	Observational, cross-sectional	Self-report: Alcohol and drug use (use at work, recent use, lifetime use, light/heavy drinking)	Self-report: Minor or disabling injury, or accident not causing injury but disrupting work or damaging equipment	Employees in high-risk jobs who have had accidents were more likely to have used drugs or alcohol at work (21% vs. 6%) and illicit drugs, both in the past year (17% vs. 4%) and in their lifetime (34% vs. 24%) than were high-risk workers without accidents. There was no significant difference for employees in the low-risk-job sample.
Kaestner and Grossman (1998)	3,100–4,300 white workers from NLSY, followed at 1984, 1988, & 1992 waves	Observational, longitudinal	Self-report: Drug use (quantity of past-month marijuana use, ever and recent use of cocaine)	Self-report: Work injury/illness in past year	Men (1988): Use of marijuana or cocaine increased the risk of an accident by 25% over nonusers' risk. Women (1988): Use of cocaine increased the risk of an accident by 36% over nonusers' risk. Wages decreased drug use; workers compensation had little effect on drug use.
Mangione et al. (1999)	6,540 employees from 16 work sites in 7 corporations, 1994	Observational, cross-sectional	Self-report: Problem alcohol use (CAGE)[a]	Self-report: Work injury in past year	There is a parabolic relationship between drinking and injuries, with abstainers and heavy drinkers having the highest injury rates.

Table 3.1—Continued

Author	Sample	Analysis	Measure of Substance Use	Measure of Injury	Findings
Shipp et al. (2005)	3,365 high-school students in Texas, 1995	Observational, cross-sectional	Self-report: Alcohol and drug use (past-30-day use of alcohol, marijuana; lifetime use of cocaine, inhalant, and steroids)	Self-report: Injury while working for pay, during lifetime	For all substances, risk of injury increased with increasing rates of current and lifetime use.
Stallones and Xiang (2003)	872 Colorado farm residents at baseline (1993): 746 at year 2 follow-up, 643 at year 3	Observational, longitudinal	Self-report: Alcohol use (quantity and frequency, past week and past month)	Self-report: Work injury in past year	Farmers who drank more frequently had higher injury-incidence rates (3.09 for moderate drinkers and 3.35 for heavy drinkers per 10,000 days vs. 1.94 for abstainers). As days of drinking increased, so did the odds of reporting a work injury (OR = 1.44–1.45).
Veazie and Smith (2000)	8,569 24- to 32-yr-olds in 1989 NLSY	Observational, prospective, cross-sectional	Self-report: Alcohol use (quantity and frequency of current drinking, heavy drinking, and alcohol dependence)	Self report: Injury, excluding strains and sprains, in past 6 mos.	No cross-sectional link was found between work-related accidents and drinking. Prospectively, a positive and significant association was attenuated when other risk factors (e.g., job risk, managerial responsibilities, education) were included in multivariate models.
Wells and Macdonald (1999)	10,385 Canadians aged 15 and older	Observational, cross-sectional	Self-report: Alcohol use (quantity and frequency in the past week and past year, past-year heavy drinking)	Self-report: At least one accident in the past year while working at a job	Heavy weekly drinking was linked with self-report of having at least one accident in the past year while working; increased drinking was linked with having at least one accident while working for young adults (15–24) but not for older age groups.

NOTE: NHIS = National Health Interview Survey. NHSDA = National Household Survey on Drug Abuse. DSM-III-R = Diagnostic and Statistical Manual of Mental Disorders: DSM-III-R (APA, 1987). NLSY = National Longitudinal Survey of Youth. OR = odds ratio.

[a] CAGE is an abbreviation for a four-question inquiry to help professionals assess an individual's level of alcohol use: whether the person has ever felt the need to cut down on his or her drinking, whether people have annoyed the person by criticizing his or her drinking, whether the person has ever felt guilty about his or her drinking, and whether the person has ever felt the need for an eye-opener, or early-morning drink, to steady his or her nerves or to soothe a hangover.

1989–1990 NLSY using the 1979 cohort; Hoffman and Larison (1999) used a semicontinuous measure for days of drinking in the past year in the 1994 NHSDA.

Drug Use and Occupational Injuries

In their analysis of the 1994 NHSDA, Hoffman and Larison (1999) not only looked at alcohol use, but also examined the impact of drug use on occupational injuries using semicontinuous measures of marijuana or cocaine use over the past year and found no evidence of a relationship between drug use and occupational injuries. This finding, however, stands in contrast to three studies that all found evidence of significant, positive relationships between self-reports of drug-use frequency and work-related injuries. Shipp et al. (2005) examined frequency of alcohol use, binge drinking, and marijuana use over the past 30 days and lifetime frequency of marijuana, cocaine, inhalant, and steroid use. In this study of high school–aged workers, the odds of reporting an injury at work increased as frequency of use increased across all measures of substance use. Frone (1998) also studied high school–aged workers and found that self-reported *on-the-job* substance use (using a scale developed for the study based on eight frequency items related to alcohol and marijuana use) had a significant, positive effect on the probability of injury, though he did not find any relationship between general substance use and injury. Using the NLSY, Kaestner and Grossman (1998) found that past-year use of marijuana and cocaine increased the probability of reporting a workplace accident over the same time period by 25 percent among men, though there was no evidence of a relationship among women (we discuss differences by sex later).

Critique of Self-Report Methods

The use of self-report for substance use and injury is appealing for many reasons. As opposed to objective reports of injuries (via administrative records, for example), self-reported measures will more likely capture less severe injuries, such as those that do not result in a hospital visit. Self-reports of substance-using behaviors enable researchers to measure *patterns* of substance-using behaviors that are difficult to objectively measure (e.g., binge drinking or substance-use disorders). On the other hand, there are inherent limitations to using self-report data. Self-reported drug and alcohol use is always suspect due to systematic underreporting (Johnson and Fendrich, 2005). Employees may underreport injuries at work if they fear being punished for acknowledging a workplace injury (Dembe, 2001). Even when employees are not intentionally trying to give inaccurate information on a survey, poor recall will affect results when survey respondents are being asked to describe substance use or injuries in the past 30 days, past year, or throughout the entire course of their lives (Johnson and Fendrich, 2005). This may also affect the recall of less severe injuries, since respondents may be more likely to forget past injuries that were not severe.

Objective Measures of Injuries

Four studies used workers' own reports of substance use and objective reports of injuries—namely, workers' compensation claims and medical records. An additional study used administrative records of substance use and measured injuries from administrative records kept for the purposes of federal reporting. These studies are presented in Table 3.2.

Table 3.2
Studies Using Objective Measures of Injury

Author	Sample	Analysis	Measure of Substance Use	Measure of Injury	Findings
Chau et al. (2004)	880 male construction workers with injury in France, 1996	Observational, cross-sectional	Self-report: Alcohol (never/ sometimes/every day)	Injury reported by occupational physician	No association found between drinking and work-related accidents.
Kaestner and Grossman (1995)	3,300 white workers from NLSY, followed at 1984, 1988, & 1992 waves	Observational, longitudinal	Self-report: Drug use, (quantity of past-month marijuana use, ever and recent use of cocaine)	Indirect (wages and workers' compensation)	Workers' compensation claims predict lower drug use, and wages predict higher drug use (suggest that drug use does not have a significant effect on workplace injuries).
Ragland et al. (2002)	1,836 transit (bus) operators in San Francisco, 1983–1985	Observational, pooled, cross-sectional	Self-report: Alcohol use (quantity per week)	Workers' compensation claim filed	Those reporting 10–14 drinks per week had a risk ratio of 1.3, while those who drank 15 or more drinks per week had a risk ratio of 1.27 relative to abstainers.
Stockwell et al. (2002)	797 matched pairs (injured/ control) in western Australia, 1997	Quasi-experimental, cross-sectional	Self-report: Current drinking (categorical for no. per week), checked against breathalyzer results; drug use by type of drug	Emergency department (ED) visit for work-related event (interviewed while waiting for treatment)	Working increased the risk of visiting the ED for an injury, but adding alcohol actually decreased risk of injury, suggesting a "protective effect."
Spicer, Miller, and Smith (2003)	26,413 matched pairs (postinjury) of hourly transportation workers in U.S., 1993–1998	Quasi-experimental, pooled, cross-sectional	Administrative records: Health report included a substance use–related (1) disciplinary action, (2) visit to company's EAP, or (3) absence	Internally reported injury records	Problem substance use was not associated with injuries once problem behaviors were controlled for.

Workers' Compensation Claims and Other Administrative Records

Ragland et al. (2002) found a significant but small relationship between frequency of alcohol use over an average week and the incidence of workplace injuries in a study of urban transit operators, using workers' compensation claims as a proxy for injuries. They found that heavy drinkers had an approximate 30-percent increase in risk for filing a workers' compensation claim. Kaestner and Grossman (1995) also used workers' compensation claims, along with wages, to examine the relationship between injury and drug use. As described earlier, they hypothesized that drug use will decrease with higher wages and increase with higher rates of workers' compensation claim, due to the effects on the opportunity cost (i.e., forgone earnings)

of using drugs. The results of their analysis, however, did not support their hypothesis. Instead, they saw insignificant and negative effects of workers' compensation on past-year marijuana or cocaine use, which, by their reasoning, suggests no correlation between drug use and on-the-job injuries. Spicer, Miller, and Smith (2003) examined employee records among transportation workers, where substance use was measured as having had any substance-related disciplinary action, alcohol or drug-related visit to the EAP, or an excused, unpaid absence from work-related to substance use. They examined whether a composite of these dichotomous measures was associated with internally reported injury records. After controlling for other behavioral characteristics, such as absenteeism and dishonesty or unprofessionalism, no relationship was found between problem substance use and injury.

Medical Records

Medical records are another tool used to objectively measure occupational injuries. Chau et al. (2004) used occupational physician records of work-related injuries and examined self-reported predictors of causes and severity of injuries across various occupational categories of construction workers. They found no significant effects of alcohol use on the frequency of hospitalization or length of sick leave. Stockwell et al. (2002), in a quasi-experimental study in Australia, used a sample of ED visitors to measure the association between injury and alcohol use, both on and off the job. While they found that working increased the risk of visiting the ED for an injury, when they included self-reports of alcohol in the regression model and therefore removed alcohol's latent effect on working's risk of injury, the association between work and injury increased, suggesting that alcohol actually had a "protective effect." They suggest that this may be because workers may avoid high-risk work tasks while intoxicated or that the drinking may have occurred after work but before going to the ED.

Critique of Objective Measures of Injury

These studies make an effort to avoid the pitfalls of using self-reported injuries, but there are limitations to these approaches as well. Studies that use workers' compensation claims are retrospective, so it is difficult to ascertain the amount of alcohol or drugs in someone's system at the time of injury or during the period around the injury date. Additionally, administrative records on workers' injuries may be biased because employees may fear socioeconomic disincentives for making an injury aware to their employers; employers, on the other hand, may file incomplete reports out of fear of increased regulatory or financial burdens (Dembe, 2001; Rosenman et al., 2006). The major limitation to studies that use ED visits to measure injuries is that only about one-third of all occupational injuries and illnesses result in a visit to the ED, so it yields an undercount of injuries and is likely to only capture the most severe and omit those that do not require professional treatment (CDC, 2001). Similarly, only the most severe injuries will be captured using objective measures and such studies are therefore not generalizable to the full spectrum of injuries experienced in the workplace. In addition, the identification of work-related cases is dependent on the injured or ill worker reporting that the injury was work-related and that this be noted in the patient's medical chart.

Objective Measures of Substance Use

The five studies presented in Table 3.3 are those that have used objective measures of both substance use and injuries. Ohsfeldt and Morrisey (1997) used state-level variation in beer taxes across states over a 10-year period, which the authors use as a proxy for alcohol abuse and has been used previously in studies relating alcohol use to other outcomes. The other four papers

Table 3.3
Studies Using Objective Measures of Substance Use

Author	Sample	Analysis	Measure of Substance Use	Measure of Injury	Findings
Gerber and Yacoubian (2002)	69 construction companies with and without drug testing in place, 1995–2000	Quasi-experimental, longitudinal	Drug testing: Companies with drug testing versus those without	Workers' compensation modification factors (rates based on injury rate)	Modification factors and injury rate per 200,000 work hours significantly decreased over time for drug-testing companies and stayed static for nontesting companies.
Normand, Salyards, and Mahoney (1990)	5,465 job applicants to USPS were followed from drug testing in 1987–1988 for 1–2 years	Quasi-experimental, longitudinal	Drug testing: Positive test of urine sample for amphetamine, barbiturates, benzodiazepines, cocaine, marijuana, methadone, opiates, phencyclidine	Any injury or accident reported on administrative forms	No significant effects on injuries or accidents were found due to substance use.
Ohsfeldt and Morrisey (1997)	13,510 industries across the U.S., 1975–1985	Ecological, observational, pooled, cross-sectional	Taxes: Real excise tax per six-pack inclusive of federal and state levies plus sales tax (if any)	Lost workdays due to nonfatal injury per 100 FTE workers	Increases in beer tax were associated with reductions in lost work days due to nonfatal injury per 100 FTE workers (for, e.g., in 1992, a $0.25 increase in beer tax would have reduced lost workdays to injury by about 4.6 million days).
Pollack et al. (1998)	7,895 construction workers in Washington State, 1990–1991	Observational, pooled, cross-sectional	Administrative records: ICD-9 substance-abuse diagnosis on health-insurance records	Workers' compensation claim filed	Among 25- to 34-yr-olds, the rate of injury per 100 was nearly doubled for persons with substance abuse (OR = 1.93). For the total population, the OR (= 1.39) was not significant.
Zwerling, Ryan, and Orav (1990)	2,537 job applicants for USPS, 1986–1989	Quasi-experimental, longitudinal	Drug testing: Positive test split into three categories: marijuana, cocaine, and other drugs	Any injury or accident reported on administrative forms	Positive screen for marijuana was linked with subsequent injuries and accidents; screen for cocaine was weakly linked with subsequent injury.

NOTE: USPS = United States Postal Service. ICD-9 = International Classification of Diseases, 9th rev. (WHO, 1977–1978).

generally relied on either diagnoses of substance-use problems or workplace alcohol and drug testing.

Substance-Use Diagnoses

One objective measure of adverse substance-using behaviors is a record of having received some type of professional care for a substance-use problem, a method employed in two of the studies we identified. Pollack et al. (1998) examined construction workers in Washington State, matching diagnoses of substance abuse from health-insurance records to workers' compensation records. They found that, for 25- to 34-year-olds, those diagnosed with substance-use disorders were more likely (by 11 percentage points) to have filed a workers' compensation claim. However, they found no difference for workers from other age groups, though their results were based on univariate associations (meaning that other relevant factors, such as other risk-taking behaviors common among young workers, were not accounted for in the analysis).

Workplace Alcohol and Drug Testing

Another objective method of substance use is the result of employee-sponsored alcohol and drug tests (discussed in more detail in Chapter Five). Normand, Salyards, and Mahoney (1990) was one of two studies that used preemployment urinalysis among postal workers to measure drug use, the results of which were then matched to subsequent injuries and accidents. They found no effect of positive urinalysis for any drug on rates of injuries and accidents. The other study did find a positive relationship between positive preemployment urinalysis screens for marijuana and cocaine and the risk of subsequent accidents and injury among postal workers (Zwerling, Ryan, and Orav, 1990). These conflicting findings may be reconciled by differences in the study designs: Zwerling and colleagues' study looked at postal employees in only one location, while Normand et al. collected data from 21 USPS sites across the country, and geographic variation in the association may dilute any positive effects that exist at specific locations; Normand et al. also studied a wider panel of drugs.

Gerber and Yacoubian (2002) also used company drug testing as their measure of substance use but examined rates of injury at the company, rather than individual, level. If we assume that drug testing is effective in reducing substance use (we discuss evidence of this); a causal effect of substance use on injuries would be supported by evidence that shows that companies that implement drug testing have lower injury rates. These authors compared a sample of companies' workers' compensation insurance premiums (or experience-rating modification factors [MODs]), which go up and down based on the companies' previous injury rates. Over the course of the study period (1995–2000), MODs and injury rates decreased significantly for 49 companies that implemented drug testing while staying static for 20 nontesting companies.

Critique of Objective Measures of Substance Use

While studies that use objective measures of substance use may reduce underreporting of drug use via self-report, there are certain limitations to this approach as well. First and foremost, there is little information on how accurately a positive *preemployment* test may predict use after employment, and drug testing will not necessarily capture patterns of drug-using behaviors that may influence occupational injuries, such as binge drinking. On the other hand, drug-testing results will capture drugs used by workers for only a limited, proximal time span and thus miss certain substance-using patterns that may be relevant among those who are "devi-

ance prone." Hospital records or company referrals are also likely to underestimate the prevalence of substance-use disorders. According to a recent, nationally representative survey, only 10 percent of those with a probable substance-use disorder used specialty substance-abuse services in the past year (Mojtabai, 2005). Finally, it is possible that such measures are subject to selection biases: There may be systematic differences between workers who are tested for alcohol and other drugs and those who are not or between which workers with substance-use problems access EAPs and which do not.

Fatal Occupational Injuries

Finally, the seven studies presented in Table 3.4 looked at the effect of alcohol and other drug use on fatalities that occur while at work, typically using postmortem toxicology reports to identify the presence of alcohol or other drugs in the system.

All but one of the studies in this category looked at the proportion of decedents in work-related accidents with alcohol present in their systems (Bernhardt and Langley, 1999; Greenberg, Hamilton, and Toscano, 1999; Harrison, Mandryk, and Frommer, 1993; Lindström, Bylund, and Eriksson, 2006; Lipscomb, Dement, and Rodriguez-Acosta, 2000; Sahli and Armstrong, 1992). Collectively, these studies estimate the presence of alcohol among occupational fatalities to range from 4 percent to 20 percent, with the majority falling between 15 and 20 percent. These studies also vary with respect to the population that was studied (e.g., work-related road fatalities [Harrison, Mandryk, and Frommer, 1993] to fatalities among construction workers [Lipscomb, Dement, and Rodriguez-Acosta, 2000]), as well as by the level of blood alcohol that indicated a positive screen. The other study (Lucas and Lincoln, 2007) examined fatal deaths from fishing vessels in Alaskan waters for which substance use was indicated in the investigative records; over a 15-year period, the researchers estimated that 20 percent of these fatalities involved alcohol.

Critique of Studies of Fatal Occupational Injury

These studies provide a good indication of the role that substance use plays in fatal occupational injuries. However, the results of these studies should be interpreted cautiously. Perhaps most importantly, not all fatalities are given toxicology screens (Greenberg, Hamilton, and Toscano, 1999), and there may be a bias regarding who is screened for the presence of alcohol and who is not.

There are other limitations to studies using mortality statistics. Very few studies give any reference to rates of acute intoxication among coworkers who do not get into fatal or nonfatal accidents. Thus, while the proportion of fatal occupational injuries screening positive for traces of drugs or alcohol is higher than any reasonable estimate of the percentage of workers who use alcohol or drugs on the job, it is difficult to estimate the magnitude of the effect or the risk that substance use poses for having a fatal occupational injury. Studies also do not generally provide comparisons to the nonworking population, though those studies that do indicate that traces of alcohol and other substances are much lower among fatal *occupational* injuries than among fatal *nonoccupational* injuries (e.g., Lindström, Bylund, and Eriksson, 2006; Lipscomb, Dement, and Rodriguez-Acosta, 2000). In addition, identifying fatal occupational injuries in this setting typically requires that the certifier positively mark an "injury at work?" item on the

Table 3.4
Studies Examining Fatal Occupational Injuries

Author	Sample	Analysis	Measure of Substance Use	Measure of Injury	Findings
Bernhardt and Langley (1999)	342 tractor fatalities in North Carolina, 1979–1988	Observational, pooled, cross-sectional	Toxicology screen: Detectable blood alcohol level	Fatality, as derived from ME records	19% of fatalities had detectable blood alcohol level.
Greenberg, Hamilton, and Toscano (1999)	CFOI with toxicology reports: 1,899 occupational fatalities in 1993 and 1,242 in 1994	Observational, pooled, cross-sectional	Toxicology screen: Positive postmortem toxicology results for alcohol and drugs	Fatality, as recorded in the CFOI	20% of all fatalities had positive alcohol or drug tests (though only one-quarter of all fatalities had toxicology reports).
Harrison, Mandryk, and Frommer (1993)	1,544 work-related road fatalities in Australia, 1982–1984 (366 were in the course of work; rest were commuting and other related road fatalities)	Observational, pooled, cross-sectional	Toxicology screen: Blood alcohol ≥ 0.05	Fatality, as derived from coroner records	Of the 76% of at-work cases that had blood alcohol data, 15% had blood alcohol above the threshold. For commuting and other related fatalities, 13% were above the threshold.
Lindström, Bylund, and Eriksson (2006)	285 electricity-related fatalities in Sweden, 1975–2000	Observational, pooled, cross-sectional	Toxicology screen: Presence of any positive blood alcohol level	Fatality, as derived from National Cause of Death Register	132 of 285 deaths were occupational, though most of the 20% of decedents found to have alcohol in their systems died during leisure activities.
Lipscomb, Dement, and Rodriguez-Acosta (2000)	2,839 fatalities in North Carolina, 1988–1994, for those under 65 in construction trade (152 occurred at work)	Observational, cross-sectional	Toxicology screen: Presence of any positive blood alcohol level	Fatality, as derived from ME records	4% of all work-related deaths involved alcohol impairment, while 56.5% of non–work-related fatalities did.
Lucas and Lincoln (2007)	71 fatalities in Alaskan waters, 1990–2005, defined as occupationally related by the National Traumatic Occupational Fatalities (NTOF) Surveillance System	Observational, pooled, cross-sectional	Whether the USCG and state trooper investigation reports concluded that alcohol was a factor; not always based on blood alcohol levels	Fatality, as derived from USCG reports, Alaska state trooper reports, ME records, and death certificates	20% of fatal falls involved alcohol.
Sahli and Armstrong (1992)	50 occupational, confined-space fatalities in Virginia, 1979–1986	Observational, pooled, cross-sectional	Toxicology screen: Blood alcohol ≥ 0.06	Fatality, as derived from death certificates, workers' compensation files, OSHA lists, and ME records.	Of 43 decedents tested, 2 (5%) had blood alcohol levels above the threshold.

NOTE: ME = medical examiner. USCG = U.S. Coast Guard. OSHA = Occupational Safety and Health Administration.

death certificate, information that may be difficult for him or her to ascertain when completing this form.

Intervention Studies

Intervention studies are an appealing way to examine the relationship between injuries and alcohol and other drug use because of their ability to define intervention and control groups and observe data before and after a clear change in practice. We identified five intervention studies that examined occupational-injury outcomes; they are presented in Table 3.5.

Spicer and Miller (2005) looked at the effect of PeerCare, a substance-abuse prevention and early intervention program that uses the occupational peer group to achieve a cultural shift from enabling working under the influence of drugs or alcohol to maintaining a substance-free workplace. The PeerCare program trains workers to identify, intervene, and refer coworkers who may have substance-use problems to an EAP or other resources. The study followed 26,000 employees over 13 years, comparing monthly injury rates at the study company with injury rates at four other comparable companies in the same industry, with substance use measured via random drug-test results. The intensity of the intervention was measured over time based on the phase implementation using the percentage of employees covered under the program. The authors found that, for every 1-percent increase in workforce covered by the intervention, monthly injury rates decreased by 0.16 percent, resulting in a 13.8-percent decrease in monthly injuries when intervention participation reached its peak (i.e., 86 percent of employees in the study company covered). This was significant even when other covariates were included, though the intervention's impact was somewhat diminished when industry-wide random drug and alcohol testing was implemented during the later years of the study period.

Lapham, McMillan, and Gregory (2003) conducted an intervention for health-care professionals working for a managed-care organization. An intervention group consisted of 3,442 professionals at one site who were given substance-use counseling, education, and awareness training but no random testing. The control group consisted of 2,032 employees of the same company at other locations, and both groups were followed for a three-year period. Alcohol use—specifically, the amount and frequency of binge drinking—was self-reported by all employees and compared to the average monthly injury rate. Looking at the data pre- and postintervention, the authors found no significant effect of the intervention on injury rates or binge drinking.

Ozminkowski et al. (2003) looked at the effect of drug testing via urinalysis on work-site injury rates at a manufacturing company. Their intervention included pre-employment, reasonable cause, postaccident, and random drug testing, as well as stricter punishment for undisclosed use and greater benefits for disclosing use and seeking treatment. Controlling for various other personal characteristics (age, sex, race, duration of employment, and occupation), they concluded that there was a significant relationship between testing and decreased injury rates and that doubling testing rates would reduce the odds of injury by more than half. However, the authors recognized in this study that, in that company, injury rates were already very low, so increased testing would result in a small overall change. A similar strategy was employed by Snowden et al. (2007), who examined alcohol-related fatal crashes of drivers of large trucks from 1988 through 2003 on public roadways before and after implementation of random alcohol testing on August 1, 1994. They found that implementing such testing resulted in a

Table 3.5
Studies of Intervention

Author	Sample	Analysis	Measure of Substance Use	Measure of Injury	Findings
Lapham, McMillan, and Gregory (2003)	3,442 managed-care organization workers at one site were administered the intervention between 1997 and 2000, compared to 2,032 control employees at other locations	Intervention, longitudinal (pre- and post-intervention)	Self-report: Alcohol use (binge-drinking frequency and desire to reduce drinking, past 30 days)	Average monthly rate of injury at site	No significant effects of the program on injuries or rates of binge drinking.
Ozminkowski et al. (2003)	1,791 manufacturing employees at 15 work sites of a U.S.-based manufacturing company, 1996–1999	Intervention, pooled, cross-sectional time series	Drug testing: Pre-employment and random urine-sample testing for any illicit drug	Medical report of any work injury for each employee for one month	Doubling testing rates would reduce the odds of injury by more than half, though injury rates were already very low, indicating a relatively small change.
Snowden et al. (2007)	Fatal motor-vehicle crashes, 1988–2003	Intervention, ecological, pooled, cross-sectional time series (pre- and postintervention)	Toxicology screen: Blood alcohol > 0.00	Fatality	There was a significant net reduction in fatal alcohol-involved crashes of 14.5% for drivers of large trucks, controlling for a general trend in reductions of all alcohol-involved fatal crashes.
Spicer and Miller (2005)	26,000 employees tracked through intervention, 1983–1996, with comparison group	Intervention, cross-sectional time series	Drug testing: Random drug and alcohol testing results	Monthly workplace-injury counts	For every 1% increase in workforce covered by intervention, monthly injury rates decreased by 0.16%, resulting in a 13.8% decrease in monthly injuries when intervention participation reached its peak.
Wickizer et al. (2004)	Workers' compensation claims and employer data from Washington, 1994–2000	Quasi-experimental, pooled, cross-sectional time series (pre-, during, post-)	Program participation: Participants in the Washington drug-free workplace program versus nonparticipants	Injuries per 100 person-years	In construction and service industries, a significant effect was seen in reducing injuries over the intervention period as opposed to a fairly static injury rate in the comparison group.

14.5-percent reduction in such crashes after controlling for a general declining trend of alcohol-related fatal crashes during the same period.

Finally, Wickizer et al. (2004) followed 261 companies in Washington State across a variety of industries that had implemented drug-free workplace interventions and compared them to a nonequivalent comparison group of 20,500 companies over six years. Based on the

federal drug-free workplace program, the Washington intervention required companies to do the following: develop formal, written substance-abuse policies; pay for preemployment, post-accident, and posttreatment drug testing; select an EAP and provide treatment for employees through that EAP; ensure that employees received an educational program on substance use annually; and ensure that all supervisors and managers receive two hours of training on substance abuse, treatment referral, and drug testing. Examining injury rates pre- and postintervention, the authors of this study found statistically significant decreases in injury rates at the company level for three of the eight industries (services, construction, and manufacturing), suggesting an industry-specific effect of drug-free workplace interventions and providing some evidence supporting a causal relationship between substance use and being injured at work.

Critique of Intervention Studies

Intervention studies may provide some indication of a relationship between substance use and injury, identified when a reduction in injuries is brought about by an intervention targeting substance-using behaviors. However, a null finding could be interpreted as no relationship between the two constructs, but it could also indicate an ineffective intervention in the presence of an actual relationship. Also, a true intervention study would randomize workers to intervention and control groups such that the two groups have comparable substance-using behavior and risk-taking profiles before the intervention begins. Such studies are rare.

CHAPTER FOUR

Emergent Themes

When examined collectively, a number of themes emerged from the literature. We discuss these in this chapter.

The impact of substance use on occupational injuries varies by age and gender, which may reflect differing rates of substance use and job hazards across these groups. Epidemiologic and surveillance data consistently indicate that male workers are much more likely to suffer both nonfatal and fatal work-related injuries than are female workers, though the gap for nonfatal injuries narrows with increasing age (CDC, 2007b). In addition, survey data indicate that heavy alcohol use and substance disorders are higher among male workers than among female workers (SAMHSA, 2002).

Given these differences in rates of both substance use and occupational injuries, it is likely that there would be differences by gender in the relationship between substance use and injury. Kaestner and Grossman (1998) found such differences: For females, they found no evidence that drug use affects the probability of workplace injuries, though they estimate that drug use leads to about a 25-percent increase in mens' risk of having a workplace injury. They argue that this is a reasonable finding given that the rate of drug use is lower among females and because females tend to work in less hazardous jobs than males. A number of studies found gender to be a significant covariate in their regressions, with males more likely to drink or use drugs, have an injury on the job, or have a correlation between alcohol and substance use and injury (Ames, Grube and Moore, 1997; Hoffman and Larison, 1999; Stallones and Xiang, 2003; Stockwell et al., 2002; Veazie and Smith, 2000). In his study of employed adolescents, Frone (1998) found that gender effects disappear when substance use and job characteristics were entered into the regression model, signifying that males are more likely to be injured on the job either because they are more likely to use alcohol or other drugs on the job or because they are exposed to more physical hazards at work. On the other hand, Ragland et al. (2002) actually found that female transit operators were more likely to have an occupational injury in multivariate models that accounted for substance-using behaviors.

With respect to age, surveillance data indicate that the rate of *nonfatal* injuries declines as age increases, though rates of *fatal* injuries increase with age (CDC, 2007b). Among adults, substance use and substance-use disorders are typically highest among younger adults and decline with age (SAMHSA, 2002). Thus, such findings as those by Pollack et al. (1998) may be expected: These authors found that, among construction workers, there was a positive association between having a recorded substance-use disorder and filing a workers' compensation claim among 25- to 34-year-olds, though not for older age groups. Similar findings were seen among the Canadian population, in which increased drinking was associated with a higher likelihood of being in a work-related accident for younger adults (15- to 24-year-olds) than

older adults (Wells and Macdonald, 1999). This may be the result of a general tendency for greater risk-taking among youth than adults and associated differences in cognitive processes (Steinberg, 2004), though further research is needed to examine the role of age in modifying substance use's effect on occupational injuries.

Some studies have focused exclusively on adolescent workers, which is a group that deserves specific attention. While working is common among adults, it is not as common among youth. Moreover, there is some evidence that young persons who work are more likely to report tobacco use (Ramchand, Ialongo, and Chilcoat, 2007), alcohol use (McMorris and Uggen, 2000), and other drug use (Bachman and Schulenberg, 1993). Two studies focused exclusively on adolescent workers, and both found some positive correlations between substance use and injuries (Frone, 1998; Shipp et al., 2005). However, the relationship between general substance use and injury was not significant when employment characteristics were included in Frone's model, whereas Shipp and colleagues did not condition the sample on workers, so the positive correlation between substance use and workplace injuries could be due entirely to the correlation between substance use and working among this group.

There is also variation in substance use, occupational injuries, and the association between the two across different industries. National estimates reveal notable differences in substance use across categories of occupations and industries. More than 15 percent of persons in construction and extraction occupations and approximately 15 percent of those in installation, maintenance, and repair occupations report heavy alcohol use in the past month. Construction and extraction occupations along with food preparation/service–related occupations had the highest rates of past-year alcohol abuse or dependence (17 percent and 15 percent, respectively). Food preparation/service workers and construction and extraction workers also had the highest rates of past-month illicit drug use (17.4 percent and 15.1 percent, respectively) and past-year drug abuse or dependence (6.5 percent and 6.2 percent, respectively) (Larson et al., 2007). In multivariate analyses controlling for demographic and other covariates (e.g., financial dependents, work hours, job tenure), those in occupations categorized as management, arts/entertainment/sports/media, food preparation/serving, and building and grounds maintenance were more likely than those in other occupations to report using alcohol during the workday (Frone, 2006a), while those in legal, food preparation/serving, and building ground maintenance occupations were significantly more likely to report using illicit drugs in the workplace (Frone, 2006b).

With respect to industry differences, those persons in construction have higher rates of substance use and related disorders than persons in other industries: 16 percent with past-month heavy alcohol use, 14 percent with past-month illicit drug use, 16 percent with past-year alcohol abuse or dependence, and 5 percent with past-year illicit drug abuse or dependence. Heavy alcohol use was also prevalent among those in arts, entertainment, and recreation (14 percent) and mining (13 percent), while those in food service had higher rates of alcohol abuse or dependence (15 percent). Past-month illicit drug use and past-year illicit drug abuse or dependence were highest among accommodation and food-service industries (17 percent and 6 percent, respectively) (Larson et al., 2007).

Rates of occupational injury also vary across occupations and industries. As we might expect, fatal occupational injuries are highest within the mining/natural resource (47.9 per 100,000 employed workers) and construction (14.6 per 100,000 employed workers) industries (NCHS, 2006). Among private companies, the number of injuries and illnesses resulting in days away from work are highest for transportation and material-moving workers. Construc-

tion was the industrial sector with the highest rate of injury and illness resulting in days away from work, but the mining and natural-resources sector had the longest median time away from work, which can be considered a proxy for injury severity (IIF, 2006).

Because certain occupations and industries carry higher risk of injury than others, certain jobs may be riskier for persons whose cognitive or psychomotor skills may be impaired by substance use. In addition, certain workplace policies, such as flexibility of sick-day use, amount of time spent working alone, and time of shift, may allow workers to indulge more in alcohol and substance use or conceal it better from their superiors, which would increase their risk of injury more than their nonusing coworkers in the same positions (Normand, Lempert, and O'Brien, 1994). In industries with policies such as these, we expect a positive significant correlation between substance use and injuries. The Committee on Drug Use in the Workplace (Normand, Lempert, and O'Brien, 1994) pointed out that the transportation industry may see a higher correlation between alcohol and substance use and accidents due to the nature of the work, schedules that limit employee use of sick days when high or drunk, and schedules conducive to the use of stimulants to stay awake on the job. They cite several studies that found that, while less than for off-the-job vehicle accidents, alcohol and substance use is a significant contributor to occupational vehicle accidents. They provide estimates based on a 1990 report that showed that 13–15 percent of fatal truck crashes involved alcohol use and one-third involved alcohol or illicit drug use. Among railroad employees, 27 percent of fatal accidents and 16 percent of nonfatal accidents involved alcohol or substance use. Aviation fatalities showed very low rates of any alcohol or substance use, but there are also much fewer airplane crashes due to any cause, so small sample sizes may prevent any findings similar to other industries (Normand, Lempert, and O'Brien, 1994).

Among the studies in our review, Holcom, Lehman, and Simpson (1993) analyzed the correlation between injury and alcohol and substance use separately for those in high-risk and low-risk jobs. They found a significant difference between users and nonusers in the high-risk group but found no significant results in the low-risk group. Chau et al. (2004) derived ORs for various job categories of construction workers and found significant differences in the odds of injury across the job categories, though they did not find any overall effect of alcohol on injury. Wickizer et al. (2004) looked at this variation in their company-level analysis and found statistically significant decreases in injury rates due to a drug-free workplace intervention in only three of the eight industries examined (services, construction, and manufacturing) and a reduction of serious injuries in the latter two industries. For a company of 50 employees, they estimated that, by implementing drug-free workplace interventions, a firm would save $11,450 in the service industry, $3,800 in the manufacturing industry, and $11,600 in the construction industry (this does not include the cost of an EAP, which they estimate to decrease savings by $1,500–$2,000).

Other factors related to alcohol and substance use, such as social structures and level of risk aversion, may better explain injury than alcohol and substance use do. Positive correlations between substance use and injury may be due to factors that independently lead to both outcomes. As described earlier, deviance proneness, in which substance use is considered one of many deviant behaviors a worker exhibits, is one such explanation. Alternatively, social factors, such as religious and familial associations and the psychosocial work environment, may also be latent factors that "protect" persons from high levels of drug and alcohol use and, independently, from being injured at work (Rugulies and Krause, 2005).

Several studies have tried to control for these other, sometimes hard-to-measure, covariates. Spicer, Miller, and Smith (2003) and Hoffman, Larison, and Sanderson (1997) showed that the estimated positive relationship between substance use and workplace injuries was attenuated and no longer significant when they control for other work-related problem behaviors. Likewise, Frone (1998) found a positive correlation between general substance use and workplace injuries but that the positive correlation disappears when controlling for other factors that could affect the probability of getting injured and that are positively correlated with substance use (such as rebelliousness, job boredom, and impulsivity). Dawson (1994) used smoking as a proxy variable for risk-taking behavior, and the inclusion of this variable attenuated the association of drinking with occupational injury, suggesting that some of the relationship between drinking and injury is explained by risk-taking behavior. And while they still found a significant relationship between substance use and injury, Holcom, Lehman, and Simpson (1993) found that an index of "general deviance" behaviors that included measures of religious attendance, parent's substance use, depression, problematic peers, and other related issues was positively associated with higher rates of occupational injury.

In their assessment on the impacts of wages and workers' compensation on drug use, Kaestner and Grossman (1995) also controlled for religiosity and previous crimes and found (as expected) that religiosity was inversely, and previous crime was directly, associated with drug use. However, this study is not fully comparable with the other studies mentioned due to the methodological strategy they employed (i.e., the use of wages and workers' compensation benefits as indirect measurements of injury risk). In a different approach, these same authors instrumented for drug use with religiosity, personality variables (e.g., self-esteem), and area-specific factors (including local crime and poverty rates and the urbanicity of the area) (Kaestner and Grossman, 1998). However, while they do find some significant relationships between substance use and injury at work among males, these instruments are questionable in their validity because they could have independent effects on the probability of getting injured.

Studies including such covariates have a rich set of variables that are typically not available in studies on the relationship between substance use and workplace injury. For instance, Ragland et al. (2002) found positive effects between substance use and occupational injury, though their analysis adjusted for few confounding factors. Thus, for all of the studies that find such a relationship and do not sufficiently adjust for these seemingly important factors, one must wonder whether unobservable factors are producing the relationship or whether there is an underlying causal effect of substance use on injury at work.

Even where correlations between alcohol and drug use and injury are significant, only a small proportion of occupational injuries can be attributed to alcohol and drug use. In their study of the impact of drug testing in a manufacturing company, Ozminkowski et al. (2003) found that increasing the rate of testing would reduce the rate of occupational injuries. However, they caution that, in the company under study, injury rates were already low and that reducing the odds of any injury by one-half would reduce a worker's probability of experiencing an injury by only 0.01 percent. Likewise, Lindström, Bylund, and Eriksson (2006) found very low rates of alcohol-related workplace fatality among accidental deaths caused by electricity in Sweden over a 25-year time period. Two studies of occupational fatalities found that only 4–5 percent of workplace fatalities were related to alcohol (Lipscomb, Dement, and Rodriguez-Acosta, 2000; Sahli and Armstrong, 1992). However, these numbers are at odds with two studies that estimated the proportion of occupational fatalities related to alcohol and drug use to be closer to 20 percent (Bernhardt and Langley, 1999; Greenberg, Hamilton, and Toscano, 1999). The

differences between these estimates could be due to industrial differences, differing thresholds for defining blood alcohol levels, or selection processes. For instance, only one-fourth of the records of occupational fatalities analyzed by Greenberg, Hamilton, and Toscano (1999) included toxicology reports, and estimates may be biased if those given toxicology reports differ in some systematic and relevant way from those who were not. In addition, because they offer no information on the actual number of drug and alcohol users in the workplace, these studies do not assess the risk of fatal injury among persons with comparable levels of drug and alcohol use.

Few studies look at the cost to industry of off-the-job worker injuries through disability and absenteeism. This may, in fact, be a bigger concern. Only a minority of alcohol- and other substance-related injuries actually occur on the work site; generally, these accidents happen during leisure hours. Lindström, Bylund, and Eriksson (2006) found that the majority of alcohol-related fatalities caused by electricity in Sweden occurred off the job, and Lipscomb, Dement, and Rodriguez-Acosta (2000) found that, while only 4 percent of workplace fatalities were related to alcohol, 57 percent of all non-workplace fatalities were. When examining the transportation industry, the Committee on Drug Use in the Workplace (Normand, Lempert, and O'Brien, 1994) also noted that the percentage of on-the-job fatalities related to alcohol (15 percent) paled in comparison to the percentage of all car-crash fatalities that were related to alcohol (45 percent to 59 percent).

The disparity in findings between on-the-job and off-the-job settings may simply be due to the greater likelihood of acute intoxication off the job, lending greater statistical power to those studies that focus on that setting. Regardless, despite the fact that a company may not be liable for workers' compensation or short-term disability when a worker is injured off the clock, it still faces real costs due to absenteeism or decreased productivity at work due to injury and, in extreme cases, the cost of hiring and training a replacement.

CHAPTER FIVE

Policies and Programs to Curb Occupational Injuries Related to Substance Use

Although the evidence linking substance use and misuse and occupational injury is mixed, suspicion of this link and more consistent evidence connecting substance use with other occupational outcomes (e.g., productivity and absenteeism) have led many employers to adopt strategies to target substance use and misuse in the workplace. Although these programs are often multipronged approaches with many different components working in conjunction, we review the components separately.

Workplace Drug Testing

In the 1980s, testing for drug and alcohol use in workplaces emerged as a strategy employers adopted to combat adverse outcomes associated with alcohol and drug use. Data from a 1993 survey of private work sites in the United States indicated that 48 percent conducted work-site drug testing (Hartwell, Steele, French, and Rodman, 1996), though more-recent sources indicate that up to 90 percent of Fortune 200 firms conduct some sort of drug testing (Flynn, 1999). The most-recent estimates from NHSDA (now the National Survey on Drug Use and Health, or NSDUH) indicate that approximately 46 percent of workers aged 18 and over reported being aware that their employer performs workplace drug testing (Carpenter, 2007).

The details about workplace drug testing across occupations vary. Among 18- to 64-year-old workers in the 2002–2004 NSDUH, 63 percent of those in transportation and material-moving occupations reported being aware of random substance-use testing at their workplace, relative to 10 percent of those in arts, design, entertainment, sports, and media occupations (Larson et al., 2007). Most work sites that use drug testing test all employees, while some test only applicants and others test only those in occupations regulated by the U.S. Department of Transportation. Also, data from 1992–1993 indicate that most work sites that conduct drug testing do so on a random, as opposed to regular, basis (Hartwell, Steele, French, and Rodman, 1996), though more-recent updates at the company level are not available. Typical methods used to conduct drug testing include blood tests, urinalysis, and breath-alcohol tests and are most often conducted by an outside contractor (Hartwell, Steele, French, and Rodman, 1996).

In 1994, the Committee on Drug Use in the Workplace indicated that, at that time, there was no evidence indicating that workplace drug-testing programs had any preventive effects on drug use (Normand, Lempert, and O'Brien, 1994). Since that time, studies using the NSDUH have indicated a consistent and inverse relationship between employee reports of work-site drug testing and self-reported drug use (French, Roebuck, and Alexandre, 2004;

Hoffman, Larison, and Sanderson, 1997). Carpenter (2007) advanced this research by examining sanctions for positive test results and programs that may exist in conjunction with drug testing in the NSDUH and still found support of a deterrent effect of drug use; he found that the strength of association is strongest when a first offense results in a severe penalty, such as being fired. Mehay and Pacula (1999) also found evidence of deterrence using multiple surveys before and after the adoption of a zero-tolerance drug-testing policy in the U.S. military. They found that, 15 years after the policy was implemented, rates of drug use were much lower in the military than in the civilian population, even after accounting for differences that existed between the groups before the policy was implemented. While both of these studies have limitations and are not sufficient for establishing a causal effect between drug testing and a reduction in substance use, they do provide more concrete evidence of a deterrent effect. As reviewed in Chapter Three of this report, research on the effect of drug testing on occupational injuries indicates that, generally, companies and industries that employ testing tend to have lower rates of occupational injury (Gerber and Yacoubian, 2002; Ozminkowski et al., 2003; Spicer and Miller, 2005; Zwerling, Ryan, and Orav, 1990; Snowden et al., 2007).

Observational studies on the effect of drug testing on both substance use and injury outcomes suffer from limitations that, for the most part, make it impossible to state that reductions in either of these outcomes are caused by the implementation of drug-testing programs. In many cases, drug testing occurs alongside other workplace drug interventions, such as the establishment of EAPs, peer interventions, or educational campaigns, and, in many cases, researchers may not have isolated the independent effects of testing (Carpenter, 2007; French, Roebuck, and Alexandre, 2004; Spicer and Miller, 2005; Wickizer et al., 2004). Employer-imposed sanctions for positive drug-test results vary across employers, and it is these sanctions that may influence employee behavior but that are often unaccounted for in many studies on workplace drug testing (Carpenter, 2007). Studies that use preemployment drug screens may also not reflect patterns of substance use that occur on the job, resulting in biased results (Normand, Salyards, and Mahoney, 1990; Zwerling, Ryan, and Orav, 1990). Finally, when a company institutes a drug-testing policy, it may induce individuals who use substances to self-select out of the applicant pool for that company. If this is the case, and substance use has a relationship to occupational injury, then testing may influence workplace drug use and occupational injuries indirectly. However, we found no study that examined potential selection effects of applicants to companies with established workplace drug testing.

Although widespread, workplace drug testing remains a controversial policy issue. At the heart of the controversy is the issue of employee privacy. Critics of workplace drug testing argue that testing is an attempt by employers to control their employees' behaviors outside of the workplace and thus, beyond where they have legitimate control (Maltby, 1987). The federal government does not impose rules regulating or prohibiting testing in the private sector and instead gives direct governance to specific agencies for employees under their jurisdictions and to the states. Two federal departments (Department of Transportation and Department of Defense) require random drug testing for contractors and employees holding certain jobs and in certain circumstances (e.g., after an accident). In addition, there is a federal law (the Omnibus Transportation Employee Testing Act, Pub. L. No. 102-143) that requires testing for specific types of transit operators. For private industries, state laws cover drug testing for both job applicants and employees. The details of laws across states vary: Random testing may be explicitly prohibited but may also be required for certain jobs, such as school-bus drivers. Some

states also have conditions detailing the confidentiality afforded to test results or the policies and procedures for conducting such tests (ACLU, 2000).

Although most laws concerning drug testing are at the state level, federal law must be considered when employers do test for ethanol (i.e., alcohol). The Americans with Disabilities Act (ADA) (Pub. L. No. 101-336) protects individuals with disabilities from discrimination in the workplace. Individuals with current *alcohol-induced* impairments and past *alcohol* problems *are covered* under the ADA. Thus, applicants cannot be tested or questioned about alcohol-use disorders until after a job offer has been made, and, even then, the law restricts when and under what conditions employees can be tested for alcohol use and other alcohol-use disorders. Moreover, employment decisions, particularly negative ones, cannot be based on these test results unless the employer can establish impairment caused by alcohol use (Hartwell, Steele, and Rodman, 1998). On the other hand, use of illegal drugs and of prescribed drugs used illegally and the drug-use disorders associated with such use are not covered under the ADA.

Alcohol-Exclusion Laws

Kaestner and Grossman (1995a) hypothesize that higher opportunity costs resulting from suffering an occupational injury, measured by lost wages minus workers' compensation benefits, may affect substance-using behaviors that could increase the risk of enduring an injury at work. Therefore, a policy that required an individual to pay for medical costs resulting from an injury attributed to substance use may affect substance-using behaviors among workers and any occupational injuries attributed to such use. Since 1950, many states have had alcohol-exclusion laws, which enable insurance companies to explicitly exclude insurance coverage, including health and accident coverage, for injuries that were "sustained or contracted in consequence of the insured's being intoxicated or under the influence of any narcotic unless administered on the advice of a physician" (NIAAA, undated). Along with allowances for denial of health-insurance payments, many states have statutes that allow insurers to deny claims for life insurance, disability insurance, death benefits, workers' compensation, and unemployment benefits if there is evidence that the injured or deceased person consumed alcohol before or during the incident leading to the claim (Chezem, 2005). According to the Alcohol Policy Information System, as of January 1, 2006, 34 states had a law that allowed insurance to deny coverage for this reason (NIAAA, undated). However, it is unknown how alcohol-exclusion laws are practiced throughout states and the degree to which claims are denied for injuries that may be attributed to alcohol or other drug use (Chezem, 2005). Also unclear is the degree to which employees know that such policies exist in their state and, therefore, the extent to which the existence of these policies may actually influence individual substance use at work.

Alcohol-exclusion laws have recently come under close scrutiny and have been criticized by many in the public-health community. Critics of these policies indicate that alcohol exclusions act as barriers against screening patients for alcohol problems, which are noted by trauma surgeons as important (Gentilello, Donato, et al., 2005) but are rarely performed (Schermer et al., 2003). Screening for alcohol and other substances in trauma centers can reduce substance-using behaviors and future substance-related injuries (Gentilello, Rivara, et al., 1999) and may also substantially reduce direct medical expenditures (Gentilello, Ebel, et al., 2005). On the other hand, insurance-industry lobbyists argue that trauma providers should screen patients regardless of third-party reimbursement and that people who abuse alcohol and other drugs

should face the consequences of their behavior and should not receive services that are paid for by persons who do not abuse alcohol and drugs (Gentilello, Donato, et al., 2005).

In June 2001, members of the National Association of Insurance Commissioners (NAIC) voted to amend the Uniform Accident and Sickness Policy Provision Law (UPPL) to omit the alcohol-exclusion provision. A number of organizations support amending state insurance laws to omit the alcohol-exclusion policy, including the National Conference of Insurance Legislators (NCOIL), the American Medical Association, American Bar Association, Mothers Against Drunk Driving, and American Public Health Association. As of January 2006, only six states had laws that prohibited insurers from denying coverage for injuries resulting from being under the influence of alcohol or other drugs (NIAAA, undated).

Employee-Assistance Programs

EAPs are "the most common intervention used in the workplace to address alcohol problems" (Roman and Blum, 2002). They are often offered as a benefit to employees and afford short-term counseling and long-term referrals to employees with emotional and behavioral concerns, including substance-use problems. EAPs are available at about 39 percent of workplaces with 50 or more employees (French, Zarkin, et al., 1999) and at about 76 percent of large companies (Hartwell, Steele, French, Potter, et al., 1996).

The services offered by EAPs are widespread and have the potential of reaching individuals of diverse occupations, backgrounds, and income levels. Services are brief, typically four sessions, and include evaluation, brief treatment, or outside referral or some combination of these. Employees and their dependents may self-refer to the EAP, but the majority of cases of alcohol-use disorders result from informal referrals, whereby the referral stems out of considerable discussion and social interaction with a supervisor (Blum and Roman, 1995; Roman and Blum, 2002). Formal referrals are also possible, whereby a supervisor mandates an employee to the EAP based on performance problems (Roman and Blum, 2002). In fact, clients with addiction issues are more likely to be referred by their supervisors to the EAP than clients with any other type of presenting problem (Chan, Neighbors, and Marlatt, 2004). Little research has examined how supervisory referrals affect behavior change; however, some research does suggest that service utilization motivated by external sources is more likely to elicit resistance (Deci and Ryan, 1985). In most cases, information about EAP sessions is kept confidential. However, in the case of formal referrals, supervisors typically request that the EAP provide general documentation of the treatment services delivered, though the degree of information conveyed from EAP to employer varies and is likely influenced by internal EAP policies (Chan, 2007). In all cases, however, employees must agree to the release of their information.

While studies indicate that EAPs save employers money by improving the work performance of employees not meeting optimal performance levels at work (Blum and Roman, 1995), the effectiveness of EAPs in reducing substance use and related problems, including occupational injuries, among employees is undetermined. Some research suggests that EAPs help reduce stress and absenteeism and improve work and personal relationships at three- and six-month follow-up (Masi and Jacobson, 2003). However, the overall effectiveness of EAPs is not well understood primarily because EAP services vary significantly and because studies of their effectiveness often have poor research designs (Roman and Blum, 2002). For example, although many studies have revealed that programs are effective in promoting performance

among persons referred to EAPs for alcohol problems, these studies typically offer no rigorous comparison, and it is difficult to isolate the services of the EAP with services that may complement those offered by the EAP (Asma et al., 1980; Edwards et al., 1973; Eggum, Keller, and Burton, 1980; Roman and Blum, 2002).

Education Campaigns in the Workplace

Many employers will offer education programs to their employees that focus on substance use and misuse. Typically, these programs exist alongside EAPs and are designed to educate employees about dangerous drinking behaviors and encourage employees with substance-use problems to self-refer to the EAP. Many of these programs have reported benefits, at least in the short term, though these short-term successes often diminish over time (Brochu and Souliere, 1988). Thus, researchers suggest that strategically planned educational campaigns are generally worthwhile investments, though they should be complemented with boosters over time to sustain any positive effects (Roman and Blum, 2002).

Changing Social Norms in the Workplace

Researchers have noted that workplace cultures surrounding drug and alcohol use can also be modified to reduce any potential adverse outcomes associated with these substance-using behaviors. Certain occupations may attract employees who are heavy drinkers, such as bartending and restaurant work (Hoffman, Larison, and Sanderson, 1997). Organizational cultures may also promote substance misuse by encouraging on-the-job drinking and tolerating spillover effects of alcohol or other drug use (Ames and Delaney, 1992; Mangione et al., 1999; Rice, Longabaugh, and Stout, 1997). While designing programs and interventions to change drinking cultures is recognized as inherently difficult (Roman and Blum, 2002), researchers have shown that managerial structures and health-promotion and wellness programming may influence these drinking norms (Ames, Grube, and Moore, 2000; Mangione et al., 1999). In addition, interventions that encourage workers to recognize substance-use problems in their coworkers (Roman and Blum, 2002; Spicer and Miller, 2005) may be considered educational in nature but may also either directly or indirectly encourage changes in social norms.

CHAPTER SIX

Summary and Future Research Directions

Summary

In general, we can summarize our review of the literature in a few sentences. We conclude that there is an association between substance use and occupational injury. This association is stronger for males and in certain industries, such as manufacturing and construction, and may also be stronger for younger workers, though future research is needed on this last point. The proportion of injuries *caused* by substance use, however, is relatively small. Instead, there is mounting evidence that harmful substance use is one of a constellation of behaviors exhibited by certain individuals who may avoid work-related safety precautions and take greater work-related risks. Thus, we suspect that it is more likely that risk-taking dispositions, often termed *deviance proneness*, and other omitted factors can explain most empirical associations between substance use and injuries at work.

If substance use were the cause of a significant number of workplace injuries, then EAPs, educational campaigns, and efforts to change social norms regarding substance use in the workplace would hold the greatest promise in addressing the risks that substance use may pose for occupational injuries. This assessment, however, is made based on only a few studies; these programs are highly variable, and there is a noticeable lack of studies of good design that evaluate these initiatives. Drug testing does also appear to deter substance use among employees, though this may be due to the fact that persons who engage in harmful alcohol-using behaviors or illegal drug use do not apply to or work for companies with drug-testing programs. Finally, opportunity costs associated with being injured at work do not appear to be related to substance-using behaviors, which implies that alcohol-exclusion policies are unlikely to affect workers' substance-using behaviors.

Future Research Directions

The review of the literature and policy environment indicates that, while a great deal is known about the relationship between substance use and occupational injury, there are significant gaps in the research that should be filled. While the evidence may suggest that only a small proportion of occupational injuries are due to alcohol's acute effects, the evidence suggesting indirect effects is mounting. Further research is thus needed to clarify this relationship. We identify some of these gaps and highlight promising methods that will help fill these areas ripe for future research.

Identifying Causal Relationships

The research has failed to establish reliable estimates for the magnitude (or existence in most industries) of a causal relationship between substance use and occupational injury. Typically, randomized control trials are the gold standard for identifying such relationships. In this scenario, however, workers would need to be randomized to actively engage in substance use or abstain from such use—such an experiment is obviously impractical and unethical. Thus, there is a need for more creative ways to identify the extent to which substance use *causes* occupational injuries. These efforts include disentangling causal mechanisms, such as direct versus indirect pathways between substance use and injuries.

Alternative model specifications, such as the use of instrumental variables, could potentially isolate the causal effect of substance use on workplace injury. In this application, an instrumental variable would directly affect substance use but have no independent correlation with the probability of getting injured outside any effect on substance use itself. With proper instrumental variables, researchers could estimate two-stage models similar to that of Kaestner and Grossman (1998). In these models, a properly specified instrumental variable would indicate what the estimated effect of substance use is on work-related injuries. Alternatively, one could estimate a reduced-form model of the effect of the instrumental variables directly on the probability of having a workplace injury.

Finding satisfactory instrumental variables is a difficult task. Kaestner and Grossman (1998) use self-esteem and area-specific factors; these variables, however, are not convincing, as they could be independently correlated with the probability of getting injured. Recently, researchers have begun using as instruments variables that reflect the geographically specific prices of alcohol and drugs or policies affecting drug and alcohol use (Cook and Moore, 2002; DeSimone, 2002; Saffer and Chaloupka, 1999). These can include prices of alcohol or illegal drugs, taxes (for alcohol), and sanctions for drug use. These methods, however, can be quite challenging and require that researchers have data across several geographic areas for multiple time periods.

Assess Moderating Effects, Particularly Moderation by Sex, Age, Occupation, and Industry

Past research has indicated that the association between substance use and work-related injuries is moderated by sex (e.g., Kaestner and Grossman, 1995), age (e.g., Pollack et al., 1998), and industry (e.g., Wickizer et al., 2004). To the extent that future research uses observational designs to describe the association between substance use and injuries at work, it should at the very least control for these items in multivariate analyses but make efforts, when possible, to examine moderating effects. Additionally, researchers should begin to identify mechanisms explaining why these characteristics moderate these associations. For instance, there is some evidence that males are more likely to both drink at the job and work in physically hazardous jobs, which, when entered into multivariate models, attenuate any relationship between being male and reporting an occupational injury (Frone, 1998; Kaestner and Grossman, 1998). Future research should rigorously evaluate how and why these associations may differ by sex, age, and industry. Also, research should continue to explore other possible moderating effects, including but not limited to wage levels and industry-specific social and cultural drinking norms.

Identifying Factors Associated with Deviance Proneness

Many researchers have hypothesized about a cluster of behaviors that include disregard for safety precautions and heavy substance use and substance-using behaviors and have termed this construct *deviance proneness*. In fact, the literature appears to consistently convey that the effects of substance use on injuries while at work are attenuated, if not diminished entirely, when including other risk-taking behaviors in the model. However, there is substantial variability in those constructs included in multivariate models that represent risk aversion or characteristics associated with an underlying deviance-proneness construct. Some have used single constructs, such as smoking (Dawson, 1994), others have examined different work-related behaviors (Hoffman and Larison, 1999; Spicer, Miller, and Smith, 2003), and others have included personality constructs, such as depression (Holcom, Lehman, and Simpson, 1993), or impulsivity (Frone, 1998). Efforts should be made to identify those characteristics among workers that align themselves with varying levels of substance use and misuse to identify whether a latent construct, such as deviance proneness, truly exists. Once these are identified, researchers may be able to examine the types of jobs and industries in which persons who exhibit these traits work and identify intervention strategies and policies that may prevent or minimize these individuals' risk of being injured while at work.

Evaluating the Effectiveness of EAPs

Although there is some evidence that they save costs, the effectiveness of EAPs on reducing rates of substance use and misuse, substance-use disorders, and associated outcomes (injuries, absenteeism, and productivity) is unknown. Future research should critically examine the effectiveness of these programs, independent of other drug-prevention policies, on each of these sets of outcomes. While we acknowledge that the focus of EAPs naturally extend beyond these behaviors, research evaluating these outcomes will help identify whether EAPs in and of themselves would lead to reductions in the fraction of occupational injuries that may be attributed to substance use.

Additional research may also evaluate the potential effectiveness of empirically based treatments within EAPs. For example, brief interventions that utilize motivational interviewing (Miller and Rollnick, 2004) are short and have been shown to be effective in primary-care, academic, and other health-care settings (Bien, Miller, and Tonigan, 1993; Dunn, Deroo, and Rivara, 2001; Hettema, Steele, and Miller, 2005), yet only one study has examined the effectiveness of these interventions in EAPs (Osilla et al., 2008). Studying the effectiveness of EAP services and improving them with empirically based methods has a great potential for decreasing the prevalence of alcohol-use disorders in the workplace as well as decreasing the costs of occupational, societal, and health problems associated with untreated substance-use problems.

Identifying the Scope of Alcohol-Exclusion Laws

As documented in Chapter Five, although many states permit insurance companies to deny coverage and benefits for injuries that may be attributed to alcohol and other drug use, the extent to which this practice occurs is unknown. It is also unclear whether employees are aware that these policies exist. For instance, a recent study of trauma surgeons indicated that only 13 percent believed that they practiced in a state with an alcohol-exclusion policy, though 70 percent actually did (Gentilello, Donato, et al., 2005). This raises the question whether these policies actually deter at-risk drinking and drug use but potentially cause significant hardship

to the injured employee in terms of the costs he or she may face associated with paying for an injury (Chezem, 2005). Policy research should address these issues to identify whether the effective costs associated with drug use in terms of compensation from injury might actually deter a person from working while intoxicated or hung over.

Evaluating Drug Testing Prospectively

The use of preemployment and random drug testing at businesses opens the door for research that could prospectively investigate the effect of drug testing on substance use, injuries, and other work-related performance measures. In our review, we found no studies that conducted such an analysis. Instead, studies have been conducted at the company level (Gerber and Yacoubian, 2002) or have employed pooled, cross-sectional time-series designs (Mehay and Pacula, 1999; Ozminkowski et al., 2003). A prospective design may be used to follow individuals and inquire about drug-using behaviors before and after random drug tests occur at the workplace. Such a study could identify the effectiveness of the intervention on substance use, try to control for any possible selection bias, and provide potentially valuable information on the causal influence of substance use on occupational injuries. Other studies on workplace drug testing should examine variability across employers with respect to sanctions imposed and whether these vary by the laws governing drug testing across states.

Designing New Workplace-Based Interventions

Regardless of their impact on occupational injuries, heavy substance use and substance-use disorders are serious public-health issues that are prevalent among workers, and interventions centered in workplaces hold great promise for recognizing and treating these problems (Roman and Blum, 2002). Researchers should continue to design and evaluate the effectiveness of these strategies. For example, how might social-norm campaigns affect substance use and occupational injuries? Might they affect off-the-job substance use and nonoccupational injuries? Could training supervisors or altering a managerial structure influence substance use? Workplace interventions have also recently been established to prevent smoking among employed youth and should be extended to encompass other substance-using behaviors among this particularly vulnerable group (Stoddard et al., 2005).

CHAPTER SEVEN

Conclusion

Occupational injuries cause significant morbidity and mortality in the United States, and efforts should be made to minimize the burden of these injuries on public health. Research on the impact of substance use on these injuries has advanced and confronted many limitations of prior work. Although the media often report on singular incidents attributed to substance use with grave consequences, the current research confirms that the proportion of occupational injuries attributed to acute substance use is relatively small. What is more likely is that workers who engage in harmful, substance-using behaviors may be more likely to take risks at work. This does not mean that the relationship between substance use and occupational injuries is spurious, but rather that policies and intervention strategies focused on substance use should address underlying characteristics and traits of persons with this risk profile. EAPs are an appealing venue for this type of intervention strategy. As this review has shown, while a great deal of research has examined the effect of substance use on workplace injuries, there is still significantly more work to be done.

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