Title
Nonfatal falls in construction workers

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Publication Date
1996

Nonfatal Falls in Construction Workers:
Predictors of Injury Severity

by

Marion Gillen

DISSERTATION

Submitted in partial satisfaction of the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

Nursing

in the

GRADUATE DIVISION

of the

UNIVERSITY OF CALIFORNIA

San Francisco

[redacted]

Date University Librarian

Degree Conferred: . . . .

Acknowledgments

My deepest appreciation is extended to the construction workers who participated in this study. Many were interviewed while in pain or during times of great financial hardship; still others participated simply because they were interested in helping others. I am thankful for their time, effort, and precision in answering detailed questions.

I am extremely grateful to Julia Faucett for her generosity and expert mentorship throughout my years of study. Her thoughtful direction and practical suggestions allowed me to succeed. I am thankful also to the members of my dissertation committee, Jay Beaumont and Liz McLoughlin, for their time, expertise, and critique throughout this process. Their tactful recommendations regarding the breadth of my original proposal were appreciated many times over. My thanks also to Paul Blanc who provided me with an idea critical to this research and for unexpected support and encouragement. I am thankful, as well, to earlier committee members Erika Froelicher, Susan Gortner, and Jane Lipscomb for their counsel and professionalism, and to Steven Paul, for many hours of patience, reassurance, and levity.

I am indebted to my colleagues who assisted me in identifying cases, interviewing participants, coding medical records, and data entry. Each helped me maintain my wits in ways that are very much appreciated: Davis Baltz, Margy Gassel, Catherine Portman, Luz Soluaga, Alan Seegmiller, and Diane Vaccaro. I am also thankful to Margo Marcellini for translation services, to Rayne Regush for editing assistance, and to Jill Eastwood for editing and word processing with composure and exactitude under extreme time constraints.

I thank my mother, Muriel Gillen, for sound advice and for her many prayers to St. Anthony when recruitment prospects seemed so bleak, and my father, Terence Gillen, for his belief in hard work and persistence. My friends and coworkers have been extremely kind in allowing me to be less of a friend and colleague than I would have liked during the past 4 years. I thank them all for their understanding.

I remain grateful to Susan Baker for starting me on this path, to Alice Gifford and Susan DeFrancesco for actively supporting my return to school, and to my coworkers, Jim Cone, Ana Maria Osorio, and Kate Summerill, who paid special attention to this project. Special thanks to Bob Harrison for paving the way for my study, overlooking my less than stellar work this past year, and his friendship; to my nephew, Andrew, for providing me with the window to his world; to my nephew, Conor, for delaying his birth until data analysis was complete; and to my garden for flourishing despite neglect.

I am most especially indebted to my dear friend, Linda Edelstein, for her humor, tolerance, steadfast support, and numerous trips to the library for articles I just had to have and never used.

This research was supported with funding from the National Institute for Occupational Safety and Health, #T42OH07205; California Department of Health Services, Occupational Health Branch, Memorandum of Understanding, #94-21111, MOU #05; the School of Nursing Century Club; and a Graduate Student Research award. I would also like to express my appreciation to the National Institute for Occupational Safety and Health for their dedication to occupational safety and health education through their traineeship programs.

Abstract

This study evaluated injury severity in a group of construction workers who sustained nonfatal falls at work. The convenience sample consisted of 255 adults, predominantly males, with a mean age of 34 years (standard deviation [SD] = 9.31). A full range of construction trades was represented in the sample population. More than one quarter of the sample were union members, and more than half worked in residential construction. The mean height of fall was 9.23 feet (SD = 7.05). The mean number of lost work days was 44.3 days (SD = 58.6). Cases were identified from Doctor's First Reports submitted to the California Department of Industrial Relations. Data were obtained from these reports, structured telephone interviews, medical records, and two standardized instruments—the Safety Climate Measure for Construction Sites and the Job Content Questionnaire. Two measures of injury severity were used—the Injury Severity Score and the disability section of the Health Assessment Questionnaire (HAQ) measuring functional limitations. There were 518 injuries reported including 61 extremity fractures, and four head injuries with five skull and facial fractures. Thirty-two individuals were hospitalized, and 41 required surgery. Seventeen participants (8%) were deemed permanently disabled and unable to continue working in construction. A simultaneous multiple regression model, using five independent variables, explained approximately 21% of the variance in HAQ scores. Independent variables making significant unique contributions to the variance in injury severity were height of fall, surface landed on, Safety Climate Measure score, and union status. Nonunion status and higher safety climate scores (i.e., indicating increased risk) were positively correlated with higher HAQ scores, as were greater heights and concrete surface. Higher scores on both injury severity measures were significantly and moderately associated with a greater number of days lost from work. There were no significant differences in means among the trades for either injury severity measure. These findings confirm that falls in construction workers are far too common, suggest that injury severity and permanent disability associated with falls is notable, and identify key target areas for intervention and prevention such as management commitment to safety, ongoing worker training, and hazard identification and control.

Julia Faucett, R.N., Ph.D.
Committee Chair

Table of Contents

Page

Page

Page

CHAPTER FOUR: RESULTS (Cont'd)

List of Tables

Table Page

List of Figures

CHAPTER ONE

THE STUDY PROBLEM

Introduction

The construction industry is an aggregate of many specialized groups working together to build, maintain, repair, renovate, and demolish buildings and other immobile structures, together with the building of highways, dams, and other large entities. Construction is the largest industry and provider of jobs in the United States. The nature of the work ranges from difficult physical labor to fully mechanized operations. It is often performed under extreme conditions, and in isolated or heavily congested areas (Hopke, 1990; Ringen, Englund, Welch, Weeks, & Seegal, 1995b). Worldwide, construction remains one of the most dangerous occupations, and has historically been one of the highest risk industries for fatal and nonfatal injuries.

Annual costs related to injury in the construction industry have been estimated at $10 billion to $40 billion (Ringen et al., 1995b; Zwerling, 1993). During the 1980–1989 decade, the National Traumatic Occupational Fatalities surveillance system (U.S. Department of Health and Human Services [USDHHS], National Institute for Occupational Safety and Health [NIOSH], 1993) reported that the largest number of fatalities (11,430) occurred in construction (18%). During the same time period, this industry experienced the second highest average annual fatality rate of 25.6/100,000, exceeded only by the field of mining (31.9). Despite a decrease of almost 25% in the injury death rate from 1980–1989 (Stout, Jenkins, & Pizatella, 1996), the annual fatality rate in construction is more than three times the overall average for all industries combined (7/100,000).

Falls account for the highest fatality rate in construction (6.6/100,000), followed by electrocution (4.0/100,000), motor vehicle crashes (3.7/100,000), and machine-related incidents (3.5/100,000). This is in sharp contrast to other high-risk industries where machine-related deaths and those attributed to motor vehicle crashes dominate. The service industry, where work is generally not performed from heights, is the only other industry where falls rank among the top three causes of job-related fatalities. However, this fatality rate (0.26/100,000) is considerably lower than that of construction (USDHHS, NIOSH, 1993).

The National Safety Council (1993) reports that, with 5,900,000 construction workers in the United States in 1992, there were 1,300 work-related deaths (22/100,000), and 300,000 disabling injuries. In comparison, the service industry employed 38,100,000 workers, and 1,300 deaths (3/100,000) and 740,000 disabling injuries were reported. The types of injuries resulting in disability, and their respective percentage of the total of all work injuries, are as follows: struck by or against another object or person (29%), overexertion (25.1%), falls (21.9%), bodily reaction (6.6%), and all others (17.4%).

According to the National Safety Council (1993), the construction industry exceeds the all-industry rates for lost workday cases, which are defined as number of lost workdays x 200,000/total hours worked by all employees during the period covered—6.1 cases for construction versus 3.9 cases for all industries combined. Nonfatal cases reported without lost workdays totaled 6.9 versus 4.5, and lost workdays numbered 148.1 versus 86.5. The lost workday rate for construction is higher than any other industry division.

Statement of the Problem

In the United States, one third of all nonfatal injuries and one sixth of all fatal injuries occur at work (Baker, O'Neill, Ginsburg, & Li, 1992). Despite these statistics, no single data collection system exists to support the recording of fatal and nonfatal injuries, though recent efforts have been made to standardize surveillance of fatal events (USDHHS, NIOSH, 1993; U.S. Department of Labor, Bureau of Labor Statistics, 1994). Estimates of fatal occupational injuries vary widely, even though they are the only class of injury recorded with any degree of consistency and accuracy. In the past, differences of up to 300% have been identified in the statistical data collected by various reporting sources (Suruda & Emmett, 1988; Toscano & Windau, 1991). Information related to nonfatal occupational injuries and their severity is, for the most part, poorly collected (Kraus, 1985), though estimates indicate that over 3 million severe, disabling injuries, including fatalities, and 10 million injuries occur each year in the American workplace (National Safety Council, 1993; Association of Schools of Public Health and NIOSH, 1986, 1988).

Descriptive research and surveillance activities have predominated in occupational injury studies. These methodologies have been necessary due to the historical inadequacies of relevant data collection systems. A more comprehensive picture of fatal injuries is now emerging from the National Traumatic Occupational Fatalities database of the NIOSH (USDHHS, NIOSH, 1993) and the Census of Fatal Occupational Injuries (U.S. Department of Labor, Bureau of Labor Statistics, 1994). With greater availability of surveillance data, more analytical studies should be developed for occupations and industries at high risk for injury and death.

Despite the appalling high numbers and rates of fatal and nonfatal occupational injuries in construction, comprehensive analytical or intervention and prevention studies related to such events are rare. Construction is a difficult candidate for research, due in large part to the transient and independent nature of its workforce (Veazie, Landen, Bender, & Amandus, 1994). Construction is a broad-based, complex, and multifaceted industry. It is a large industry, composed of many small employers, thereby making research and intervention difficult. This difficulty is reflected in the collection of seemingly unrelated studies published to date. It is challenging to compare results due to the variation in crafts and industries studied. Research is further complicated by the lack of a theoretical framework guiding research efforts (Ringen, 1994).

In 1990, in order to address the many health and safety hazards within the construction arena, the U.S. Congress directed the NIOSH to develop a comprehensive prevention program. The directive suggested expansion of existing NIOSH activities in surveillance, research, and intervention. With regard to research, Congress urged the NIOSH to conduct studies related to fatalities, injuries, and work practices (USDHHS, NIOSH, 1994). Kisner and Fosbroke (1994) further state that research in the construction industry needs to "identify specific risk factors associated with specific injury events" (p. 142) in order to develop effective interventions. In particular, these authors stress that intervention measures need to target specific occupations, as well as specific causes of injury such as falls, electrocutions, and motor vehicle events. They further state that additional research is needed to determine and overcome barriers to the use of existing protective technologies and, where intervention strategies are lacking, new technologies and new work practices should be developed to better protect construction workers.

Purpose of the Study

The purpose of this study was to elucidate the determinants of injury severity for nonfatal falls in construction workers. The study evaluates injury severity in a group of California construction workers who sustained nonfatal falls reported to the Department of Industrial Relations on Doctor's First Reports over a 6-month time period from October 1995 to March 1996. Information was obtained from Doctor's First Reports, structured telephone interviews, and medical records. The relationship between injury severity and the following specific variables was explored: demographic, fall-related, environmental, job activity-related, personal, and employer-related. The lost time injury experience of the construction workers was described. The relationship between disability and two injury severity rating scores was also assessed.

Significance of the Problem

Falls are the number one cause of death within the construction industry; however, they represent only 10% of all workplace fatalities nationwide (USDHHS, NIOSH, 1993). Surprisingly little data exists regarding the determinants of fatal or nonfatal falls in construction. There is some literature related to risk factors for occupational fatal falls in general (Agnew & Suruda, 1993; Buskin & Paulozzi, 1987; Cattledge, Hendricks, & Stanevich, 1993; Copeland, 1989; Goldberg, Bernstein, Garabrant, & Peters, 1989; Sorock, O'Hagen Smith, & Goldoft, 1993; Suruda, 1992), but little has been published in the area of nonfatal falls (Cohen & Lin, 1991; Heineman, Shy, & Checkoway, 1989; Hunting, Matanoski, Larson, & Wolford, 1991; Leamon & Murphy, 1995; Templer, Archea, & Cohen, 1985). Only the Hunting et al. (1991) study was specifically geared toward construction workers, and this study concentrated on painters.

Etiologic research is critically needed to identify risk factors for injury that cannot be identified through mishap investigations or accident analysis. Controlled studies are necessary to achieve this goal (Veazie et al., 1994). While fall prevention devices and environmental controls have been recognized as critical elements in preventing falls, other factors contribute to fall-related events.

This study provided a unique opportunity to investigate injury severity determinants through access to construction workers via the Department of Industrial Relations. A Doctor's First Report must be submitted to the Department of Industrial Relations office in San Francisco on every individual treated by a health care provider for an occupational injury. These reports are a rich source of information, but they have never been used for injury research. They have been routinely used to screen for work-related illnesses such as asthma and occupational tuberculosis. Approximately 50–100 reports related to occupational falls in construction are received on a weekly basis. Since all medically treated injuries must be reported, it was assumed that a mix of construction workers in various trades, as well as in union and nonunion settings, were represented, reflecting the mix of job titles and affiliations seen in the construction industry.

CHAPTER TWO

THE LITERATURE REVIEW

Introduction

Prior research regarding occupational injuries, specifically falls at work, is reviewed below to provide clarity and focus to the proposed current research hypotheses. An overview of occupational injury research will be provided, followed by a detailed analysis of fall-related research. Finally, research questions and hypotheses will be presented.

Many disciplines share an interest in preventing occupational injuries. These include occupational health nurses and physicians, safety professionals, safety engineers, epidemiologists, employers, and workers. Many different theories and explanations have developed over the years related to injuries and their causation. These range from "an almost universal view of injury events as results of aberrant behavior, to what some perceived as too much emphasis on environmental factors as initiators of injury events and determinants of their severity" (Waller, 1994, p. 664). Occupational injuries are complex events involving interrelationships between factors relating to personal life, work practice, and the environment. The method and nature of the injury itself is also a significant factor. Political forces such as regulations and legislation, and social factors such as business cycles and the economy, also play a major role in these events.

Surveillance Systems

In order to design well constructed studies that address these complex issues, systems need to be established and maintained that adequately and correctly identify patterns of occupational injury. Surveillance systems in occupational safety and health are woefully inadequate, though progress has been made in the last decade.

As stated earlier, various reporting sources such as the National Safety Council (NSC), the Bureau of Labor Statistics (BLS), and the National Institute for Occupational Safety and Health (NIOSH) (Suruda & Emmett, 1988; Toscano & Windau, 1991) have identified differences of up to 300% regarding occupational fatality reporting. However, in the mid-1980s, efforts were made to develop more accurate surveillance systems for capturing data related to the annual number of fatalities. A short review is presented here because of the critical relationship between surveillance and research and prevention activities.

National Traumatic Occupational Fatality Surveillance System

The National Traumatic Occupational Fatality (NTOF) surveillance system collects information directly from death certificates of the 50 states, New York City, and the District of Columbia. Information collection is limited to workers 16 years of age and older, those for whom an external cause of death was listed, and those whose death certificates indicated they were injured at work (U.S. Department of Health and Human Resources [USDHHS], NIOSH, 1993). Advantages of using death certificates for surveillance purposes include the following: (a) they are available for all workers who died during the study period; (b) all workers are covered regardless of the size or type of company; and (c) a synthesis of study results showed that 67% to 90% of all fatal work injuries were correctly identified by death certificate data, as compared to 40% to 70% from Workers' Compensation data, and 32% to 90% from Medical Examiner's Reports (Stout & Bell, 1991; USDHHS, NIOSH, 1993). However, certain manners of death such as motor vehicle crashes and homicide, are not captured with as much accuracy as those more easily recognizable as occupational deaths (i.e., falls, crushes, or machine-related injuries). Additionally, the NTOF system does not capture data related to some adolescent fatalities if the victim is less than 16 years of age, nor childhood injuries related to farming (Russell & Conroy, 1991; USDHHS, NIOSH, 1993). Kraus, Peek, Silberman, and Anderson (1995) determined the predictive value positive of the *at work* designation to be approximately 60%, while the sensitivity of this designation was approximately 78% and the specificity over 99%. In addition, Russell and Conroy concluded that no single data source captures all deaths or the elements necessary to comprehensively describe fatal occupational injuries. As an example, death certificates include information on the decedent's *usual* occupation and industry, not necessarily the industry and job in which the decedent was currently employed and fatally injured.

Nevertheless, despite its limitations, the NTOF database provides researchers with a more accurate estimate of the number of fatalities over the last decade. The information is useful for describing victim demographics for each state and the nation as a whole, as well as injury circumstances (USDHHS, NIOSH, 1993).

Census of Fatal Occupational Injuries

The inadequacies of workplace injury data collection prompted two national study groups, the National Academy of Sciences and the Keystone Academy, to recommend that major changes be made to occupational safety and health surveillance systems. They recommended that multiple sources be used to compile information on injuries, excluding illnesses from the results. The national Census of Fatal Occupational Injuries (CFOI) was developed as a result of these recommendations. In 1988, the BLS pilot tested this approach with the Texas Department of Health, and with both Texas and Colorado in 1990 (Windau & Goodrich, 1990).

In 1994, the first national census for injuries occurring in the calendar year of 1992 was released. Multiple sources were used to collect the data: death certificates, Workers' Compensation reports, Occupational Safety and Health Administration (OSHA) and the Mine Safety and Health Administration (MSHA) records, medical examiner's reports, police motor vehicle crash reports, and newspaper clippings. Deaths are counted as work related if that determination is supported by two independent sources. If only one source is available, the BLS and the reporting state confer and include the death in the data collection only if sufficient information exists on the sole source document (Toscano & Windau, 1993).

The National Traumatic Occupational Fatality Surveillance System and the Census of Fatal Occupational Injuries

The formation of the two parallel systems—the NTOF surveillance system and the CFOI—represented a milestone in occupational injury prevention as it has been impossible to develop successful injury prevention programs with the preexisting flawed and inadequate data (Stout-Wiegand, 1988). However, there are limitations in that both systems report only fatal injuries. The NTOF system is hampered by using only one source, death certificates. Death certificate information is inconsistent because of varied interpretations by medical examiners due to vague definitions and incomplete coding instructions. The CFOI database, which would seem to be more complete since it uses multiple sources, reports lower numbers than the NTOF system. This difference may be solely due to the CFOI decision rules dictating reliance on two source documents, or the

CFOI may be eliminating cases defined as work related by the NTOF system that are not truly work related. Additionally, neither the CFOI nor the NTOF surveillance system collect data on fatalities of workers involved in illegal activities such as prostitution or drug trafficking. Kraus (Personal communication, 1994) estimated that prostitution has the highest occupational death rate in Los Angeles, exceeding even that of taxi drivers.

Additional Sources for Surveillance Activities

Because the occupational illness and injury data have been so limited, researchers have used alternative data sources for epidemiologic studies on fatal injuries: police records, hospital records, and medical examiner's records. These sources were not developed for epidemiologic surveillance so, if used as a sole source of information, may lack key information. However, their use in research as supplementary surveillance sources warrants attention due to the valuable supplemental information that they provide (Conroy & Russell, 1990).

Since there is no national data bank for nonfatal injuries, researchers have been creative in finding innovative ways to gain access to information about injured workers. Blanc, Galbo, Balmes, and Olson (1994) conducted structured interviews with a sample of 244 workers and used Poison Control Center records to evaluate inhalation injuries and to develop recommendations for their prevention. In an earlier study regarding occupational illnesses, Blanc and Olson (1986) compared reports from a Poison Control Center to those of Doctor's First Reports and to the Department of Industrial Relations Annual Survey in California. They found that Poison Control Center reports, linked to neither compensation claims nor government inspection, were an effective supplementary source of information for certain occupational illnesses. Korrick, Rest, Davis, and Christiani

(1994) accessed Workers' Compensation data for surveillance of occupational carpal tunnel syndrome. The authors reported the following limitations using this source: under-ascertainment of cases, potential ascertainment biases, delayed case reporting, limited access to diagnostic information, and incomplete and sometimes inaccurate information. Sorock, Smith, and Hall (1993) examined the utility of a statewide hospital discharge database for surveillance of severe traumatic injuries. They concluded that using this payor code as an indicator of work-related injuries would underestimate the numbers by approximately 20%. In addition, only 11% of the records reviewed external cause of injury codes (E-codes), which greatly reduced the utility of this database for evaluating causal mechanisms of injury. Finally, Hunting, Nessel-Stephens, Sanford, Shesser, and Welch (1994) used emergency department records to learn more about the circumstances surrounding nonfatal injuries in construction workers.

Approaches to Injury Research

Occupational Injury Epidemiology

In its early days, injury research focused almost exclusively on the evaluation of hardware and personal factors (Haddon, Suchman, & Klein, 1964) until epidemiologic principles were introduced (Haddon, 1970; Haddon, 1980a). Currently the public health response to injury problems includes the following approaches: surveillance, risk factor or etiologic research, and intervention studies (Veazie et al., 1994). A major strength of epidemiology is that studies are conducted within human populations. Basic research adds to our biologic understanding, but epidemiology "allows the quantification of the magnitude of exposure-disease relationships in humans and offers the possibility of altering the risk through intervention" (Hennekens, Buring, & Mayrent, 1987, p. 13). For the most part, publications regarding occupational injuries have been either surveillance based or descriptive in nature. These have been important as they have frequently provided the first meaningful clues about injuries or occupations at high risk, and have allowed occupational safety and health professionals to plan education and prevention programs (Hennekens et al., 1987).

Observational and intervention studies have been rare. During a 22-year period from 1970 to 1992, Veazie et al., (1994) found that only 117 analytical studies addressing work-related injuries were published, excluding articles on back injuries and intentional injuries. The authors searched multiple databases and 42 journals to identify these 117 studies. Fifty-five percent of the articles were published in the following journals: *Accident Analysis and Prevention, Journal of Occupational Accidents/Safety Science, Journal of Occupational Medicine,* and *Journal of Safety Research*. The types of study designs that were employed were: cohort studies (*n* = 67), cross sectional (*n* = 21), case-control (*n* = 14), quasi-experimental (*n* = 4), and other or undetermined (*n* = 8).

Manufacturing has been the most commonly studied industry, which may reflect the large proportion of the working population in this industry (24%) and the ease with which studies can be conducted in this organized environment. Although the greatest number of work-related traumatic fatalities is found in transportation work environments, studies focusing on this industry fail to distinguish occupational injuries from other types. OSHA standards do not exist for transportation-related work, which may account for the lack of occupational study in this area. Other high-risk industries such as agriculture, fishing, logging, and construction are also rarely studied. For the most part, these industries employ transient and independent workers, which makes comprehensive etiologic research difficult (Veazie et al., 1994).

Certain types of risk factors lend themselves to epidemiologic research more than others. For example, mishap investigations or accident analysis can provide valuable information in situations regarding equipment malfunction or the absence of machine guarding. Rigorous analytical epidemiology is probably not needed in these situations to determine the causal relationships between, for example, the absence of machine guarding and traumatic crushing injuries. The need for engineering controls can be established in some situations by the use of active surveillance and accident investigation techniques. However, situations where more rigorous methods need to be employed include those where multiple risk factors are involved and where associations are less obvious. Examples of instances requiring expanded research include the relationship between job design and the ability of workers to process information, and the impact of noise on injury occurrence (Moll van Charante & Mulder, 1990; Saari & Lahtela, 1981; Veazie et al., 1994).

Accident Investigation

Accident investigation involves evaluating the chain of events and circumstances preceding a mishap, with the intention of determining the cause of the accident to avoid recurrences. Work flow patterns, personal actions, environmental conditions, and psychosocial influences such as work stress are considered (Prieskop, 1990). Determining *fault* was at one time the dominant theme of accident analysis; however now, accident analysis seeks to identify primary and contributing causes, which may include management procedures, management accountability, and leadership (The FPE Group, 1989).

Accident analysis is, in many ways, a compromise between theory and application, geared toward action and practice (Kjellen & Larsson, 1981). Many accident models are rooted in systems theory; and one model, Systems Safety Analysis, views operations as if they were a single system whose discrete parts and functions are analyzed for potential hazards (Kjellen & Larsson, 1981; Prieskop, 1990).

The reasons for performing accident investigations differ dramatically from the purposes behind epidemiologic investigations, hence the models focus on different variables. Feyer and Williamson (1991) stated that epidemiologic descriptions of occupational accidents provide limited information as to why accidents occur, and therefore are not always helpful because answering the *why* is critical to the process of accident investigation. In order to answer that basic question, the authors examined 1,020 work-related fatalities in Australia from coroners' reports to determine the sequence of precursor events and contributing factors leading to the occupational fatalities. Their research was well planned and executed; interrater and intrarater reliability was evaluated at several stages and was high, both for coding event category sequences and for assigning rankings of relative causal importance.

The authors found human error, poor work practices, and environmental factors to be the most frequent antecedents of fatalities. However, the prime causes of accidents were not necessarily those most frequently present, nor were they those occurring closest in time to the event. For example, environmental factors were involved at some point in the sequence almost as frequently as error, but were found to be prime causal factors only in a minority of cases.

In an earlier paper, Williamson and Feyer (1990) reported identifying relatively few patterns of causal pathways. They also stated that human errors often occur immediately before the fatality, allowing no time for recovery. Additionally, the unpredictable nature of errors makes the elimination of mistakes unlikely. Williamson and Feyer further state that two corrective mechanisms are possible—create work environments flexible enough to allow recovery from errors or avoid the circumstances and factors that commonly precede the errors by adjusting work practices.

Comparison of Epidemiologic and Accident Analysis Methods

Epidemiologic methods are used to summarize the occurrence of multiple events in a given population, whereas accident investigation seeks to identify and respond to the causes of a single event. Both epidemiologic surveillance and accident investigation seek to define and describe a problem, but surveillance makes no inference about the causes of a single event, whereas that is the main purpose of an accident investigation. In accident investigation, each incident represents an individual and separate investigation with its own hypotheses; in surveillance, a single hypothesis is shared by multiple injuries within a high-risk population. Methodological differences are also present. Standardized methods are used in epidemiology, restricting inquiry to predetermined questions and measurements in order to avoid the introduction of biases. Accident analysis, however, is not limiting; questions requiring expert judgement and subjectivity are often asked. In fact, exploring all possible avenues could be considered a strength of accident analysis (Veazie, Smith, & Pizatella, 1993).

Despite these differences, these approaches complement each other because both serve different needs. Accident investigations can provide additional information for the purpose of generating hypotheses, which can then be used to interpret complicated findings from epidemiological studies. Most importantly, accident analysis can provide suggestions for corrective action following a single event, which is of utmost concern to safety professionals and other practitioners in industry. On the other hand, surveillance results can identify priorities for accident investigation, and can generate hypotheses that can be disproved by rigorous accident investigations (Veazie et al., 1993).

Research on Occupational Injury in Construction

Studies focusing on construction injuries are relatively rare. A summary of recent studies on fatal and nonfatal occupational injuries in the United States and other countries is presented in this section.

Hunting, Nessel-Stephens, et al. (1994) established an emergency department-based surveillance program in order to learn more about the causes of *nonfatal* construction worker injuries in an urban area. They reviewed the medical records of all construction workers treated at one emergency department over a 20-month period. Information was obtained on 592 workers from a variety of construction trades. The injured workers were predominantly young, 62% were less than 35 years of age, and the sample presented a median age of 31 years. Of those (94%) for whom ethnicity data was available, 48% were minorities—primarily Black or Latino/Hispanic. The most prevalent occupation was carpenter (24%), followed by laborer (17%), and construction worker NOS (Not otherwise specified) (11%). Laceration was the most common injury documented (38%), followed by sprain/strain (17.9%), contusion/abrasion (15.7%), and eye injury (12.3%). The circumstances of injury involved cutting or piercing objects (25.8%), falls (17.9%), and falling objects (11.8%). Among the 28 injuries requiring hospitalization, 18 (64%) were caused by falls, with more than half being from scaffolds. Initial stay ranged from 1–55 days with a mean of 13 days. Hospital costs ranged from $1,502 to $147,384 with a mean of $24,700. The researchers found the descriptive detail related to the injury event in the respective medical records to be lacking in many cases. Also, work status or job title was not always fully documented, which may have caused some misclassification and/or missed cases. This case series was not based on population data, hence the researchers were unable to calculate rates.

Though this study (Hunting, Nessel-Stephens, et al., 1994) limited generalizability due to its design, it is important in that it provides descriptive detail on nonfatal injuries not found in other sources. It highlights the significance of falls in regard to their relative severity and associated health costs. Additionally, the authors found a lack of detail surrounding the occupational injury circumstances provided by E-codes, as did Sorock, Smith, et al. (1993) in an earlier study. Expanding E-codes to include more detailed information on occupational machinery type, for example, was recommended.

Fatal occupational injuries in the New Jersey construction industry were described by Sorock, O'Hagen Smith, and Goldoft (1993). Using multiple data sources (i.e., death certificates, medical examiner reports, OSHA fatality files, and Workers' Compensation reports), the researchers identified 200 construction-related fatalities from 1983–1989—all in men. The fatality rate was 14.5/100,000 person-years, exceeded only by agriculture, farming, and fishing (17.5), and three times higher than the New Jersey male death rate for all industries combined. The highest number of fatalities was in the 25–34 age-group, and the highest rate was in the over 65 age-group (27.7). The fatality rate was 2.3 times higher for American-born Blacks than Whites, and 3.3 times higher for those of Hispanic background, which is consistent with reports of nonfatal injuries in other studies. However, these rates are subject to instability because of the small numbers, and could be inflated due to a possible undercounting of ethnic and racial minorities in the denominator data.

By occupation, the rate per 100,000 varied from a low of 6.1 for general construction workers to a high of 109.0 for ironworkers. The leading cause of death was falls (47%), followed by motor vehicle events (15%), electrocutions (14%), and trench cave-ins (7%). Most falls were from scaffolds (22%), roofs (19%), and through roof openings such as cutouts for skylights, etc. (13%). Occupations most susceptible to fatal falls were roofers (14 out of 15 deaths were due to falls), painters (8 out of 9), ironworkers (14 out of 18), and carpenters (13 out of 19) (Sorock, O'Hagen Smith, et al., 1993).

This population-based study confirms information from unpublished NIOSH data indicating that ironworkers and roofers are at extremely high risk for falls resulting in death. This is not unexpected since both trades commonly work at significant heights. However, it is an important finding because it provides a framework for developing targeted prevention strategies for workers at high risk in New Jersey and across the nation. Because almost all injury research, such as this study, involves fatal events, it is difficult to know whether prevention strategies targeted for workers and activities at risk of fatal falls can be applied to those at risk for nonfatal falls.

Fatal injuries in the Washington state construction industry were evaluated by Buskin and Paulozzi (1987). They identified 231 deaths from 1973–1983 using death certificates and reports sent to the Washington Department of Labor and Industries. The annual mortality rate was 27.5/100,000 workers. Workers ranged in age from 16–71 years with a mean age of 38.8 years, and the mean years of experience in construction was 11.3 from a range of 4 days to 44 years. Major types of industry deaths were falls (29%); motor vehicle crashes (21%); struck by, NEC [Not elsewhere classified] (10.8%); and cave-ins and electrocutions (8.2% each). Heavy construction (Standard Industrial Classification 16) presented a death rate twice that of the other two construction subgroups. In addition, the authors found a significant trend towards increasing mortality with decreasing company size.

The authors (Buskin & Paulozzi, 1987) concluded that many of these fatal injuries could have been avoided had existing safety regulations been observed. This type of study is important because it offers regulatory and compliance agencies information to better target their activities in times of decreasing resources. It also highlights the need for increased attention to rates of injury in small businesses, the significance of falls within the construction industry, and the excessive hazards of heavy construction work.

From 1977–1990, three studies were published that investigated specific external causes of fatal injuries to construction workers. Decoufle, Lloyd, and Salvin (1977) investigated the cause of death among construction machinery operators and found a three-fold excess of fatal injuries within this group. Of 329 observed accidental deaths, 133 (40%) were induced by motor vehicle injuries. Deaths from trench cave-ins were investigated by Suruda, Smith, and Baker (1988). They examined 306 fatal cases obtained primarily from OSHA investigation records. Of those where trench depth was available (265), they found that 52% occurred in shallow trenches less than 10 feet deep. Trent and Wyant (1990) reported a case series of 62 fatal injuries from hand tools. Most of the tools were electric power tools such as saws and screwdrivers (39%) and welding tools (29%). Death occurred most commonly following a low-voltage electricity release from the supply cord or the tool itself; however, 18% of the fatalities were the result of falls.

Other research highlights musculoskeletal disorders in construction workers (Holmstrom, Moritz, & Engholm, 1995); back strain in concrete reinforcement workers (Wickstrom, Niskanen, & Riihimaki, 1985); musculoskeletal disorders in concrete workers (Niskanen, 1985); radiographically detectable degenerative changes of the lumbar spine in concrete workers (Riihimaki et al., 1990); injuries occurring during material handling activities in building construction (Niskanen & Lauttalammi, 1989); back disorders in crane operators (Bongers, Boshuizen, Hulshof, & Koemeester, 1988; Burdorf & Zondervan, 1990); significant morbidity among carpenters involved in woodworking tasks (Waller, Payne, & Skelly, 1989); shoulder tendinitis related to heavy manual work and vibration in rockblasters and bricklayers (Stenlund, Goldie, Hagberg, & Hogstedt, 1993); arm-shoulder fatigue in carpenters (Hammarskjold & Harms-Ringdahl, 1992); low back pain in machine operators and carpenters (Riihimaki, Tola, Videman, & Hanninen, 1989); knee disorders in carpetlayers, floorlayers, and painters (Kivimaki, Riihimaki, & Hanninen, 1992; Thun et al., 1987); musculoskeletal symptoms among electricians (Hunting, Welch, Cuccherini, & Seiger, 1994); and osteoarthritis of the hip in construction workers (Croft, Cooper, Wickham, & Coggon, 1992).

Research on Occupational Falls

Only five studies—two descriptive and three analytical—have been conducted on work-related falls. Only one of these solely focused on a construction-related occupation (painters), despite the fact that falls have been the number one cause of death in the construction industry for years, and in at least one analysis, the most costly nonfatal event in construction (Leamon & Murphy, 1995). One of the descriptive studies (Agnew & Suruda, 1993) clearly demonstrates the value of well designed descriptive research useful in guiding the formulation of hypotheses for analytic designs. The three analytic studies present limitations, but demonstrate that analytic research is possible in occupational injury investigation. A critical review of the five studies specifically focusing on falls are reviewed below.

Hunting et al., (1991), in collaboration with the International Brotherhood of Painters and Allied Trades, investigated the relationship between solvent exposure and slips, trips, and falls (STF) in painters. Painters are known to be at higher risk for fatal injuries, especially from falls (Buskin & Paulozzi, 1987; Sorock, O'Hagen Smith, et al., 1993; Suruda, 1992). The design was a prospective, cohort study using a convenience sample and an internal comparison group. Members (N = 166) were studied longitudinally for 11 months. Each participant was requested to submit a short, weekly questionnaire documenting paint solvent exposure, personal protective equipment use, injurious and noninjurious STFs, and job task and environmental hazards. By design, participants were allowed to start and stop submitting questionnaires at their own discretion.

Results: Reported findings of this study (Hunting et al., 1991) included the following: The proportion of time spent each week exposed to environmental hazards was strongly related to the occurrence of STFs (OR = 1.55; 95% CI; 1.25–1.93 for 10% increase in time); variability in solvent exposure was a more important predictor of falls than was the relative level of weekly solvent exposure. Alcohol consumption, age, and lack of work experience were not found to be risk factors, though age and inexperience have been reported as risk factors for occupational injury in many other studies.

Strengths: The authors (Hunting et al., 1991) were able to assemble a more than adequate sample with support and encouragement from the International Brotherhood of Painters and Allied Trades. They estimated solvent exposure using extensively tested measurement methods developed specifically for solvent exposure. Using a longitudinal design was effective in that exposure variability was found to be a more important predictor of STFs than exposure level, which would not have been possible with a cross sectional design. The results have some biological plausibility; however, they are not completely convincing. It would seem that finding a dose-response relationship would be more likely, given the acute and chronic neurologic effects of occupational solvent exposure.

Limitations: Only 11 of the 166 participants returned 40 or more questionnaires, causing the loss to follow up to be substantial. This study (Hunting et al., 1991) was weakened by this large variability in response rate and possible self-selection bias. Selection bias is of concern in this study due to the large commitment expected of participants and their extremely variable responses. Many of the variables associated with STFs were correlated with each other: age, experience, length of time exposed to solvents, etc. The crude data were not provided so it is not possible to determine whether or not potential confounders were adequately controlled for in the multivariate analysis.

Cohen and Lin (1991) conducted a retrospective, case-control study of ladder fall injuries—123 cases and 142 controls. The study was partially funded by the NIOSH. Although earlier studies had been conducted on ladder rung shape (Juptner, 1976) and the best angle of inclination (Dewar, 1976; Irvine & Vejvoda, 1977), they did not contribute to an understanding of factors contributing to ladder falls. The authors hypothesized that factors most closely related to the injury event, such as ladder use and working condition variables, would be stronger predictors than variables further removed from the event such as personal characteristics. The authors grouped factors into four categories: (a) personal, nonoccupationally related variables; (b) personal, occupationally related variables; (c) variables related to working conditions; and (d) variables related to ladder use (equipment).

Results: Cohen and Lin (1991) found that factors temporally closest to the injury event, such as specific ladder use and working condition variables, were stronger predictors of ladder falls than variables further removed from the event such as personal characteristics. The authors suggested that fatigue, induced by working long hours or in awkward positions, may be a common element across most of the risk factors.

Strengths: This study (Cohen & Lin, 1991) was population based; cases were identified through emergency room visits at hospitals participating in the National Electronic Injury Surveillance System. Controls, who had not experienced a ladder fall, were randomly selected from a pool of ladder users identified in the case employer's records. Interviews were conducted 2 to 4 weeks following the injury event, reducing the likelihood of recall bias. This study highlighted that environmental/equipment variables, which are more amenable to change, had a greater impact on ladder injuries than personal characteristics, which are more commonly evaluated. The authors discussed their results in terms of administrative and environmental controls transferrable and understandable to occupational health and safety professionals.

Limitations: The study (Cohen & Lin, 1991) results were weakened by failure of the researchers to include sufficient information in their written report to allow readers to independently evaluate their results. Examples of areas containing insufficient information include the sample description, measurement methods, and statistical results such as summary regression tables or confidence intervals. Workers treated at hospitals implementing the National Electronic Injury Surveillance System may or may not have been representative of the general population of occupational ladder users, and controls were not matched on any variable. Age, which has been suggested in prior studies as a risk factor for occupational injuries, was not evaluated. Citations provided in this study are very limited; for example, the authors refer to Haddon's work and the Holmes-Rae scale for life stressors, but provide no references.

Templer et al. (1985) evaluated stairway risk factors through videotape recordings of workers using 31 flights of stairs in eight industries with the highest frequency and severity rates for stair-related injuries. The authors determined which industries were at high risk for stairway falls through an analysis of Workers' Compensation records for two states, New York and Ohio. The study was conducted in three states: California, Georgia, and Ohio. Fifty-four sites in manufacturing, hotels and motels, educational services, local and state government, food and kindred products, apparel stores, eating and drinking establishments, and miscellaneous retail were evaluated—24 to 40 hours of videotape each. In this study, all events including falls, slips, trips, missteps, and temporary instability were evaluated. Using a matched case-control design, the authors analyzed environmental conditions, user characteristics, and behavioral characteristics—a total of 123 independent variables.

Results: Using discriminant analysis, the authors (Templer et al., 1985) found that the following factors best discriminated between those who experienced an incident and those who did not: movement impeded by another and older age (cases), and large physical stature and wearing glasses (controls). They measured risk by number of incidents per number of observed stairway uses. Physical environment factors significantly associated with higher incidence rates included higher effective riser height, less effective tread depth, tile and linoleum tread, and the size of the nosing projection during descent.

Strengths: The authors (Templer et al., 1985) analyzed 30% of the recordings to ensure reliability. Ninety-eight undisputed critical incidents were selected for the final analysis; the reliability measure was not provided. The nonincident sample was formed by selecting a third person traveling in the same direction prior to each person who had an incident on a given stairway, assuring duplication of circumstances. Coder training was extensive, lasting 7 hours, and reliability was tested throughout the study period.

Limitations: Independent variables numbering 123 in three categories were analyzed (Templer et al., 1985). Univariate correlations were used and variables statistically significant at the .05 level were entered into a stepwise multiple regression. Although many of these variables were found to be correlated with injuries in prior studies, a more thoughtful approach to initially delimiting variables may have been helpful. Stepwise regression is useful in determining parsimonious prediction equations, but it is based solely on numbers, rather than on a predetermined theoretical basis. This technique is unable to compensate for poorly selected independent variables (Cohen & Cohen, 1983; Glantz & Slinker, 1990).

Agnew and Suruda (1993) examined fatality data for 1980–1986 from a NIOSH death certificate database and official OSHA investigations from 1984–1986, in order to analyze the relationship of age to fatal work-related falls. They were able to calculate age-specific death rates from information obtained from the NIOSH and U.S. census data. From information obtained from the OSHA investigation reports, the authors retrieved information related to employers, injured employees, the nature and cause of injuries, and the location and height of falls, none of which is recorded on death certificates. The study was limited to males since 94% of the victims were men.

Findings: The authors (Agnew & Suruda, 1993) found that 9.6% of all work-related traumatic fatalities in males were caused by falls, with construction having the largest number (2,041) of fatal falls (49%), followed by manufacturing (507; 12%). The rate of fatal falls for all male workers was 1.24/100,000, while rates for males aged 45 and older were significantly higher statistically (chi-square = 34.59; $df = 1$; $p < 0.05$). Rates were 1.34/100,000 for male workers aged 45–54, 1.85/100,000 for men aged 55–64, and 3.0/100,000 for men 65 years and older. The proportion of all work-related deaths that were caused by falls ranged from 7.2% for workers 16–19 years of age to 11.6% for those 65 years and older. This trend was statistically significant (chi-square = 12.03; $df = 1$; $p < .05$). In addition, there was a significant increase in fatal falls from ladders for workers 55 years and older and a significant correlation ($r = 0.28$; $p < .0001$) between increasing worker age and decreasing height of fall, supporting the premise that susceptibility to physical trauma increases with age.

Strengths: Recognizing the limitations of the existing national databases for occupational illnesses and injuries, the researchers (Agnew & Suruda, 1993) used two sources to analyze data regarding fatal occupational falls, allowing for a more comprehensive analysis. Their description of the limitations of each database is thorough. Although correlational studies are limited in scope, this review highlighted several areas for possible hypothesis testing, such as the relationship between ladder use and age, and contributed to the search for determinants or risk factors for falls.

Limitations: A correlational study such as this one (Agnew & Suruda, 1993), is limited by design in its ability to link risk factors and outcomes in individuals, and to control for the effects of potential confounding factors (Hennekens et al., 1987). Because of the limitations of the data sources, the authors were unable to provide much detail regarding the circumstances of the falls.

Muir and Kanwar (1993) surveyed hospital and clinic records for three consecutive 6-month periods at a hospital in a major city in the United Kingdom to obtain details on all injuries related to ladder falls. They collected demographic and task-specific information such as age, height of fall, task at the time of the incident, mode of fall, and injuries sustained.

Results: Sixty-six ladder falls were identified and, of those, 26 falls occurred at work. Upper and lower extremity injuries predominated in a wide array of home and work situations. The authors (Muir & Kanwar, 1993) contend that up to 90% of the injuries could have been prevented in situations where ladders fell—47 of 66 incidents.

Strengths: This case series (Muir & Kanwar, 1993) highlights the significant problem of ladder injuries and provides useful clinical information regarding care of patients who have suffered seemingly minor injuries from a short distance fall. The authors noted that several patients suffered multiple injuries, and encouraged clinicians to conduct thorough assessments on all patients sustaining ladder falls.

Limitations: Very few details are provided in this report, and therefore do not always support the presented conclusions (Muir & Kanwar, 1993). For example, the authors contend that up to 90% of the injuries could have been prevented in situations where ladders fell. This conclusion was presumably based on the assumption that those using the ladders were not acting safely; however, no consideration was given to ladder design or environmental conditions. Their only recommendations were for increased education through a public information campaign, and distribution of consumer product information at the time of ladder sales.

In addition to these studies, the Division of Safety Research of the NIOSH is in the process of developing a case-control study of risk factors for falls in construction workers, the first of its kind. The study will select cases from Workers' Compensation records, and controls from company records in high-risk counties of West Virginia. They intend to identify and quantify risk factors associated with falls from buildings or structures, including both work-related and personal issues. Some of the risk factors they will be evaluating include: fatigue, occupational stressors, life stressors, daily commuting distance, job experience, job training and/or education, age, weather conditions, surface conditions, behavioral factors, medical problems, social habits, and company safety and health programs. From the results of this study, researchers hope to identify and evaluate intervention strategies (USDHHS, NIOSH, 1994).

Risk Factors for Occupational Injury

Because of the many types of jobs that exist, different injuries have come to be associated with distinct work tasks. Studied risk factors for injuries are generally grouped into three categories: human variables, job content, and physical and social environment. In a critical review of occupational injuries, Veazie et al. (1994) found that many different variables have been studied from an epidemiologic viewpoint and found to be associated with injury. This review, however, was limited to epidemiologic studies, excluding musculoskeletal and intentional injuries in order to narrow its scope. The authors identified 117 analytical epidemiologic studies in medicine, safety, public health, and psychology, published from 1970 through 1992, that evaluated risk factors for occupational trauma. At least one human variable was evaluated in 68% of the studies reviewed, and 36% measured some characteristic of job content. Many factors were found to be associated with occupational injuries, but only a few of the 67 human factor variables, 24 job content variables, and 39 environmental factors have been examined by multiple studies, making it impossible to draw any conclusions related to potential risk factors. A list of the human, job content, and environmental variables identified in the 32 "higher quality" studies—as defined by exhibiting external validity, providing sufficient information, and the unlikelihood of selection bias, information bias, or confounding—is included in Appendix A.

Minimal literature is published regarding the association between risk factors and injuries or injury severity, which are the focus of this study. A summary of risk factors identified in occupational fall studies is presented next. A summary of related risk factors evaluated in both fall and nonfall studies can be found in Appendix B.

In the two analytic studies of falls presented, as well as in the proposed NIOSH study, the following risk factors possibly associated with occupational falls, exclusive of solvent-related exposures, were or will be evaluated: age; attitude toward "locus" of accident control; behavioral factors; company safety and health programs; daily commuting distance; environmental factors; equipment design features; equipment maintenance; fatigue; hazardous tasks; job experience; job satisfaction; job training and/or education; life stressors; medical problems; medication use; occupational stressors; personality factors; quality of supervision; risk taking behavior; social habits (i.e., smoking, coffee consumption, alcohol/drug intake); surface conditions; weather conditions; and work shift.

Each study used or will use a different set of variables defined in different ways, making comparisons and evaluation difficult. As an example, Hunting et al. (1991) found that exposure to environmental hazards and variability in weekly solvent exposure were among the strongest predictors of STFs. Age, alcohol consumption, and lack of work experience were not found to be risk factors, though other studies evaluating occupational injuries have indicated otherwise (Baker, 1987; Heineman et al., 1989; Helmkamp & Bone, 1987; Hertz & Emmett, 1986; Hingson, Lederman, & Walsh, 1985; Mueller, Mohr, Rice, & Clemmer, 1987; Smith & Kraus, 1988; Stallones & Kraus, 1993; Trent, 1991). Because research work in the area of occupational falls has been so limited, it is also difficult to draw any conclusions related to possible risk factors.

Falls in Nonoccupational Settings

Research on falls in nonoccupational settings is more extensive than on those occurring in the workplace, but the documentation is rather basic. Despite the relatively high incidence of falls, especially among the elderly, researchers are now just beginning to investigate the complexity of risk factors including environmental, behavioral, and biomedical influences, and to identify strategies for modifying known risk factors. Further methodologic refinement is necessary in order to address these more complicated issues. It has been recommended that the following topics be explored related to nonoccupational falls in order to more fully understand the complex phenomenon of falls: (a) understanding how environmental, physiological, and behavioral factors interact to put certain age-groups at high risk for falls; (b) designing and evaluating environmental, biomedical, and behavioral interventions; and (c) integrating effective interventions into existing public health and medical services in community and institutional settings (USDHHS, Public Health Service, Centers for Disease Control, 1992).

A brief summary of research on falls among the elderly in nonoccupational settings is presented next in order to focus on research methods and risk factors that may also be relevant in the workplace. Studies focusing on risk factors for hip fractures, though they involve falls, will not be discussed because of their relationship to osteoporosis, a risk factor of different etiology.

Falls in Older Adults

Falls in older adults have long been recognized as a significant and common problem. Droller (1955) described the phenomenon of falls at home almost 40 years ago. This was followed by a smattering of studies in the following two decades (Ashley, Gryfe, & Amies, 1977; Gryfe, Amies, & Ashley, 1977; Kalchthaler, Bascon, & Quintos, 1978; Lucht, 1971; Margulec, Librach, & Schadel, 1970; Rodstein, 1964; Sheldon, 1960;

Tinker, 1979; Waller, 1974). Most of this work was descriptive in nature in an attempt to document the breadth and seriousness of the problem.

In the early 1980s, research became more focused and sought to identify the intrinsic (i.e., personal) and extrinsic (i.e., environmental) factors contributing to falls. Studies evaluated falls in home settings (Perry, 1982); falls among the institutionalized (Berry, Fisher, & Lang, 1981; Brody, Kleban, Moss, & Kleban, 1984); the relationship between falls and visual perception (Tobis, Nayak, & Hoehler, 1981); postural sway (Fernie, Gryfe, Holliday, & Llewellyn, 1982); and fall prevention (Morris & Isaacs, 1980).

From the mid-1980s to the present time, research on falls in the elderly has sought to identify risk factors and appropriate risk prevention strategies; however, the occurrence of falls is increasingly recognized as a multifaceted, multifactorial event (Sattin, 1992). The following intrinsic or personal risk factors have been reported, and though study results have not been consistent, they are believed to be associated with an increased risk of falling: decreased perceptual acuity; vestibular dysfunction; proprioreceptive dysfunction; cervical degenerative disorders; peripheral neuropathy; dementia; musculoskeletal disorders; foot disorders; and use of medications including sedatives, antidepressants, antihypertensives, antiarrhythmics, anticonvulsants, diuretics, and alcohol (Tinetti & Speechley, 1989). Extrinsic or agent factors identified include mechanical energy, impact position, and impact location, while environmental considerations include lighting, stairs, rugs and flooring, bathtubs, shelving, footwear, and street and sidewalk conditions.

In a prospective study of 336 community-living persons at least 75 years of age, where detailed physical examinations and standardized measures of mental status, reflexes, balance, and gait were assessed, the following predisposing factors were identified: sedative use, cognitive impairment, disability of the lower extremities, palmomental reflex, abnormalities of balance and gait, and foot problems. The risk of falling increased linearly with the number of risk factors (Tinetti, Speechley, & Ginter, 1988). Speechley and Tinetti (1991) also studied falls in a range of individuals rated *frail* to *vigorous*. A surprising finding was that almost 20% of those rated as vigorous also experienced falls, but the incidents tended to occur outside the home and on stairs, in the presence of environmental hazards, or during activities that displaced the individual's center of gravity.

Robbins et al. (1989), in a study of fallers and nonfallers in institutions ($N = 149$) and in the community ($N = 68$) found that, in institutionalized individuals, hip weakness, poor balance, and the number of prescribed medications were most strongly associated with falling. They were further able to develop a fall prediction model yielding a 76% overall predictive accuracy with 89% sensitivity and 69% specificity.

Other studies have identified a myriad of risk factors including advanced age, use of benzodiazepenes (Ryynanen, Kivela, Honkanen, Laippala, & Saano, 1993), alcohol consumption, antianxiety and antipsychotic drugs, certain cardiovascular diseases, and smoking (Malmivaara, Heliovaara, Knekt, Reunanen, & Aromaa, 1993).

Many of the studies related to falls report contradictory results, and comparison among studies is difficult because the study populations, data collection techniques, and study designs vary (Robbins et al., 1989). In addition, not all studies define *fall* and, when it is defined, the definitions are not consistent. Defining the term is indeed difficult, however, because a fall is not a disease, but "often a syndrome, which represents symptoms and signs of a disordered function in a disordered environment" (Sattin, 1992, p. 491).

Nursing Research in Institutional Falls

Nursing research related to falls has focused on two major areas—identifying risk factors for institutional falls and developing risk prediction tools. In general, research over the past 30 years has changed from surveillance type activities such as estimating the numbers and outcomes of falls, to predicting the likelihood of falling and identifying and testing strategies for prevention (Morse, 1993). In most nursing studies, individual patient characteristics have received greater attention, though staffing issues and environmental conditions such as the use of restraints and guard rails, have been heavily evaluated. While predictor variables associated with falls in institutions are not necessarily relevant to those in construction, research designs and other methodological issues *are* relevant.

Most nursing studies have been descriptive, identifying demographic characteristics of fallers and nonfallers in order to develop a risk profile of a patient likely to fall. Retrospective chart review designs are common but the use of comparison groups has been infrequent (Gross, Shimamoto, Rose, & Frank, 1990; Hendrich, 1988; Morse, 1993; Rainville, 1984; Tack, Ulrich, & Kehr, 1987; Whedon & Shedd, 1989).

Janken, Reynolds, and Swiech (1986) however, did use a comparison group in their study. They found that 5 of 12 potential predictor variables (i.e., confusion, decreased mobility of the lower extremities, general weakness, vertigo, and substance abuse) explained 21.9% of the variance. Limitations of the study include failure to control for hospital length of stay, a reliance on incident reports to identify falls, and a retrospective design. The authors recommended that a prospective study be developed in the future to validate their findings and to identify critical variables not considered in their study. A prospective design by Mion et al. (1989) in a rehabilitation setting, found that impaired judgment, impaired proprioception, presence of physical restraints, use of major tranquilizers, use of sedatives, and the presence of a psychiatric diagnosis, were each individually associated with an inpatient fall. However, logistic regression identified only altered proprioception as a major predictor.

Four scales have been identified that attempt to predict patient probability of falling (Arsenault, 1982; Byers, Arrington, & Finstuen, 1990; Easterling, 1990; Morse, Morse, & Tylko, 1989). Two of the scales do not provide reliability and validity testing information (Arsenault, 1982; Easterling, 1990), and a third is still in development (Byers et al., 1990). Only the scale developed by Morse et al. provides reliability and validity information; 80.5% of the patients were correctly identified as fallers, the sensitivity was reported as 78%, and the specificity as 83%. The interrater reliability correlation was $r = .96$.

Instrument development methodology that has been reported in the nursing literature may be useful in occupational health as a management tool. However, scale development is dependent on identifying risk factors, which has not yet been accomplished for falls in occupational settings.

In nursing research, the development and testing of fall prevention strategies is the most underdeveloped area. Nurses acknowledge, however, that in order to be successful, fall prevention programs need to account for physiologic, psychologic, environmental, and patient care factors. Whedon and Shedd (1989), in their literature review of fall prevention strategies, identified 59 potential interventions in five categories that have been recommended in both research and nonresearch publications. The numbers in each category were as follows: assessment and care planning (8), direct care activities (14), environmental interventions (19), patient education (14), and staff education (4). There is little evidence in the literature of comparative effectiveness of any of these interventions, making it difficult for clinicians to choose the most effective and cost-efficient choices in patient care settings (Whedon & Shedd, 1989).

Research utilizing intervention strategies has been sketchy and consists of six studies (Fife, Solomon, & Stanton, 1984; Hernandez & Miller, 1986; Innes, 1985; Innes & Turman, 1983; Rainville, 1984; Widder, 1985); most have been published in nonresearch journals with inadequate description of the study goals, dependent variables, hypotheses, or statistical analyses. The majority of the studies concluded that their interventions led to decreased falls, despite the fact that methodological issues would have precluded such conclusions (Whedon & Shedd, 1989).

Morse (1993) has identified two major weaknesses in nursing research on falls: (a) a trend towards developing and implementing the use of assessment tools without establishing their validity and reliability, and (b) a tendency towards collecting chart review data retrospectively when there is a critical need for prospectively collected data. Recommendations for future nursing research include: testing common sense; simple interventions such as railings between beds and bathrooms in institutions; decreasing the distance between these rooms; decreased use of floor polish; more refined assessment coupled with intervention-based studies; and increased multidisciplinary research that might include design and development of a safe, low geriatric bed. Input from multiple disciplines could result in a practical and safe design.

Measuring Injury Severity

Several different measurements can be used in injury research, including those that measure the severity of injuries or their long-term effects. Some systems, such as the Abbreviated Injury Scale (AIS), and a related measure, the Injury Severity Score(s) (ISS), have been tested for reliability and validity. In occupational settings, lost time from work has been used as a measure of injury severity, as well as very broad measures categorizing falls as *minor* (i.e., requiring first aid), *medical* (i.e., requiring medical treatment), and *lost time* (i.e., disabled for 72 hours or more) (Mueller et al., 1987).

The ISS was developed in 1974 and has received considerable attention. It was originally developed as a tool for researchers to compare morbidity and mortality in persons with different injuries of similar severity. The ISS applies a mathematical formula to the AIS in order to determine a valid numerical description of the overall severity of injuries in patients with more than one injury. The AIS, developed in 1971 primarily to evaluate motor vehicle crashes (Committee on Medical Aspects of Automotive Safety, 1971), is the most broadly recognized severity scoring system based on anatomic evaluations. Raters grade all injuries for six body areas on a scale that ranges from one, which is minor, through six, which is fatal. The major body areas presenting injury include head and neck including the cervical spine; face including the mouth, nose, eyes, and ears; chest including the thoracic spine; abdomen including the lumbar spine; extremities; and external body parts. The major drawback of this system has been the need to review an entire medical record in order to calculate an accurate score and what Champion, Sacco, Carnazzo, Copes, and Fouty (1981) described as "aggravatingly clinically inconsistent elements" (p. 675). The AIS, although rather elementary, has become the standard for crash investigation teams funded by the U.S. Department of Transportation, as well as other teams in the United States, Australia, and Europe (Association for the Advancement of Automotive Medicine (AAAM), 1990; Baker, O'Neill, Haddon, & Long, 1974; Champion et al., 1981; Greenspan, McLellan, & Greig, 1985; Hansson, 1986; Rice, MacKenzie, & Associates, 1989).

A pilot study regarding reliability of the ISS was conducted in 1978 and found 76% agreement in vehicular trauma cases and 69% in nonvehicular cases. A more systematic study was designed in 1985 evaluating the AIS coding capabilities of a group of 15 health care professionals consisting of physicians, nurses, emergency medical technicians, and nonmedical personnel. Interrater reliability was evaluated by comparing injury scores assigned by the raters with a total of 375 patients. Intrarater reliability was evaluated by examining scores given to 185 charts, rated twice by each rater, 3 months apart. A weighted Kappa was computed that accounted for unequal importance of scoring disagreements, especially with larger AIS values. To measure agreement among raters in ISS scores, the intraclass correlation coefficient was computed for each class of raters. All raters agreed within ±1 AIS score for more than 80% of the injuries. The magnitude of the weighted Kappa statistics ranged from 0.79 to 0.93, and variation among individual raters was greater than for any other type (MacKenzie, 1984; MacKenzie, Shapiro, & Eastham, 1985).

In 1983, a conference on trauma severity indices proposed a minimal set of criteria for the evaluation of measurement tools. In order of importance, determined by a modified Delphi approach, this group of epidemiologists, statisticians, and traumatologists identified the following characteristics: criterion or predictive validity, construct validity, face validity, interrater and intrarater reliability, index based on easily accessible data, quality of medical care factored out, and simplicity. Given the above, this group judged the AIS/ISS to be the most promising anatomical index (MacKenzie, 1984).

The AIS has been revised several times: in 1980, 1985, and again in 1990. Many studies evaluating the ISS have been conducted, most of which demonstrate its superiority as a severity index (Goldberg, Goldberg, Levy, Finnegan, & Petrucelli, 1984; Osler, 1993). Osler recommends that a simple correction to the AIS intensity scores on an injury-by-injury basis would improve the tool. Further directions for research include the following: continuous refinement of AIS scoring; accurate determination of the appropriate severity for each injury; measurement of severities, rather than assignment; a possible new definition of the ISS that would be the simple product of the expected survivals for each sustained injury case; the effect of prior disability on survival outcome; and identification of predictors for early and late mortalities.

Injury severity has not been considered or measured to any degree in occupational research. When it has been measured, lost workdays have been used as a proxy. This may measure the cost of an injury more precisely, but it is not the most appropriate measure of severity since lost workdays are also a function of job demands and work policies (Veazie et al., 1994). An office worker who sustains a fracture to the foot, may be able to return to work much earlier than a carpenter. A company with a modified duty policy may demonstrate markedly reduced lost time work injuries if workers are able to return temporarily to positions requiring less physical expenditure. Return to work becomes a challenge in the construction industry since almost all tasks require full physical capability; light or modified duty is not well accommodated.

Injury severity scores such as the AIS and the ISS have been validated (Baker & O'Neill, 1976; Baker et al., 1974; MacKenzie, 1984; and MacKenzie et al., 1985) and widely used in trauma situations, but they have not been found discriminating enough to distinguish between severity levels of less life-threatening events such as those found in occupational settings (Veazie et al., 1994). For example, an acute lumbosacral strain and a rib contusion/fracture are classified as minor injuries (Association for the Advancement of Automotive Medicine, 1990). In occupational settings, and more specifically in construction environments, both of these injuries would most likely preclude a worker from continuing with normal duties, and thus would not be considered *minor*. Mitchell, Cloeren, and Schwartz (1993) used the AIS to code 195 occupational injuries that occurred in an industrial plant. In this study, they were unable to document an association between AIS scores and lost work time; however, the range of scores assigned to these occupational injuries was narrow. No injury received a score greater than three out of a possible maximum rating of six. The ISS ranged from one to nine (mean score = 1.5; median score = 1). The authors documented an average of 1.9 AIS diagnoses per injury, in contrast to 2.57 to 4.24 injuries in a study of vehicular and nonvehicular, hospitalized trauma patients (MacKenzie et al., 1985).

Wong (1994) used the AIS to code 122 occupational injuries among construction workers in Hong Kong. In this study, the range of AIS scores was also quite narrow, though one injury was assigned a score of four and another was assigned a score of five. The ISS ranged from 1 to 29 (mean score = 2.4; median score = 1). Eighty-two cases (67%) received an ISS of one.

The AIS scale also does not include a coding mechanism for chronic injuries unique to occupational settings. A new rating system attempting to evaluate long-term effects of injury, the Injury Impairment Scale (Association for the Advancement of Automotive Medicine, 1994), is also geared toward injuries generally more severe than seen in occupational settings.

Another coding system that is used for classifying injuries is the International Classification of Disease (ICD)-9CM (U.S. Department of Health and Human Services, 1989). This scheme is comprehensive and allows for more thorough classification of the types of injuries seen in occupational settings (e.g., foreign bodies), but it does not incorporate a mechanism for classifying injury severity (Mitchell et al., 1993). A system for converting ICD-9CM codes into AIS scores has been developed. This was developed, however, using a hospital population. To date, it has not yet been fully validated, and has not been used in occupational settings (MacKenzie, Steinwachs, & Shankar, 1989; MacKenzie, Steinwachs, Shankar, & Turnkey, 1986; Mitchell et al., 1993).

Conceptual Framework

Injury events are studied by a wide variety of professionals. Each approaches research from their particular world view, disciplinary perspective, and associated domain of professional practice (Morse, 1993). No unifying theoretical framework guides occupational injury research. Presented next is a discussion of William Haddon's models (Baker & Haddon, 1974; Hadden, 1980a) developed as tools for guidance in injury prevention activities and research, and their utility in occupational health research.

William Haddon, Jr. began publishing his pioneering work in the field of injury prevention in the mid-1960s (Haddon et al., 1964). He credits John Gordon (1949) with providing researchers with a framework for evaluating injuries, and cites Hugh DeHaven as being the first to realize the importance of injury thresholds and impact conditions (Haddon, 1980b). He strove to understand and convey those processes involved in injury causation that he described as: "When energy is transferred in such ways and amounts, and at such rapid rates, that inanimate or animate structures are damaged" (Haddon, 1973, p. 323). His 10 strategies for reducing losses from injuries were first proposed in 1970 and refined in 1973, and again in 1980 (Haddon, 1970, 1973, 1980a). To Haddon, these strategies represented the means for identifying the theoretical possibilities or options for reducing damage from injuries, as well as for clarifying interventions. For a listing of Haddon's Ten Countermeasure Strategies, see Appendix C.

Haddon later developed a conceptual model for injury causation that was to become known as the Haddon Matrix. This 3 x 3 table combined the traditional epidemiologic factors of host, vehicle (i.e., agent), and the environment, with preinjury, injury, and postinjury phases (Baker & Haddon, 1974; Haddon, 1980b; Kraus & Robertson, 1992). Haddon envisioned that this model could be used for resource allocation, strategy identification, and planning (Haddon, 1980b). Along with other public health professionals, he has revolutionized the way professionals view injuries by encouraging them to look at causation as an "acute exposure to physical agents" (Baker et al., 1992, p. 4) (see Appendix D for a modified version of Haddon's Matrix).

Haddon (1980b) surmised that the ingrained human need to explain "accidents" with luck, chance, fate, and sometimes "divine retribution" has contributed to the lack of scientific interest in injury research. As a research tool, Haddon's models could provide a structure for developing research programs, and to lend clarity and exactness to the methodology. His matrix is unambiguous and widely used for intervention programs. It is particularly well suited for use in occupational settings because of its compatibility with the traditional hierarchy of controls used in industry: engineering controls, administrative controls, and the use of personal protective equipment (Olishifski & Plog, 1988). Haddon's explanation of injury causation in terms of energy is persuasive and should be well appreciated by occupational health professionals.

Haddon's models (Baker & Haddon, 1974; Haddon, 1980a) are also compatible with nursing models where person-agent-environment interactions are seen as the cornerstones of nursing research. Evaluation of the person in this model is conducted through all phases of the injury event. In addition, influences on the person, as well as his or her interaction with the vehicle of injury and the environment, are explored. All too often, personal factors are emphasized in the literature as the sole cause of injuries when it is person-environment interactions that are more critical. For example, after writing a very thorough piece on injuries, Mayhew (1991) concluded that nurses could "help decrease the frequency of injuries by counseling clients regarding the consequences of their behavior and recommending basic precautions appropriate to the activity" (p. 893).

Environment has been described by Haddon (1980a) in very broad terms, including its biological, physical, and political components, thus making this concept useful for occupational settings. Smith (1987) emphasized the need for more comprehensive interpretation of environment by broadening Haddon's concept further and adding the term *socioeconomic* to the description of environment. This expanded view is not unlike interpretations provided by researchers in nursing who encourage nurses to evaluate the socioeconomic structures of society along with the personal environment when planning research (Chopoorian, 1986; Kleffel, 1991; Stevens, 1989).

Summary of Literature Review

Surveillance activities and identification of occupations and industries at high risk for injury have been a historical focus of occupational injury research. Until recently, available data to guide the identification of high-risk groups has been extremely inadequate. With the advent of two parallel data systems, the NTOF surveillance system and CFOI, occupational safety and health professionals can be reasonably assured that information regarding fatal events is accurate. However, no single data source regarding nonfatal events exists.

In addition, no consistent framework for guiding injury research is commonly used by the various disciplines involved in occupational injury work. With a more comprehensive picture of fatal injuries emerging, some analytical studies have been published. It is difficult, however, to develop prevention strategies based on this limited research because of the almost infinite variety of occupational tasks and settings in which injuries occur. Additionally, deficiencies and inconsistencies in research methodology make it difficult to assess the contributions of various factors to occupational injury.

Construction remains one of the most dangerous occupations, but research in this area has been limited. Although it is a large industry, it is composed of many small employers, hence research and intervention is difficult (Ringen, 1994). In addition, construction, for the most part, employs transient and independent workers making it a challenging candidate for comprehensive etiologic research (Veazie et al., 1994). Despite these difficulties, research related to construction falls needs to be developed since falls have consistently been found to be a major cause of death, injury, and suffering for workers in this key industry. Falls and their sequelae are enormously costly to both the industry and the workers. Yet despite this fact, there is an unexpected tolerance of slips and falls, and an equally disturbing low expectation for technological improvement (Leamon & Murphy, 1995).

Multidisciplinary research in occupational injury control is the key for decreasing the enormous toll that both fatal and nonfatal injuries are taking in the construction industry and others. Research activities need to include the study of workplace systems, including the workers, tasks, tools, and processes that make up these systems, in order to identify potential causal mechanisms, intervention strategies, and prevention activities that contribute to safe and healthful workplaces (Waxweiler, Rosenberg, & Fenley, 1993). Research studies are critically needed that have the potential to identify and quantify information related to possible risk factors. However, successful injury prevention strategies cannot be developed until risk factors for injury and injury severity have been identified.

Research Questions

In order to determine risk factors for injury severity in construction workers who sustain nonfatal falls within the workplace, the following research questions have been selected for this current study:

1. Does a functional limitation measure provide a more normal distribution of ISS, compared to the AIS or ISS alone when scoring less serious occupational injuries?

2. What are the relative contributions of the following factors to injury severity in a representative group of construction workers who have sustained a nonfatal fall at work in California: (a) demographics (age); (b) fall-related variables (height of fall and surface landed on); (c) environmental factors (work surface); (d) job activity-related factors (activity at time of injury, carrying an item, and weight of carried item); (e) personal factors (job title, length of time at site, and length of time in trade); (f) employer-related factors (Safety Climate Measure score, project type, size of work group, and union status); and (g) job characterization (Psychological Job Demands score and Decision Latitude score)?

3. To what degree do construction workers who have sustained a nonfatal injury with a low severity score differ from those who have sustained an injury with a higher severity score in terms of the demographic, fall-related, environmental, job-related, personal, and employer-related factors?

4. Are the risk factors correlated with number of days lost from work up to a period of 3 months following the initial injury event?

5. Is there a relationship between the functional status measure or the ISS and time lost from work?

In addition to collecting information on the potential risk factors, information regarding other personal, employer-related, and job activity-related variables will be assembled. While these may contribute to the occurrence of injury, they are not expected to contribute to injury severity. Information on these factors is provided in order to present a comprehensive description of falls in this sample. Examples of general information that will be assessed are date and time of fall, usual job tasks, and general demographic information.

Research Hypotheses

The following research hypotheses have been developed regarding risk factors for injury severity from falls in construction:

1. A functional limitation measure will provide a more normally distributed range of values than the AIS or ISS alone for less serious, occupational injuries.

2. The following sets of variables make a statistically significant contribution to the explained variance in injury severity: (a) demographic, (b) fall-related, (c) environmental, (d) job activity-related, (e) personal, (f) employer-related, and (g) job characterization.

3. The individual variables, height of fall and surface landed on, will make a significant contribution to the explained variance in injury severity.

4. When controlling for height of fall and surface landed on, older workers will have a higher injury severity score and will experience a significantly higher number of lost work days than younger workers.

5. When controlling for age, height of fall, and surface landed on, the following unique variables will contribute to injury severity: union status, construction type, Safety Climate Measure score, size of work group, length of time at job site, job, and Psychological Job Demands score.

6. The functional limitation measure and the ISS will be significantly positively associated with the number of days lost from work.

Definition of Terms (Rice et al., 1989)

Case definition is any construction worker who sustained a nonfatal fall for whom a Doctor's First Report was filed with the California Department of Industrial Relations, Division of Labor and Statistics Research, within 2 months of the initiating event. Only workers with job titles within construction occupations and who work within the Standard Industrial Classification 15–17 or 8711 (construction engineering) will be eligible for inclusion. Workers with a title such as electrician or carpenter, who work in industries other than construction, will not be eligible for participation.

Fall to a lower level applies to "instances in which the injury was produced by the impact between the injured person and the source of injury, the motion producing the contact being that of the person, under the following circumstances: 1) the motion of the person and the force of the impact were generated by gravity; and 2) the point of contact with the source of injury was lower than the surface supporting the person at the inception of the fall" (U.S. Department of Labor [USDOL], BLS, 1992, p. DE-4). This definition excludes incidents where a person slips, trips, or catches their fall, even if an injury occurs. A person who falls from a ladder and lands on a lower rung will be eligible for consideration, as would a person who falls on a stairway or on steps.

Fall on a same level "applies to instances in which the injury was produced by impact between the injured person and the source of injury, the motion producing the contact being that of the person, under the following circumstances: (a) The motion of the person was generated by gravity following the employee's loss of equilibrium (the person was unable to maintain an upright position), and (b) the point of contact with the source of injury was at the same level or above the surface supporting the person at the inception of the fall" (USDOL, BLS, 1992, p. DE-5). This would include falls to floors, walkways or other surfaces, falls onto or against objects, or onto the same level.

Jump to a lower level involves "impact injuries sustained as a result of the employee jumping from an elevation. Jumps are differentiated from falls by the fact that they are controlled and voluntary even if the worker jumped to avoid an uncontrolled fall" (USDOL, BLS, 1992, p. DE-5).

Slip is defined as a sliding motion when the friction between a supporting surface and an opposing surface of the foot or foot gear is inadequate. A slip can lead to a loss of balance and can result in a fall (Ellis, 1993).

Trip is defined as a loss of balance due to the foot or leg contacting an object or obstruction. Occasionally, too much friction between the foot or footwear and the walking surface can also cause a trip. A trip can lead to a loss of balance and can result in a fall (Ellis, 1993).

Injury is defined as damage inflicted on the body as the direct or indirect result of an external force, with or without disruption of structural continuity. Any intentional or unintentional wound or damage to the body resulting from acute exposure to thermal, mechanical, electrical, chemical, or other form of energy, or from the absence of such essentials such as heat or oxygen caused by a specific event or incident or series of events within a single workday or shift. Included are open wounds, intracranial and internal injuries, poisonings, suicides, homicides, and work injuries listed as underlying or contributory causes of death (USDOL, BLS, 1994).

Injury severity, in this study, was determined by the ISS score and the functional limitation measure within the first week following the injury.

The *Abbreviated Injury Scale* is a threat-to-life scale that categorizes injury severity by the nature of damage to various body regions. The scores range from one (i.e., minor) to six (i.e., maximum; virtually unsurvivable). It is the most widely recognized severity scoring system based on anatomical description.

The *Injury Severity Score* is a scalar measure of anatomic injury. It is the sum of the squares of the highest AIS grade in each of the three most severely injured body regions (Baker et al., 1974; Copes et al., 1988).

The *E-Code* is the ICD external cause of injury codes, developed by the World Health Organization. E-codes include injuries caused by falls, motor vehicles, firearms, fires, electrocution, and other causes.

The *ICD-9 Codes* are International Classification of Diseases codes for classification of morbidity and mortality information (USDHHS, 1991).

Lost work day is a day on which, because of occupational illness or injury, the employee was away from work, or limited to restricted work activity (NSC, 1993: OSHA definition).

Lost work day cases are cases involving days away from work or days of restricted activity (NSC, 1993: OSHA definition).

Occupational injury is any injury such as a cut, fracture, sprain, or amputation, resulting from a work accident or from a single instantaneous exposure in the work environment (NSC, 1993: OSHA definition).

CHAPTER THREE

METHODOLOGY

Introduction

This chapter focuses on the methodology used in this research of injury severity from construction falls. The following aspects of the study will be described: the research design, the sample, data collection methods, and the statistical analysis plan.

Research Design

This study expands current information related to occupational falls in construction settings by using an observational study design with descriptive and analytical components. It evaluates injury severity and its determinants in a group of construction workers who have sustained an injury from a nonfatal fall severe enough to require medical evaluation and treatment. Injury data must have been reported to the Department of Industrial Relations (DIR), Division of Labor Statistics and Research (DLSR) on a Doctor's First Report (DFR) for inclusion in the study. Information obtained from the DFR, as well as from telephone interviews with injured construction workers, was analyzed. The workers were interviewed at least once near the time of their injury. Those who had not returned to work at the time of the interview received a follow-up call to determine their return to work date.

Sample

Approximately 50–100 injuries from construction falls, on a statewide basis, are reported to the DIR, DLSR each week. The nonprobability convenience sample (n = 255) was drawn from all cases that qualified for inclusion over the 5-month period from

October through March 1995. When interviewers required new cases, the research assistant (RA) was notified to pull all those from the next available full week of cases. Cases were selected from 11 different weeks during this 5-month interval. An introductory letter and consent form were sent to every potential participant meeting the inclusion criteria during those 11 weeks.

Criteria for Sample Selection

Only those cases whose injuries occurred within industries categorized with the Standard Industrial Classification 15–17 or 8711, and who carried a job title common within the construction trades, were eligible to participate. Participants must have sustained a fall, and a health care practitioner must have filed a DFR with the DLSR attesting to the fact that the fall was work related. Those workers who slipped or tripped (i.e., not resulting in a fall) or who caught their fall were not eligible for participation, even if they sustained an injury. Only those workers meeting this definition of *fall* qualified for inclusion. The sample consisted of both males and females. A questionnaire was translated by a certified Spanish language translator, and administered by a Spanish-speaking RA to monolingual, Spanish-speaking individuals. Potential participants whose primary language was neither English nor Spanish were excluded.

Maintaining Confidentiality

Confidentiality was maintained to the extent permissible by law. Response data was protected by assigning numerical codes to each participant. Forms requiring participant identification such as the DFR, informed consent, and medical records, were held separate from the questionnaires. All material was kept in secured files. Names or personal identifiers will not be used in the published results of this study. Statistical summaries will be presented in an aggregate manner, protecting against individual identification of participants. Reporting on subgroups, necessitating data of small numbers, will also be presented in a manner protective of confidentiality. Reviewing and editing data containing identifiers was performed by authorized project personnel trained in proper procedures to maintain anonymity.

Human Subjects Protection

This study received approval from the Committee on Human Research, University of California, San Francisco (UCSF) (H1932-11524-02), as well as from the Committee for the Protection of Human Subjects, State of California, Health and Welfare Agency (95-04-05).

Data Collection Methods

The study variables, measures, and time estimates for questionnaire administration are presented in Table 1. Following case retrieval and introductory participant mailings, the interviewers placed a follow-up phone call. This was approximately one week after the respondent received the introductory letter. The phone call verified accuracy of the contact information on the DFR and, if the respondent was reached, provided the interviewer the opportunity to answer any questions, and to determine level of interest and availability to participate in the study. Efforts were made to locate correct phone numbers when information on the DFR was inaccurate. If interest had been generated, the interviewer scheduled a telephone interview. Participants were asked to read and sign an informed consent and return it to the investigator in a self-addressed, stamped envelope.

Table 1

Study Variables, Measures, and Time Estimates

Variable	Measure	Minutes	Items
Demographic variables			
Age	DFR and self-report	½	1
Fall-related variables			
Height of fall	DFR and self-report	½	1
Surface landed on	NIOSH Fall Supplement	½	4
Environmental factors			
Work surface	CSAO checklist	2	6
Job activity-related factors			
Activity at time of fall	CSAO checklist	2	5
Carrying an item	DFR and self-report	½	1
Weight of carried item(s)	DFR and self-report	½	1
Personal factors			
Job title	DFR and self-report	¼	1
Length of time at site	Self-report	¼	1
Length of time in trade	Self-report	½	1
Employer-related factors			
Safety climate score	Safety Climate Measure	3	10
Size of work group	Self-report	½	1
Project type	Self-report	¼	1
Union status	Self-report	¼	1

(table continues)

Variable	Measure	Minutes	Items
Job characterization			
Psychological Job Demands scale	Job Content Questionnaire		
Decision Latitude scale	Job Content Questionnaire	12	50
Outcome variable			
Injury severity	AIS and ISS scores	None	
Functional limitations	HAQ	5	20
Return to work	Follow-up phone call	1	1
Other information			
Demographics	Questionnaire	2	4
Fall-related factors	Questionnaire	2	5
Job-activity factors	Questionnaire	1	1
Personal factors	Questionnaire	1	2
Employer-related factors	Questionnaire	1	2
Injury-related factors	Questionnaire	4	12
Estimated time		35–45	

Note. DFR = Doctor's First Report; NIOSH = National Institute for Occupational Safety and Health; CSAO = Construction Safety Association of Ontario; AIS = Abbreviated Injury Scale; ISS = Injury Severity Score; HAQ = Health Assessment Questionnaire.

The consent form had been reviewed and approved by the UCSF Committee on Human Research and the State of California, Committee for the Protection of Human Subjects (see Appendix E). During the interview, the participants were reminded that the interviewer would be sending them a medical release form to be signed and returned to the investigator. Following the interview, participants were reimbursed $25 for their time and inconvenience.

Measures and Instruments

Subjective self-report and objective measures were used in this study. The measures of injury severity (dependent variable) will be explained first, followed by a description of the independent variables.

Measures of Injury Severity and Dependent Variables for the Study

Abbreviated Injury Scale

Injury measurement tools, such as the Abbreviated Injury Scale (AIS), use a numerical method for ranking and comparing injuries by severity. The AIS is essentially a *threat to life* scale. It does not measure chronic injury severity or ability to work or return to work, and in occupational settings, it tends to be restricted to a narrow range of values that cluster toward the lower end of the scale. Additionally, medical documentation related to minor injuries varies greatly among practitioners, which can potentially bias the results of injury scoring even when a full medical record review has been performed (C. Mitchell, personal communication, 1995; Mitchell et al., 1993). Medical record review is required in order to assign an AIS score; however, even adhering to this process, information may still be lacking regarding less severe occupational injuries. Despite the limitations of the AIS, this scoring method was selected since it is the most widely recognized injury scoring tool. A trauma nurse with an advanced degree and experienced in AIS coding, scored all records with the assistance of the investigator. In addition, the investigator attended a coding workshop on the use of the AIS to enable full collaboration in the coding process. Injuries were also coded according to the ICD-9-CM classification system, including the external causes of injury codes (E-codes).

Functional Limitation Associated With Injury

Since quantifying minor occupational injuries has been difficult, a functional limitation score was assigned to each participant utilizing the disability subsection of the Stanford University Health Assessment Questionnaire (HAQ). This assessment tool was selected because it measures overall functional limitation, as well as limitations specific to both upper and lower extremities. The HAQ consists of eight categories of questions and is easy to administer and score (Fries, Spitz, Kraines, & Holman, 1980; Fries, Spitz, & Young, 1982).

The disability index of the HAQ was developed from 62 potential questions, and was administered in over 20 locations to more than 7,000 patients. It consists of 20 questions grouped into eight components: dressing and grooming, arising, eating, walking, reach, personal hygiene, gripping and grasp, and activities. Participants are asked to respond to each item, in terms of their usual ability over the past week, and indicate if they used assistive devices or required support from another person. The disability section of the HAQ can be administered in 5–8 minutes, and manual scoring can be accomplished in 1 minute. The total score is calculated by adding individual scores for each of the categories and dividing by the number of sections answered. Correlations of the HAQ instrument against observed patient performance have ranged from 0.47 to 0.88. Reliability scores of 0.60 to 0.85 were obtained between two methods of administration—interview and self-administered (Brown et al., 1984; Fries et al., 1980; Fries et al., 1982).

The HAQ and the Arthritis Impact Measurement Scale (AIMS), which also measures disability associated with arthritis, were developed at different institutions. In a study evaluating both instruments, they were found to be highly correlated (0.91), and provided convergent validation for the existence of discrete components of health status. Three, quite distinct dimensions of health status surfaced: pain, physical disability, and psychological disability. Together they identify the majority of variance in a factor model (82%). In addition to arthritis patients, these scales have been successfully used with patients presenting with systemic lupus, ankylosing spondylitis, and a number of other chronic diseases (Brown et al., 1984; Goeppinger, Doyle, Charlton, & Lorig, 1988). While this instrument has not been used to measure functional limitations associated with acute injuries, it was chosen for this study because it measures overall functional ability as well as upper and lower extremity abilities. The health and daily activities portion of the Medical Outcomes Study (MOS) 36-Item Short-Form Health Survey (SF-36) also measures functional limitations (Ware & Sherbourne, 1992). The HAQ was selected over the SF-36, however, because it evaluates fine motor limitations as well as gross motor limitations of the upper extremity.

Independent Variables

The independent variables evaluated in this study were: demographics (age); fall-related variables (height of fall and surface landed on); environmental factors (work surface); job activity-related factors (activity at time of injury, carrying an item, and weight of carried item); personal factors (job title, length of time at site, and length of time in trade); employer-related factors (Safety Climate Measure score, project type, size of work group, and union status); and job characterization (Psychological Job Demands score and Decision Latitude score) (see Table 1). A previously developed instrument, the Safety Climate Measure for Construction Sites, was used to measure worker perceptions regarding the attitude and practice of safety in their respective work settings (Dedobbeleer & Beland, 1991; Dedobbeleer, Champagne, & German, 1990). The Job Content Questionnaire (Karasek, Pieper, Schwartz, Fry, & Schrier, 1985; Karasek & Theorell, 1990) was used to evaluate job strain as measured by the Decision Latitude and Psychological Job Demands scales.

Demographic Information

Baseline data collected from the DFR included the participants' name; address; phone number; date of birth; gender; date and time of fall; a summary of the incident in the participants' own words; and the name, address, and telephone number of their medical provider.

Construction-Specific Variables

The Construction Safety Association of Ontario (CSAO) developed a surveillance system to track construction injuries in Ontario, Canada. It has been implemented there for the past 20 years (D. McVittie, personal communication, 1994). CSAO allowed the investigator to use portions of this system for the current study, including employee activity further categorized into three major job activities: work surface, condition of work surface, and project type (see Appendix F for a copy of their approval letter). The individual options within these categories were collapsed into like groups for ease in coding during the interview and to reduce the number of study variables.

Employee activity. Participants were asked to describe exactly what they were doing at the time of their injury. Following an analysis of the this description, a word describing the primary activity was chosen from 84 variables such as walking, hammering, climbing, or pushing. The activity was then categorized according to four major construction activities: in-transit activities, manual material handling, direct installation, and other.

Work surface. Fifty-five commonly encountered work surfaces were divided into six categories. Participants were asked to describe their work surface at the time of injury and this was also coded according to the above categorization. For purposes of analysis, work surface was further collapsed into four categories. Examples include ladder, scaffold, roof, wood skeleton, and pole.

Condition of work surface. Seventeen options describing work surfaces were used, including dark, dusty, rough, slippery, and wet. These words were used for descriptive purposes only.

Project type. Thirty-seven options describing typical construction projects such as commercial building (high-rise), residential building (low-rise), bridge, and sewer and water main, were divided into three categories: residential, commercial, and other.

Job title. The participant's job title was determined from information solicited in the interview questions. Participants with similar job titles were grouped into nine categories for descriptive purposes and six categories for analysis.

Fall-Specific Information

The following single-item questions developed by the National Institute for Occupational Safety and Health (1992), Division of Safety Research, for the investigation of fatal occupational falls, were also used in this study. One variable, surface landed on, was collapsed into five categories for coding purposes. These descriptive questions were asked in order to more fully describe general work practices and the work environment of construction workers. The following forced-choice questions were used from the 1992 version of the National Institute for Occupational Safety and Health Fall Supplement:

1. On what kind of surface did you land? [10 choices]
2. In which direction were you moving just prior to the fall? [7 choices]
3. What type of fall protection devices were being used? [8 choices]
4. What types of fall protection equipment were you wearing? [6 choices]

Safety Climate Measure for Construction Sites

This instrument was modified by Dedobbeleer and Beland (1991) and was based on work by Brown and Holmes (1986) who adapted and revised an eight-factor safety climate instrument initially developed by Zohar (1980). The Brown and Holmes model was a three-factor safety climate model validated in a sample of 425 manufacturing and production employees in Washington and Illinois. Their work did not validate the model developed by Zohar for an Israeli working population, hence they modified the tool. Their final tool included the following three factors: employee perception of the level of concern management had with their well-being, employee perception of how active management was in responding to this concern, and how employees viewed existing physical risk.

Dedobbeleer and Beland (1991) tested their model, adapted for the construction industry, with 384 construction workers—response rate of 71%—on nine nonresidential construction sites located in a large, metropolitan area. Construction sites were limited to new projects or new projects with alterations that were valued at $500,000 or more; they were at various stages of construction ranging from framing to finishing work. Using a maximum likelihood method, the researchers concluded that the Brown and Holmes (1986) model was supported by their data (chi-square = 28.67; $df = 24$; $p = .233$). When they reduced the model from three to two factors, they found that the two-factor model was barely acceptable (chi-square = 36.57; $df = 26$; $p = 0.082$). However, when they tested the two-factor model incorporating the weighted least squares model more appropriate for their data, they determined that the two-factor model ($p = 0.732$) was as efficient as the three-factor adaption in describing safety climate, and was the best fitting model according to the difference between the chi-squares.

While the sample for this current study involves construction workers, it is expected that the population will differ slightly from that of the Dedobbeleer and Beland (1991) study. The workers presented here were involved in either residential or nonresidential projects, in union and nonunion settings, and the budgets may well have been less than $500,000. However, all stages of construction from framing to finishing were considered. The items from this instrument can be found in Appendix G. Several questions of this 10-item scale were modified slightly following the pilot survey due to the difficulty in administering the questions over the telephone. In addition, one question was separated into two, maintaining the response sequencing of the original question.

Job Content Questionnaire

The Job Content Questionnaire (JCQ) evaluates job strain as measured by work demands and control over work situations. The scale has been used extensively in the evaluation of psychological strain and coronary heart disease (Alfredsson, Karasek, & Theorell, 1982; Alfredsson, Spetz, & Theorell, 1985; Karasek, Baker, Marzer, Ahlbom, & Theorell, 1981; Karasek & Theorell, 1990; Karasek et al., 1988; Karasek, Triantis, & Chaudhry, 1982). The questionnaire has been used only once in the evaluation of lower back conditions in the construction industry (Holmstrom, Lindell, & Moritz, 1993). The JCQ was developed using three nationally representative Surveys of Working Conditions also known as the Quality of Employment Surveys supported by the U.S. Department of Labor. The interviews were conducted by the University of Michigan with males, aged 20–65, who worked a minimum of 20 hours in 1969 (N = 993), 1972 (N = 985), and 1977 (N = 968). Factor analyses were conducted to construct scales regarding decision latitude, psychological job demands, and physical exertion. The Decision Latitude scale consists of two equally weighted subscales, Skill Discretion and Decision Authority (Schwartz, Pieper, & Karasek, 1988).

Within-survey reliabilities of the multiple item scales were estimated by Cronbach's alpha coefficient, as well as a pooled measure of within-survey reliability and between-survey consistency. The within-survey reliability ranged from .592 to .847. The between-survey consistency was very high ($\geq$.96). Content validity was conducted by comparing the 1970 census occupation scores for decision latitude and its components to analogous scales from the U.S. Dictionary of Occupational Titles, which are based on direct observation rather than self-report. Correlations were made in the following categories: occupational self-direction (0.76), routineness (-0.53), closeness of supervision (-0.71), functional complexity with people and data (0.51), and physical exertion (0.62). Differences among occupations in job characteristics (i.e., between occupation variance) are high for decision latitude (44.7%) and physical exertion (25.9%), but low for psychological job demands (7.1%) (Karasek et al., 1988; Schwartz et al., 1988).

Procedures and Data Collection

Retrieval of Cases From Doctor's First Reports

Cases were selected from DFRs submitted to the Department of Industrial Relations (DIR), Division of Labor Statistics and Research (DLSR). As a contract employee of the California Department of Health Services (CDHS), Occupational Health Branch (OHB), the investigator had access to the DFRs. Concurrently, DFRs were being used for two other research projects conducted by the OHB; one related to occupational respiratory disease and one to occupational tuberculosis surveillance. A research assistant (RA), trained in manual sorting of DFRs, identified all falls and possible falls in the construction industry for each week the investigator requested. Approximately 3,000 forms are filed with the DIR daily. The RA reviewed all cases for occupational diseases and then re-sorted through the cases to identify construction falls.

To guide the search, the RA was provided with a list of standard industrial codes for the construction industry (Executive Office of the President, Office of Management and Budget, 1987) and for occupations within construction developed by the Bureau of the Census (U.S. Department of Commerce, Bureau of the Census, 1990). Any case possibly related to a construction fall was pulled. The investigator subsequently reviewed all cases in order to identify those meeting the inclusion criteria. The investigator checked the Standard Industrial Classification code for each potential case using a CD-ROM business directory (Phonedisc Business, 1995). For those employers not listed in the directory, the investigator evaluated the company name, industry, and occupation listed on the form, and made a final determination regarding participation status. Cases displaying a construction occupational title but who worked outside the Standard Industrial Classification 15–17 or 8711 were not included. Please refer to Appendix H for a copy of a DFR.

Recruitment of Participants

Prior to mailing the introductory packet of information, the investigator validated all addresses using a zip code directory. Potential participants with seemingly valid addresses were sent a letter, consent form, copy of the consent form, self-addressed stamped envelope, and a refusal postcard. The letter explained the research project and requested their participation (see Appendix E for a copy of the letter). Participants for whom no phone number was listed were mailed the same letter with a supplemental note asking them to call the investigator collect if they had a valid phone number. Approximately one week after receiving this communication, these potential participants were contacted by telephone. The purpose of the study and how the participant was identified were discussed, and an opportunity for questions was provided. The potential participants were then asked if they were willing to participate in a voluntary and confidential 35–45 minute interview.

Upon the initial phone call, if participants were Spanish-speaking, they were referred to the Spanish interviewer and translated packets were mailed to them. This same interviewer made the follow-up phone call approximately one week after the mailing.

Subjects were informed that they had the option to decline answering any question at any time, or withdraw from the interview entirely. They were also informed of the potential benefits of participating such as increased future knowledge of risk factors for injury severity from falling, and who to contact if any questions or concerns arise. If respondents declined participation, no further contact was made. If a participant agreed to be interviewed, an appointment was scheduled and the individual was reminded to sign and return the consent form in the provided envelope.

Interview Format

Data from the DFR was abstracted prior to the initial phone call. Interviews were conducted via telephone using a structured questionnaire. Pertinent information missing from the DFR was collected at this time (e.g., height of fall, actual days lost from work, etc.). Information from the Safety Climate Measure (Dedobbeleer & Beland, 1991), the Job Content Questionnaire (Karasek et al., 1985), and the Health Assessment Questionnaire (Fries et al., 1982) was also collected during the telephone interview. Information was not collected on two devices listed in the HAQ, built-up utensil and chair, since it was unlikely that acutely injured individuals would have used them. One Spanish-speaking and four English-speaking, postgraduate researchers conducted interviews, in addition to the investigator. During the interview, participants were reminded that, if they had not yet returned to work, they would receive a second phone call to determine their return to work date. All interviewers received a thorough orientation to the interview process and were provided a guide to interviewing techniques developed by the University of California, Survey Research Center (1995), Berkeley. Periodic checks of completed questionnaires were conducted to assure that data were being collected correctly.

Pilot Study

Prior to the study, the questionnaire was pilot tested with 12 workers in the construction industry who had sustained a fall at work. They were identified in exactly the same manner as all other participants. The purposes of the pilot study were to evaluate the length and appropriateness of the questionnaire, as well as the recruitment procedures. Following the pilot study, several changes were made to the questionnaire and the recruitment procedures such as deleting questions to shorten the interview time, and the substitution of UCSF stationery for CDHS letterhead.

Access to Fall-Related Medical Records

The request for permission to review medical records was mentioned in the introductory letter, the consent form, and again in the telephone interview. Consent forms were mailed to the participants following the interview. Participants were asked to provide permission for access to their fall-related medical records for several purposes: to classify and code their injuries, and to verify the initial treatment received. Information on the DFRs is frequently sketchy, or the reader is referred to emergency department records or summary notes, which are not submitted to the DIR. In order to correctly classify injury severity, a review of the medical records is preferred due to this frequent lack of information on the DFR. Please see Appendix E for copies of the medical release form in Spanish and English.

Data Management

Data from DFRs, telephone interviews, and injury coding sheets were entered into an IBM-PC data management and analysis system using SPSS, Inc. (1993) software. SPSS combines data entry, analysis, and management in one software package. Primary functions include descriptive statistics, measures of association, scatter diagrams, multiple regression analyses, analysis of variance, and loglinear analysis.

Code Book Development

A code book was developed and provided to all interviewers to assist with data abstraction and questionnaire completion. The investigator checked all data for coding consistency prior to data entry.

Data Analyses

Descriptive Statistics: Injury Severity

Descriptive statistics (i.e., means, standard deviations, and minimum and maximum values) provided a profile of the injured workers, the severity of their injuries, and their functional limitations. A combination of categorical, nominal, and continuous independent variables were evaluated for their relationship with injury severity, the dependent variable. Nominal variables such as job activity, job title, and project type were divided into like groups for coding. Cases were categorized according to group membership within these nominal categories.

Analytic Statistics: Injury Severity

Correlational measures were used to describe relationships between risk factors of interest and injury severity. When multilevel categories were being analyzed, such as project type or job activity, analysis of variance was used to determine eta^2—the percent of variance in the dependent variable explained by the independent variable. When a dichotomous independent variable was used, the point biserial r was used, and when the independent variable was continuous, the Pearson Product Moment r was used. Associations were examined for direction, size, and significance. Individual correlations among the risk factors were reviewed for the presence of multicollinearity in areas where this may have occurred, such as in the relationship between height of fall and work surface. Reliability coefficients (i.e., Cronbach's alpha) were determined on appropriate instruments. Injury severity and functional limitation scores were evaluated to determine if they were normally distributed. Statistical significance for all tests was set at $p < .05$.

For the multiple regression model, injury severity, as measured by the functional limitation score (HAQ), was the dependent variable. The independent variables used in the model were selected *a priori*. A hierarchical multiple regression had originally been proposed to evaluate the relative contribution of the following independent variables to injury severity: demographic, fall-related, environmental, job activity-related, employer-related, personal, and job characterization. This method of analysis was not used because only five of the independent variables indicated statistically significant, single-order correlations with the dependent variable. Had the hierarchical multiple regression been performed, the following procedures would have been implemented:

(a) fall-related variables were to have been entered into the model to determine the effect of height and surface landed on; (b) the demographic variable, age, would have been entered into the model to control for its effect; (c) personal factors (job title, length of time at site, and length of time in trade) would have been entered into the equation in the third step; and followed by (d) job activity-related factors (job activity); (e) employer-related variables (Safety Climate Measure score, project type, size of work group, and union status); (f) Psychological Job Demands and Decision Latitude scores; and lastly (g) environmental factors (work surface).

Because there were fewer than anticipated statistically significant, single-order correlations between the dependent variable (HAQ score) and the independent variables, a simultaneous-entry, multiple regression procedure was implemented. The following quantitative or dichotomous independent variables were entered into the multiple regression model: height of fall, surface landed on, union status, and Safety Climate Measure score. The categorical variable, work surface, had four levels: ladder, roof, other, and ground. Work surface was represented in the multiple regression by a set of three dummy-coded variables: Surface 1, Surface 2, and Surface 3, with *ground* serving as the reference category.

Descriptive and Analytic Statistics: Disability

Descriptive statistics were used to summarize case demographic information and disability outcome measured as lost time from work. The t test was used to evaluate the statistical significance of differences in means for the descriptive data. In this situation, work disability was the continuous dependent variable, and injury severity was the continuous independent variable. To test the hypothesis that the occupational injury severity score has predictive validity, simple linear regression was used to evaluate the relationship between injury severity and lost time from work.

Sample Size Estimates and Power Analysis

Assuming that the demographic, age, fall-related, environmental, job-activity-related, personal, and employer-related variables, as well as job characterization, would have accounted for 28% of the explained variance in injury severity, a sample size of approximately 250 individuals was needed in order to identify an individual contribution of 3% of the variance from a single item. This number was determined using a very conservative estimate of effect size. These calculations assume an alpha of 0.05 and a beta of 0.20 (S. Paul, personal communication, 1995).

CHAPTER FOUR

RESULTS

Introduction

This chapter presents the results of a study focused on predictors of injury severity in construction workers who sustained a work-related, nonfatal fall. An overview of acceptance and refusal rates is initially presented, followed by a description of the study population. Reliability testing of the instruments used to measure independent variables is then analyzed and an overview of the injury and disability experience of the sample is described. Finally, using multivariate analysis, the statistically significant relationships between independent variables and the dependent variable (i.e., functional limitation as measured by the Health Assessment Questionnaire [HAQ] scores) are examined, as well as the linear relationship between functional limitation and lost time from work.

Study Population

Acceptance and Refusal Rates

A total of 628 potential participants were identified as meeting the inclusion criteria for this study. Of these, 259 participated in the study; 185 could not be reached and 171 declined to participate. Sixteen participants were excluded from participation following the initial contact, and four withdrew from the study after completing all or part of the interview. The final number of participants totaled 255. The overall participation rate was 60%, taking into account the final number of participants and those who refused.

The response rate of women in the sample (*n* = 7) was 100%. Twenty percent of the sample (*n* = 52) were interviewed in Spanish.

Forty-five people (26% of the refusals) signed and returned a postcard declining to participate; therefore, the reason for their refusal is unknown. The most frequent reasons given by those declining participation upon the initial phone contact were (a) not interested (*n* = 53; 31%) and (b) too busy or too tired (*n* = 29; 17%). Some were afraid of losing their job (*n* = 8; 4%) or were advised against participating by their attorney or another advisor (*n* = 7; 4%). In the *lost to follow up* category, 124 (67%) could not be reached due to incorrect or disconnected phone numbers, and another 28 (15%) were never reached despite numerous attempts. Additionally, 22 (12%) agreed to participate and/or returned consent forms, but subsequently could not be located.

Sixteen individuals, appearing to meet inclusion criteria, were sent letters and received telephone calls. Upon initial contact, it was determined that they, in fact, did not meet the inclusion criteria completely and they were excluded from participation. Reasons for exclusion included the following: injury event was not a fall or the fall occurred more than 2 months prior to case retrieval (*n* = 7; 44%), language spoken was not English or Spanish (*n* = 5; 31%), or the injury did not occur within the construction industry or other reasons (*n* = 4; 25%).

Demographic Characteristics

Demographic characteristics of the sample are presented in Table 2. The mean age of the sample was 34.6 years (standard deviation [SD] = 9.31) with minimum and maximum values of 18 years to 69 years. There were 248 males (97%) and 7 females

Table 2

Demographic Characteristics of Participants

Characteristic	*N*	Percent
Age distribution	255	100
18–24 years	31	12
25–29	50	20
30–34	62	24
35–39	43	17
40–44	31	12
45–49	17	7
50–54	11	4
55+	10	4
Gender	255	100
Male	248	97
Female	7	3
Marital status	255	100
Married/long term relationship	144	56
Never married	69	27
Divorced/Separated	41	16
Widowed	1	< 1
Ethnicity	255	100
White	151	59
Hispanic	83	32
Black	7	3
Multiracial/Other	7	3
Native American	5	2
Asian/Pacific Islander	2	< 1

(3%). The predominant ethnic group was White (59%); other ethnic groups represented were Hispanic (32%), Black (3%), Multiracial/Other (3%), Native American (2%), and Asian/Pacific Islander (< 1%). Table 3 compares the ethnic distribution of individuals employed in construction trade occupations in California with those in the current study. While Whites, Blacks, Hispanics, and Native Americans were adequately represented in this study, Asians and Pacific Islanders are underrepresented (State of California, Employment Development Department, Labor Market Information Division, 1990). Over half the sample was married or involved in a long-term relationship (56%); 27% had never been married; and 17% were divorced, separated, or widowed.

The average number of years employed within the construction industry was 11.79 (SD = 9.10), and the average number of years in their current trade was 8.79 (SD = 8.21). The mean length of formal education (i.e., high school and college) was 11.84 years (SD = 2.82); 78 participants (30%) also attended some trade school (mean 2.36 years; SD = 3.30). Using analysis of variance (ANOVA) and the Scheffé pairwise comparison (Munro, Visintainer, & Page, 1986), a statistically significant difference in mean number of years of education was identified between ethnic groups ($F_{(2, 250)} = 37.73$; $p = < .001$). The mean number of years of education, including high school and college, for Whites was 12.75 (SD = 1.49), 9.88 for Hispanics (SD = 3.68), and 12.95 for Others (SD = 2.39). Data regarding education and experience can be found in Table 4.

The most frequently represented occupation was carpenters (n = 54; 21%); followed by laborers (n = 42; 16%); roofers (n = 31; 12%); painters (n = 22; 9%); drywallers, tapers, and lathers (n = 20; 8%); plumbers and pipefitters (n = 16; 6%); ironworkers and welders (n = 14; 6%); and plasterers (n = 6; 2%). Compared to total

Table 3

Ethnic Distribution of Persons Employed in Construction Trade Occupations in California and in the Current Study

Race/Ethnicity	% Current study	% Construction trades in California*
White	59	57
Hispanic	32	30
Black	3	4
Asian/Pacific Islander	< 1	7
Native American	2	< 1

Note. * State of California, Employment Development Department, Labor Market Information Division, 1990.

Table 4

Education and Work Experience of Participants (N = 255)

	Mean	SD	Min	Max	Number (%)
Years in construction	11.79	9.10	< 1	46	255 (100)
Years in trade	8.79	8.21	< 1	46	254 (100)
Education in years (high school & college)	11.84	2.82	2	18	254 (100)
Education in years (trade school)	2.36	1.35	.2	5	78 (30)
Total education in years	12.57	3.30	2	20	255 (100)

Note. SD = standard deviation, Min = minimum, Max = maximum.

employment figures for California for construction-specific trades (see Table 5), drywallers, tapers and lathers, structural metal workers, and roofers were overrepresented in the sample, while electricians and plumbers were underrepresented. No statewide information was available for the construction laborer job category, thus no comparisons can be made for this group (State of California, Employment Development Department, Labor Market Information Division, 1996).

Demographic characteristics related to the circumstances surrounding the falls can be found in Table 6. Falls occurred equally throughout the week, although 32% of the incidents took place between 10:00 a.m. and 12 p.m. Most of the events involved falling to a lower level (74%). Thirty-eight percent of the falls occurred while moving forward or backward, 32% while moving up or down. Almost half of the sample (46%) were involved in direct installation activities when they fell, and almost all were performing their usual duties (91%). The most frequently reported specific activity being performed at the time of the fall was walking (22%), followed by descending (11%), and climbing (10%). Standing, reaching, and pulling accounted for 12% of the activities.

The average height of the fall was 9.23 feet (SD = 7.05) with a range of 35.5 feet, and participants were carrying an average of 20 pounds, which included the weight of tool bags (see Table 7). Thirty-eight participants fell from heights of 15 feet or more, a height at which fall protection is mandated in most situations. The proposed standard requires fall protection for workers at heights of 6 feet or more under specific conditions (U.S. Department of Labor, Occupational Safety and Health Administration, 1994). At the time of their injury, participants had worked an average of 59.55 days (SD = 181.46) at the site of the incident. The median time at the site was 10 days. Several participants in the study

Table 5

Number Employed in Specific Construction Occupations in California (N = 273,250) Compared to Number Employed in Specific Occupations in Current Study (N = 255)

	Annual average employment (1993) [*]	% of total in California	N current study	% current study
Carpenters	59,920	22	54	21
Drywallers, tapers, lathers	15,200	6	20	8
Electricians	38,220	14	12	5
Painters, paperhangers	25,360	9	22	9
Plasterers, stucco masons	4,790	2	6	2
Plumbers, pipefitters, steamfitters	25,350	9	16	6
Roofers	11,890	4	31	12
Structural metal workers	2,310	< 1	14	6

Note. [*]State of California, Employment Development Department, Labor Market Information Division, 1996.

Table 6

Demographic Characteristics Regarding the Circumstances Surrounding the Falls

Characteristic	*N*	Percent
Day of week	255	100
Monday	55	22
Tuesday	47	18
Wednesday	49	19
Thursday	43	17
Friday	48	19
Saturday/Sunday	13	5
Time of fall	254	100
6:00 a.m.–8:59 a.m.	36	14
9:00 a.m.–11:59 a.m.	115	45
12:00 p.m.–2:59 p.m.	69	27
3:00 p.m.–5:59 p.m.	32	12
Other times	2	< 1
Type of fall	255	100
Fall to lower level	189	74
Fall on same level	55	22
Stairs/Steps	6	2
Tumble, slide	5	2
Direction moving just prior to fall	254	100
Forward/Backward	98	38
Up/Down	82	32
Other/Unknown	40	16
Sideways	34	13

(table continues)

Characteristic	*N*	Percent
Overall activity at time of fall	255	100
Direct installation	118	46
In-transit	74	29
Manual materials handling	61	24
Other/Unknown	2	< 1
Specific activity at time of fall	255	100
Walking	57	22
Descending	28	11
Climbing	26	10
Standing	11	4
Pulling	10	4
Reaching	10	4
Other	113	44
Surface working from	255	100
Ladder/Scaffold/Platform	105	41
Roof/Steel or wood skeleton	61	24
Ground/Floor	70	28
Pole/Wall/Tree	7	3
Equipment/Vehicle	10	4
Trench/Ditch/Hole	2	1
Surface landed on	255	100
Concrete/Asphalt/Rock	127	50
Packed dirt/Wood/Tile/Carpeted floor	95	37
Loose soil	14	5
Other	11	4
Boxes/Objects/Work materials	8	3

Table 7

Height of Fall, Hours Worked, and Weight Carried at Time of Fall

	Mean	SD	Median	Min	Max	N (%)
Height of fall	9.23	7.05	7.00	.5	40	255 (100)
Time at site at time of injury (days)	59.95	181.46	10	1	1813	253 (99)
Hours worked at time of fall	4.07	2.48	4.00	< 1	10	254 (99.6)
Weight carried at time of fall (pounds)*	20.45	21.76	15.00	.25	102.00	180 (70)

Note. * Includes weight of tool bags worn or carried. SD = standard deviation, Min = minimum, Max = maximum.

worked for extended periods of time at the same site (i.e., 3–7 years), and these values were considered outliers. Over 100 workers (44%) had worked 5 days or less at the site of injury when they fell.

Workers who fell from a height, fell most often from ladders, scaffolds, or planks (41%), followed by roofs and wood skeletons (24%). Same-level falls comprised 28% of the sample. Half of the sample (50%) landed on concrete, asphalt, or rock surfaces. Unfavorable work surface conditions were frequently reported (see Table 8). Thirty-five percent of the workers stated that the work surface from which they fell was slippery. Other conditions included, steep (28%), wet (23%), rough or uneven (22%), dirty (21%), and unprotected (20%)surfaces. When asked if there were other words to describe the condition of their work surface, participants used terms such as dry, dusty, oily, gravelly, leaf covered, and unmarked.

Participants tended to work in small groups (mean = 3.13 workers; SD = 2.61); at sites with few workers (mean = 7.52 workers; SD = 13.02); and for small to midsize employers (mean number of employees = 58.48; SD = 142.56; median = 15). Twenty-seven percent of the participants were union workers, and the majority worked in residential construction (54%) (see Table 9). Nationwide, approximately 23% of skilled trade workers, including construction workers, are unionized (U.S. Department of Labor, Bureau of Labor Statistics, 1996).

Injury and Disability Status

Injury data and disability-related characteristics of the participants can be found in Table 10, Figure 1, and Figure 2. The Injury Severity Score(s) (ISS) was, on average,

Table 8

Percent of Sample Reporting Unfavorable Work Surface Conditions (N = 255)

Condition	N	Percent
Slippery	89	35
Other condition	74	29
Steep	72	28
Wet	58	23
Rough/Uneven	55	22
Dirty	54	21
Unprotected	52	20
Unstable	44	17
Narrow	44	17
Confined	36	14
Sandy	35	13
Unshored	35	13
Defective	32	12
Littered	23	9
Muddy	22	9
Dark	11	4
Ice-covered	3	1

Table 9

Employer and Site-Related Characteristics

Characteristic	Mean	SD	Median	Minimum	Maximum	*N* (%)
Number of employees in company	58.48	142.65	15	2	1200	240 (94)
Number of employees at site	7.52	13.02	4	1	100	254 (100)
Number of employees in group	3.13	2.61	2	1	25	255 (100)
Union status						255 (100)
Nonunion site						186 (73)
Union site						69 (27)
Project type						255 (100)
Residential						139 (54)
Commercial						88 (34)
Other						28 (11)

Note. SD = standard deviation.

Table 10

Injury and Disability-Related Characteristics of Participants

	Mean	SD	Median	Minimum	Maximum	*N* (%)
Time between injury and interview (days)	72.93	26.62	69.00	20	196	255 (100)
Number of injuries per event	2.04	1.28	2.00	1	8	255 (100)
Injury severity scores (ISS)	3.18	3.00	2.00	1	22	255 (100)
Functional limitation score (HAQ)	1.46	.75	1.38	0	3	255 (100)
Days lost from work (all participants)*	44.3	58.6	10.0	0	224	255 (100)
Days lost from work (not yet returned to work)	158.2	39.6	166	53	224	26 (10)
Return to work status						189 (74)
Light or modified duty						97 (51)
Full duty						92 (49)
Hospitalized						32 (12)
Required surgery						41 (16)
Prior history of injury at work						151 (60)
Prior history of a "near miss" fall						169 (67)

Note. * Includes 26 participants not yet back to work at the completion of the study and 4 lost to follow up. HAQ = Health Assessment Questionnaire, SD = standard deviation, Min = minimum, Max = maximum.

Figure 1

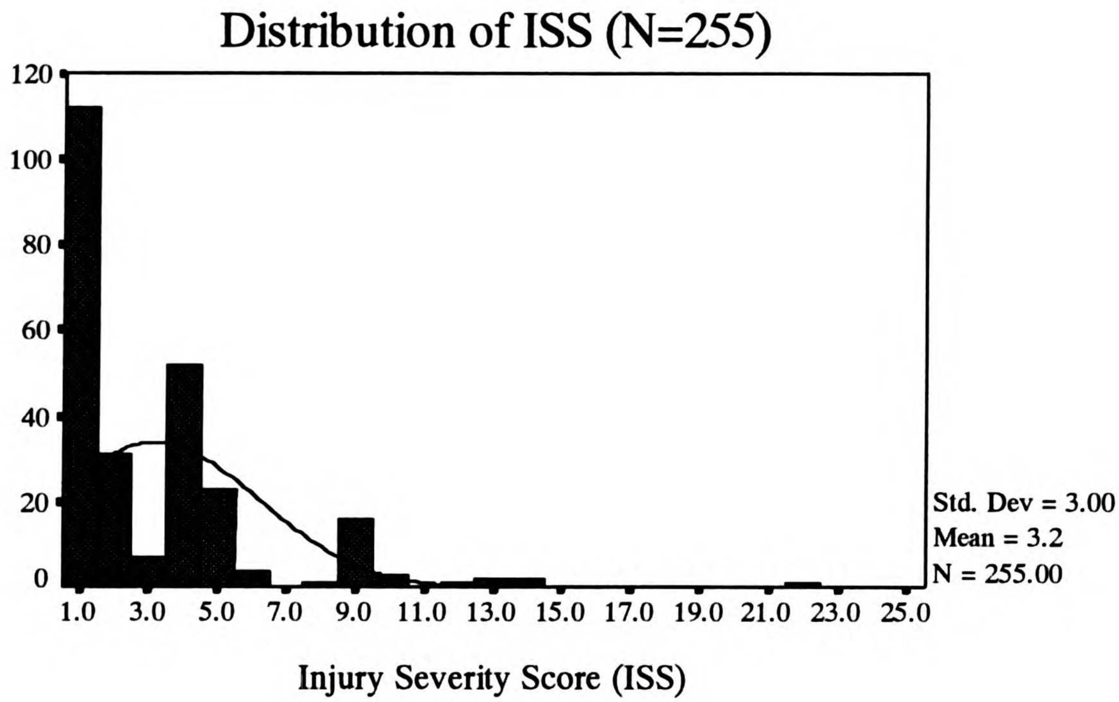
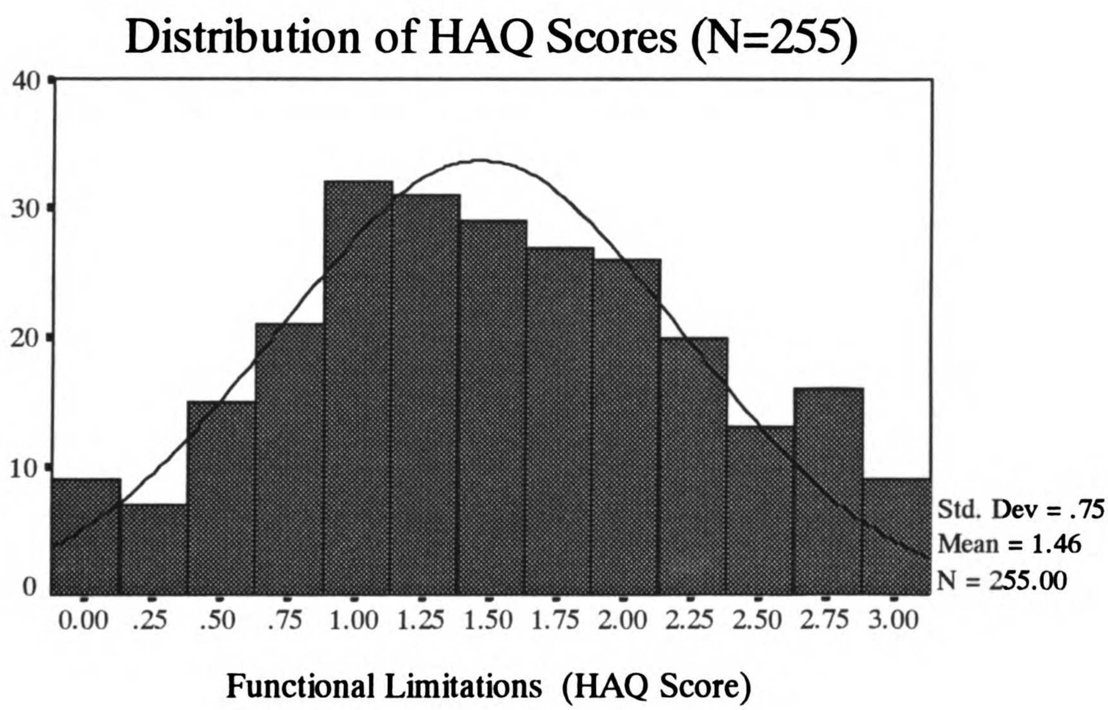


Figure 2



3.18 (SD = 3.00; median = 2.00) on an ordinal scale from 1 to 75. The highest ISS was 22. The scores were clustered toward the lower end of the scale, with 112 injuries (43%) receiving a score of 1. A wide range of injuries, with varying effects on ability to work, received an ISS of 1 including lumbosacral strain, cervical strain, simple fracture of the finger, tendon laceration, contusions, and abrasions.

The mean functional limitation, as measured by the HAQ score, was 1.46 (SD = 0.75) on a scale of 0 to 3, with higher numbers representing more limited functioning. The median HAQ score was 1.38. The mean HAQ score for those who fell from heights 15 feet or greater was 1.90 (SD = .77), and the mean ISS was 5.55 (SD = 4.04). Using ANOVA, a statistically significant difference in mean HAQ scores and ISS was identified between those who fell from 15 feet or greater and those who fell from heights less than 15 feet (HAQ: [$F_{(1, 253)} = 16.35$; $p = < .001$]; ISS: [$F_{(1, 253)} = 31.19$; $p = < .001$]).

The mean number of injuries per event was 2.04 (SD = 1.28) with a maximum of eight. Thirty-two participants required hospitalization (12%) and 41 required surgery (16%). Almost two thirds of the participants reported a prior work-related injury (*n* = 151; 60%), and more than two thirds reported prior history of a "near miss" or "close call" where they *almost* fell (*n* = 169; 67%). A slip, trip, or fall was cited by 50 workers as the cause of prior injury. Some earlier injuries, not necessarily from falls, were quite severe, requiring extensive surgery for head and eye injuries and repair of fractures. Comments related to "near miss" experiences included "hundreds of times," "everyone has," "it's common," or "plenty of times." Participants described slipping and tripping (43 incidents), and losing balance, footing, or grip (22 incidents) as causes of their near misses.

Days lost from work was calculated as work days, not as calendar days, with a 5-day work week as the standard. There was some discrepancy in how participants reported days lost from work when the length of time was 8 hours or less. Some reported time lost as one day, some as one half day, and others as no lost time, even if they missed 7 hours of work. For consistency, cases were classified using the following decision rules: (a) If participants lost 4 or more hours of work, they were classified as having lost one day; (b) if participants lost less than 4 hours of work, they were classified as having no lost time.

Participants, on average, lost 44.3 days from work (SD = 58.6), or approximately 2 months, as a result of their injuries. The median number of lost work days was 10, or 2 weeks. At the completion of the study, 26 participants had not yet returned to work, and four were lost to follow up. Days lost from work for these 26 individuals was calculated as the number of days between the time of injury and a predetermined date in June 1996. For those lost to follow up, days lost from work was determined to be the time interval between their injury and the interview date. This resulted in an underestimate of the actual time lost for these four cases. The mean number of days lost from work for the 26 participants who had still not returned was 158 days (SD = 39.6) with a median of 166 days. For those who answered the question, "Did you return to light or modified, or full duty?" (*n* = 189), 51% (*n* = 96) reported that they were able to return to light or modified duty for periods of time from 1 day to 6 weeks.

Data regarding differences in injury severity and functional limitation between the trades can be found in Table 11. The highest ISS were found in ironworkers (mean = 4.36; SD = 4.14) and roofers (mean = 4.16; SD = 4.00); the lowest were identified in laborers (mean = 2.33; SD = 2.55) and plumbers and pipefitters (mean = 2.91; SD = 2.78). The highest functional limitation scores (HAQ), indicating poorer functioning, were reported by drywallers, lathers, and plasterers (mean = 1.71; SD = 0.75), as well as ironworkers (mean = 1.53; SD = 0.61). The lowest were seen in plumbers and pipefitters (mean = 1.26; SD = 0.83) and electricians (mean = 1.03; SD = 0.64). Ironworkers fell from the highest levels (mean height = 16.67 feet; SD = 11.16), followed by roofers (mean height = 9.66 feet; SD = 6.01), while plumbers fell from an average height of 5.29 feet (SD = 4.78). Drywallers, lathers, and plasterers experienced the most lost time from work (mean = 59 days; SD = 70), followed by roofers (mean = 58 days; SD = 64) and painters (mean = 54 days; SD = 60). Trades experiencing the least numbers of lost work days were plumbers and pipefitters (mean = 21 days; SD = 29) and electricians (mean = 8 days; SD = 11). There were no statistically significant differences of the means among groups with regard to ISS and HAQ scores, or to days lost from work.

Participants differed from nonparticipants in several ways (see Table 12). The mean age of those who refused participation in the study (37.22 years; SD = 9.94) was statistically significantly greater than either the participants or those lost to follow up ($p = .002$; Scheffé method of post hoc comparisons). The mean ISS of the participants (3.18; SD = 3.00) was statistically significantly higher than either the ISS of the refusals or

Table 11

Job Group, Mean Functional Limitation Score (HAQ), Mean Injury Severity Score, Mean Height of Fall, and Mean Number of Lost Days From Work.

Job group	*N*	HAQ	*ISS*	*N* of injury diagnoses (SD)	*N* (% fell from a height)	Height of fall (SD)	Days lost from work (SD)
Carpenters	54	1.45 (0.68)	3.02 (2.65)	2.04 (1.21)	44 (82)	9.65 (5.89)	44 (56)
Drywallers, lathers, plasterers	26	1.71 (0.75)	3.65 (2.74)	2.31 (1.46)	22 (85)	9.28 (7.06)	59 (70)
Electricians	12	1.03 (0.64)	3.42 (3.63)	2.00 (1.48)	12 (100)	5.29 (4.78)	8 (11)
Ironworkers, welders	14	1.53 (0.61)	4.36 (4.14)	2.29 (1.38)	9 (64)	16.67 (11.16)	44 (63)
Laborers	42	1.50 (0.86)	2.33 (2.55)	1.69 (1.09)	24 (57)	8.79 (9.14)	38 (58)
Painters	22	1.48 (0.77)	2.91 (2.41)	1.86 (0.88)	19 (86)	9.63 (7.41)	54 (60)
Plumbers, pipefitters	16	1.26 (0.83)	2.56 (2.78)	2.12 (1.45)	9 (56)	7.44 (4.50)	21 (29)
Roofers	31	1.48 (0.80)	4.16 (4.00)	2.26 (1.61)	28 (90)	9.66 (6.01)	58 (64)
Other	38	1.41 (0.71)	3.16 (2.73)	2.05 (1.14)	28 (74)	8.05 (6.24)	45 (62)
All trades combined	255	1.46 (0.75)	3.18 (3.00)	2.04 (1.28)	195 (76)	9.23 (7.05)	44 (59)

Note. HAQ = Health Assessment Questionnaire, ISS = Injury Severity Score, SD = standard deviation.

Table 12

Demographic and Injury Severity Characteristics of Participants (N = 255) and Nonparticipants
(Refusals: N = 171 and Lost: N = 185)

Characteristic	Participants	N	Refusals	N	Lost	N
Mean age (SD)*	34.6 (9.31)	255	37.22 (9.94)	166	33.8 (9.40)	180
Percent Northern California location	70%	255	71%	171	64%	185
Mean Injury Severity Score (ISS) (SD)**	3.18† (3.00)	255	2.57‡ (1.99)	159	2.27‡ (2.06)	177
ISS (minimum-maximum scores)	1–22†	255	1–9‡	159	1–14‡	177
E-Codes		255		168		183
Percent falls from ladder (881.0)	22%	57	20%	34	28%	52
Percent falls from scaffolds (881.1)	8%	21	10%	18	10%	18
Percent falls from roofs (882)***	23%	58	16%	27	13%	24
Percent slip, trip, stumble (885)	24%	63	30%	52	26%	48

Note. *p = .002 (Scheffe test): refusal group older as compared to both participants and those lost to follow up. **p = .001 Scheffe test): mean participant ISS higher as compared to both refusals and those lost to follow up. ***p = .008 (Chi-square): percent falling from roofs higher for participants than those lost to follow up. † = 20% coded from DFR only. ‡ = 100% coded from DFR only. SD = standard deviation, DFR = Doctor's First Report.

those lost to follow up ($p = .001$; Scheffé method of post hoc comparisons). In addition, participants were more likely to have fallen from roofs than those lost to follow up ($p = .008$; $df = 1$; chi-square). The higher ISS of the participants, combined with the surface from which they fell, suggests they may have been more seriously injured than the nonparticipants.

All injuries were coded with External Cause of Injury Codes (E-Codes) and International Classification of Disease (ICD)-9 codes (see Tables 13 and 14). Review of participant medical records and Doctor's First Report (DFR) revealed that 518 injuries were sustained as a result of the 255 falls. As mentioned earlier, this figure is likely to be an underestimate due to the inconsistent manner in which minor injuries are reported. For example, some physicians meticulously reported each contusion and abrasion, while many others seemed to report only the major injuries sustained. Each injury that received an ICD-9 code was counted as an injury. If, for example, a physician documented "multiple contusions," one ICD-9 code was assigned to that group of injuries. If, on the other hand, a physician documented three contusions, and three ICD-9 codes were able to be assigned, that patient was determined to have three injuries. Rib fractures were given one ICD-9 code, regardless of the number of ribs fractured; therefore, if an individual sustained four rib fractures, only one injury would have been assigned to that participant.

The highest number of injuries were seen in the category of spinal sprains and strains ($n = 99$), followed by lower extremity sprains and strains ($n = 50$); trunk, abdomen, and back contusions ($n = 42$); and upper extremity fractures ($n = 40$). Complete medical records were reviewed for 80% of the cases. Medical records were unavailable for the

Table 13

Description of Fall by External Cause of Injury Codes (*N* = 255)

Description (E-Code)	*N*	Percent
Fall on same level from slip, trip, stumble (885)	63	25
Fall from roof or out of building (882)	58	23
Fall from ladder (881.0)	57	22
Other fall from one level to another (884.9)	24	9
Fall from scaffold (881.1)	21	8
Fall into hole or other opening (883.0–883.9)	14	5
Fall from stairs/steps (880.9)	6	2
Struck by falling object, struck against, or struck accidentally by objects or persons (916–917)	6	2
Fall from stationary machinery (919.2–919.7)	3	1
Fall from motor vehicle (824.0–824.9)	2	< 1
Other, unspecified fall (888)	1	< 1

Table 14

Description of Injuries by ICD-9 Codes (*n* = 518 injuries)

Description (ICD-9 Code)	Number	Percent
Spinal sprains and strains (846.0–848.8)	99	19
Lower extremity sprains and strains (843.0–845.19)	50	10
Trunk, abdomen, and back contusions (922.1–922.9)	42	8
Upper extremity fractures (812.09–817.1)	40	8
Upper extremity contusions (923.0–923.9)	37	7
Lower extremity contusions (924.00–924.9)	37	7
Abrasions (910.0–919.0)	36	7
Upper extremity sprains and strains (840.0–842.10)	33	6
Open wounds, UE and LE, including tendon & nerve lacerations (880.02–891.0)	24	5
Open wounds, head and face (872.01–873.63)	22	4
Lower extremity fractures (822.0–825.35)	21	4
Facial, head contusions (920–921.0)	15	3
Head injuries (850.0–854.01)	14	3
Dislocations, all sites (831.00–839.41)	13	2
Rib fractures (807.01–807.06, 29 fractures total)	9	2
Injuries to nerves (953.0–956.0)	7	1
Contusion, lacerations to internal organs (860.4–866.1)	6	1
Skull and facial fractures (801.0–803.0)	5	1
Spinal fractures (805.07–806.09)	5	1
Pelvic, clavicle, and scapula fractures (808.2–811.00)	3	< 1

Note. ICD = International Classification of Disease, UE = upper extremity, LE = lower extremity.

remaining 20% (*n* = 50) due to (a) participant refusal and/or failure to return medical release forms (*n* = 43; 86%), and (b) medical provider failure to submit medical records (*n* = 7; 14%). These cases were coded for injury severity, external cause of injury, and type of injury by using the DFR alone. In order to ascertain the appropriateness of coding solely from DFRs, 55 case records (10 pilot cases and 45 study cases) were coded first, using only the DFR, and again using the complete medical record. There was 70% agreement between the ISS calculated from the DFR alone and those from available medical records. The DFR scores that were not in agreement with the medical record scores were all lower than the ISS calculated after medical record review. Therefore, it is assumed that very few, if any, of the ISS calculated from the DFR alone, overestimated the ISS. It is estimated that the DFR method of scoring most likely underestimated approximately 15 of the ISS in the study.

Dimensions of Disability

Short-Term Disability

Participants were asked to describe their ability to complete certain activities during the first week following their fall (HAQ). As mentioned earlier, the overall mean score for all activities was 1.46 (SD = .75). With regard to individual tasks (see Table 15), participants reported having the most difficulty performing heavy chores (mean = 1.89; SD = 1.02), followed by dressing themselves (mean = 1.54; SD = 1.05), bending and picking up clothing from the floor (mean = 1.40; SD = 1.02), and taking a tub bath (mean = 1.38; SD = 1.08). Tasks which caused the least difficulty were opening car doors (mean = .62; SD = .96), turning faucets on and off (mean = .34; SD = .72), and

Table 15

Functional Limitation (HAQ) by Task During the First Week Following the Fall (N = 255, Except Where Indicated)*

Task	Mean	SD	% Unable to do or do with much difficulty
Heavy chores (N = 253)	1.89	1.02	60
Dress self	1.54	1.05	48
Bend, pick up clothes from floor	1.40	1.02	40
Take a tub bath (N = 251)	1.38	1.08	43
Wash/Dry entire body	1.34	.95	41
Reach/Get a 5-pound object from just above head	1.33	1.08	38
Run errands/shop	1.31	1.06	36
Get in/out of bed	1.27	.89	41
Get in/out of car	1.26	.86	39
Climb up five stairs	1.25	1.07	41
Stand up from a straight chair	1.25	.98	38
Shampoo hair	1.06	1.08	32
Walk on flat ground	.91	.96	26
Cut meat	.78	1.12	24
Open car doors (N = 254)	.62	.96	17
Turn faucets on/off	.34	.72	9
Lift full glass to mouth	.31	.71	7

Note. *Scoring: 0 = no difficulty; 1 = some difficulty; 2 = much difficulty; 3 = unable to do. HAQ = Health Assessment Questionnaire, SD = standard deviation.

lifting a full cup or glass (mean = .31; SD = .71). At least one third of the participants reported either inability to complete the following tasks or great difficulty in accomplishing them: run errands and shop, stand up from a straight chair with no arms, reach and get a 5-pound object from just above their head, get in and out of a car, bend and pick up clothing from the floor, wash and dry their entire body, climb up five stairs, get in and out of bed, take a tub bath, dress themselves, or perform heavy chores.

Long-Term Disability or Absence From Work

By the completion of the study, 17 individuals (7% of total sample) were determined to be physically unable to return to construction work (see Table 16). For this study, they were determined to be permanently disabled if they had been told by their physician that they were unable to return to construction work and/or if they had plans to receive vocational rehabilitation following their injury. The ISS of the 17 workers unable to return to work ranged from 1 to 22 (mean score = 6.06; SD = 5.38), and their HAQ scores ranged from 1 to 3 (mean score = 2.13; SD = .68). Another 21 participants (8% of total sample) had not yet returned to work, but still considered themselves to be temporarily disabled, despite the fact that several mentioned the possibility of later entering vocational rehabilitation. Five people voluntarily switched to another career as a result of their fall, and one quit his position because he was unable to adequately perform his job. At the time of the interview, some participants (*n* = 7) had not yet been able to locate work after being released for work by their physicians. It is unknown how many of these workers ultimately returned to their trades. In addition, five workers were fired or

Table 16

Reasons for Not Returning to Work*

Reason	*N*	% Sample
Unable to work, temporary disability	21	8
Unable to work, permanent disability	17	7
Other	12	5
Fired/Threatened with dismissal	5	
Switch to another career	5	
Quit, unable to continue in job	1	
Other	2	
No work available	7	3
Total unable/chose not to return to construction work	27	10
Total (at completion of study)	57	23%

Note. * In addition, 10 workers were laid off or fired *after* return to work, per participant report at time of interview.

threatened with dismissal before they were able to return to work, and another 10 were laid off or fired following their return.

Missing Data

Individual items that participants declined to answer were handled in the following manner. Missing values from items on the Safety Climate Measure (20 items; only 0.78% of all possible responses) were replaced with the mean value for that item as calculated for all study participants. It was not possible to substitute values from the mean value from each individual's responses because the items were not equally weighted across scales. Missing values from items in the Job Content Questionnaire (JCQ) were left as missing and omitted from final analyses causing the sample size to vary slightly.

Reliability Testing

Because the reliability of an instrument is dependent on the sample to which it is administered (Polit & Hungler, 1991), reliability coefficients were determined for four subscales of the JCQ (see Table 17) and the Safety Climate Measure. The Cronbach's alpha coefficients for the subscales of the JCQ ranged from 0.57 to 0.82. Except for the Skill Discretion subscale, these levels were comparable to those reported by Karasek and Theorell (1990). The reliability score for the Skill Discretion subscale seemed to be affected by one question asking if the participant's job involved a lot of repetitive work. A lack of repetitive work is thought to contribute to a high level of skill discretion. In this sample of construction workers, 94% of them reported performing a large amount of repetitive work, suggesting limited variability in this item for this sample. Had this one

Table 17

A Comparison of Reliability Assessment (Cronbach's Alpha) of Four Scales of the Job Content Questionnaire

		Karasek & Theorell (1990)		Current study	
	# Items	*n* (Men)	Alpha	*n*	Alpha
Decision Latitude	9	2946	.78	250	.72
Skill Discretion	6	2946	.74	254	.57
Decision Authority	3	2946	.70	251	.70
Psychological Job Demands	5	2946	.59	253	.68
Social Support	8	2946	.83	249	.82

item been deleted from the subscale, the overall alpha would have been 0.71. The Cronbach's alpha coefficient for the 10-item Safety Climate Measure was 0.78.

Dimensions of Participant Perception of Job Safety

The Safety Climate Measure analyzed worker perception of job safety in three areas: management concerns, management safety activities, and employee risk (see Table 18). A lower safety score indicates a safer work environment, as perceived by the worker. The mean safety score was 18.64 (SD = 4.87) with a minimum score of 10 and a maximum score of 32. There was a statistically significant correlation between functional limitation (HAQ) and the safety score ($r = .183$; $p = .003$).

Sixty percent of the workers ($n = 154$) stated that safety practices were very important to the management of the company for which they worked. Slightly more than half ($n = 132$; 52%) reported being made regularly aware of dangerous work practices or conditions, but only one fifth of the workers ($n = 56$; 20%) received regular praise for safe work. Thirty-eight percent of the respondents ($n = 97$) stated that supervisors could do more to promote job safety, and 56 (22%) stated that supervisors were more interested in completing the job quickly and inexpensively than they were in safety matters. More than half (58%) received instructions on company safety policies when hired, and more than half (56%) attended regular job safety meetings. Less than 20% ($n = 48$) stated that taking risks was not an expected part of their job.

Dimensions of Job Content

The JCQ (Karasek & Theorell, 1990; Karasek et al., 1988) was administered to evaluate job strain as measured by work demands and control over work situations.

Table 18

Participant Perception of Safety Practices as Measured by the Safety Climate Measure
(N = 255 except where indicated)

Characteristic	Frequency	Percent
Management concerns		
Worker's safety practices very or somewhat important to management	221	87
Regularly made aware of dangerous work practices or conditions (N = 254)	132	52
How much supervisors do to make the job safe (N = 254)	254	
Do as much as possible	101	40
Could do more	97	38
Only interested in doing job fast/cheaply	56	22
Regularly praised for safe conduct (N = 254)	52	20
Management safety activities		
Received instructions on safety when hired (N = 247)	143	58
Regular job safety meetings (N = 252)	140	56
Proper equipment always available	119	47
Employee risk perception		
Have almost total control over personal safety	153	60
Taking risks not a part of the job (N = 253)	48	19
Possibility of being injured in next 12 months very likely or somewhat likely	112	45

Neither the Psychological Job Demands score, nor the Decision Latitude score was correlated with injury severity. The JCQ is scored in such a way that the Decision Latitude scale, a sum of two subscales (i.e., Skill Discretion and Decision Authority), has a possible low score of 24 and a possible high score of 96. The Psychological Job Demands scale has a possible low score of 12 and a possible high score of 48. The mean score for all trades combined for decision latitude was 67.70 (SD = 10.78) and for the Psychological Job Demands scale was 33.11 (SD = 5.91). There was a statistically significant difference among the means of the trade groups for the subscales, Skill Discretion ($F_{(5, 248)} = 2.43$; $p = .036$) and Decision Authority ($F_{(5, 250)} = 3.146$; $p = .009$). However, no statistically significant pairwise contrasts were observed when the Scheffé method of post hoc comparison of means was used, suggesting the differences might be evident in more complex contrasts (Munro et al., 1986). In the Decision Authority subscale, there were two pairwise contrasts between laborers and electricians and plumbers, and between laborers and other workers, that approached near-statistical significance ($p = .061$ and $p = .079$ respectively).

Tables 19–22 provide a summary of participant responses to select items on the JCQ. More than 80% of the participants stated that their job required a high level of skill ($n = 232$), was varied ($n = 219$), and required learning new things ($n = 219$). Seventy-five percent of the participants agreed that their jobs required creativity, an opportunity to develop their own special abilities, and allowed personal decision making. Many participants stated that their jobs required a great deal of physical effort ($n = 227$; 89%), rapid and continuous activity ($n = 215$; 85%), and physically hard work ($n = 213$; 84%). Between 56–60% reported working regularly with their head and arms ($n = 142$) or their

Table 19

Percent Agreement With Decision Latitude Characteristics From the Job Content Questionnaire (*N* = 255 except where indicated)

Characteristic	Frequency	% Agree/Strongly agree
Requires high level of skill	232	91
Variety of different things	219	86
Requires learning new things	219	86
Requires creativity (*N* = 254)	202	80
Opportunity to develop special abilities	198	78
Allows decision making on own (*N* = 254)	190	75
Freedom to decide how to do work (*N* = 253)	174	69
Lot of say about what happens (*N* = 254)	130	51
Not a lot of repetitive work	16	6

Table 20

Percent Agreement With Select Physical and Psychological Job Demands From the Job Content Questionnaire (N = 255 except where indicated)

Characteristic	Frequency	% Agree/Strongly agree
Lots of physical effort	227	89
Rapid and continuous activity	215	85
Work very hard	213	84
Often lift or move heavy loads	202	79
Work very fast	183	72
Body of physically awkward positions	153	60
Head/Arms in physically awkward positions (N = 254)	142	56
Not free from conflicting demands (N = 254)	125	49
Asked to do excessive work (N = 254)	121	48
Not enough time to get the job done	98	38

Table 21

Percent Agreement With Social Support Characteristics From the Job Content Questionnaire (*N* = 255 except where indicated)

Characteristic	Frequency	% Agree/ Strongly agree
Supervisor support		
Supv. helpful (*N* = 254)	219	86
Supv. gets people to work together (*N* = 254)	204	80
Supv. concern for welfare (*N* = 254)	194	76
Supv. pays attention to what saying (*N* = 254)	191	75
Co-worker support		
Co-workers friendly (*N* = 254)	241	95
Co-workers helpful in getting job done	231	91
Co-workers competent (*N* = 253)	215	85
Co-workers interested in me	201	79

Note. Supv = supervisor.

Table 22

"Job Insecurity" as Measured by the Job Content Questionnaire (N = 255 except where indicated)

Characteristic	Frequency	Percent
Job steadiness (N = 254)		
Regular and steady	138	54
Seasonal	56	22
Frequent layoffs	19	7
Both seasonal and with layoffs	31	12
Other	10	4
Agree/Strongly agree—job security good (N = 254)	156	61
Somewhat or very likely to lose job in next year (N = 252)	125	50
Actually layed off within last year	77	30
Faced possible layoff at least once in last year	58	23

body (n = 153) in physically awkward positions. Seventy-five percent or more of participants indicated a high level of supervisor and coworker support. Fifty percent (n = 125) stated that they were somewhat or very likely to lose their job within the next year, and 30% (n = 77) had been laid off within the last year.

Testing Assumptions of the Statistical Model

Tests were conducted to check for violations of statistical assumptions. In assessing correlational measures, bivariate scatterplots were examined for outliers, linearity, homogeneity of variance, and curvilinearity. Outlier values were checked to ascertain whether answers had been correctly coded and entered into the database. Only one variable, time at site, revealed any evidence of outlier values (two extreme values); each was found to have been correctly coded and entered. These cases were reviewed to assess whether or not they varied in other major ways from others in the sample. Because these cases only varied from the sample norm with this one variable, a decision was made to retain the cases and the outlier values.

The dependent variable, functional limitation score (HAQ), was plotted against the independent values of age, height of fall, weight of carried item, length of time at site, length of time in trade, Safety Climate Measure score, size of work group, and Psychological Job Demands and Decision Latitude scores. Scatterplots were examined for linearity. There was no evidence of curvilinear relationships between functional limitation (HAQ) and the independent variables.

Multicollinearity may occur when independent variables are highly correlated, containing redundant information (Glantz & Slinker, 1990). Correlations between

independent variables entered into the multiple regression showed no evidence of multicollinearity. Correlations ranged from -.469 to .313, revealing little concern for redundancy. Evidence of multicollinearity between the height of the fall and the work surface was expected, but this was not revealed for the correlation matrix (see Table 23). It was also expected that the correlations between age and length of time in construction and length of time in trade would be high, and this was found to be true. A significant relationship was found between age and years in construction ($r = 0.74$; $p < .001$), and between age and years in trade ($r = .68$; $p < .001$). Based on these tests, it was determined that the assumptions of homogeneity of variance, linearity, and independence were met; therefore, the analyses were completed.

Relationships Among the Dependent and Independent Variables

This section describes the relationship between the dependent and independent variables as measured by the direction, strength, and statistical significance of the single-order correlations. The relationship between HAQ and the independent variables will be explored, followed by a summary of the relationship between lost days and the two measures of injury severity, ISS and HAQ.

Functional limitation (HAQ) was significantly associated with height of fall ($r = .377$; $p = < .001$), surface landed on ($r = .134$; $p = < .05$), union status ($r = .213$; $p = < .001$), Safety Climate Measure score ($r = .183$; $p = < .01$), and work surface ($r = .204$; $p = < .01$). Among the independent variables, union status was statistically significantly associated with the height of the fall ($r = .150$; $p = < .01$), as well as the

[illegible]

Table 23

Pearson Product Moment Correlations Among the Dependent Variable (HAQ) and the Independent Variables (n = 255)

	HAQ	Height	Surface landed on	Union	Safety score	Work Surface		
						Surface 1	Surface 2	Surface 3
HAQ	1.000	.377***	.134*	.213***	.183**	.204**	.049	-.069
Height		1.000	.088	.150**	.118*	.313***	.188	-.043
Surface landed on			1.000	-.117*	-.110*	.139*	-.099	.076
Union				1.000	.255***	.079	.135	.072
Safety score					1.000	-.030	.085	.000
Work Surface 1						1.000	-.469	-.237
Work Surface 2							1.000	-.159
Work Surface 3								1.000

Note. $*p < .05$; $**p < .01$; $***p < .001$. Surface 1 = ladder; Surface 2 = roof; Surface 3 = other; Surface 4 = ground (reference group); HAQ = Health Assessment Questionnaire.

surface landed on (r = -.117; p = < .05). Work surface and height of fall were correlated (r = .313; p = < .001), but not to a degree where extreme redundancy would be suspected.

The safety score, as measured by the Safety Climate Measure, was significantly associated with the height of fall (r = .118; p = < .05), union status (r = .225; p = < .001), and surface landed on (r = -.110; p = < .05). The correlation between union status and Safety Climate Measure is most likely explained by five items in the instrument where union and nonunion members differed in their perceptions surrounding safety conditions at their job sites. They are as follows:

1. Union members were more likely to perceive supervisors as caring about their safety than nonunion members (chi-square = 8.46; *df* = 2; Cramer's V = .18; p = .015). For example, 52% of union members stated their supervisors did as much as possible regarding safety, as compared to only 35% of nonunion members.

2. Union members were made aware of dangerous work practices and conditions more often than nonunion workers (chi-square = 10.86; *df* = 3; Cramer's V = .21; p = .012). For example, 66% of union members stated they were regularly reminded of safety conditions, as compared to 46% of nonunion members.

3. Union members were more likely to have received safety instruction when hired than nonunion workers (84% compared to 48%; chi-square = 24.89; *df* = 1; Cramer's V = .32; p = < .001).

4. Union members were more likely to have regular job safety meetings than their nonunion counterparts (75% compared to 49%; chi-square = 15.10; *df* = 1; Cramer's V = .24; p = < .001).

5. Union members were less likely to perceive that taking risks was a part of the job than nonunion members (chi-square = 9.63; *df* = 2; Cramer's V = .20; *p* = .008). For example, only 20% of union members stated taking risks was very much a part of their job, as compared with 34% of nonunion members.

Functional limitation, as measured by the HAQ score, was not statistically significantly associated with the following variables suggested in the *a priori* hypotheses: age, activity at time of fall, carrying an item, weight of carried item, job title, length of time at site, length of time in trade, size of work group, project type, or Psychological Job Demands and Decision Latitude scores.

The number of days lost from work was significantly associated with both measures of injury severity, the HAQ score (r = .518; p = < .001) and the ISS (r = .428; p = < .001). A significant relationship was also present between the HAQ measure and the ISS (r = .362; p = < .001).

Hypothesis Testing

The first hypothesis stated that a functional limitation measure would provide a more normally distributed range of values than the ISS alone for less serious occupational injuries. As mentioned earlier, the ISS scores clustered toward the lower end of the scale and were not normally distributed. The HAQ scores, measured on a scale of 0 to 3, were more normally distributed (mean = 1.46; SD = .75; median = 1.38) (see Figures 1 and 2). This hypothesis was supported.

The second hypothesis stated that the following sets of variables would make a statistically significant contribution towards explaining the total variance in injury severity, as measured by the HAQ scores: demographic, fall-related, environmental, job activity-related, personal, employer-related, and job characterization. The overall model, including the above seven sets, was not statistically significant after entering the fall-related variables. Only five of the independent variables, contained within the sets of variables listed above, demonstrated single-order correlations with the dependent variable, HAQ score. Using simultaneous multiple regression, these variables—height of fall, surface landed on, union status, Safety Climate Measure score, and surface working from—explained 20.6% ($F_{(7, 247)} = 9.141$; $p = < .001$) of the total variance in HAQ scores (see Table 24). Being a nonunion member and having a higher Safety Climate Measure score were associated with greater injury severity. No other variables demonstrated single-order correlations with HAQ, including age. The second hypothesis was partially supported.

The third hypothesis stated that the individual variables, height of fall and surface landed on, would make a significant contribution towards explaining the variance in injury severity as measured by HAQ scores. Again, both height of fall and surface landed on contributed to the overall model, and each uniquely contributed to the variance in HAQ scores (see Table 24). This hypothesis was supported.

The fourth hypotheses stated that, when controlling for height of fall and surface landed on, older workers would have a higher severity score and would experience a significantly higher number of lost work days than younger workers. A two-step multiple regression was used to test each section of this hypothesis. Using this procedure, age did

Table 24

Simultaneous Multiple Regression Analysis: Dependent Variable—Functional Limitation Score (HAQ)

Variable (units)	*df*	Beta	R^2	R^2 change	*F*-value	*p*-value
Height (feet)	1, 247	.307		.068	21.16	< .001
Surface (concrete; other)	1, 247	.134		.017	5.24	.023
Union (1 = union; 2 = nonunion)	1, 247	.152		.020	6.16	.014
Safety score (higher = increased risk)	1, 247	.125		.014	4.46	.036
Work surface	3, 247			.010	.99	.398
Surface 1 (ladder)	1, 247	.062		.002	.58	.446
Surface 2 (roof)	1, 247	-.008		.000	.01	.921
Surface 3 (other)	1, 247	-.063		.003	.98	.323
Overall model	7, 247		.206		9.141	<.001

Note. HAQ = Health Assessment Questionnaire.

not contribute toward the variance in injury severity after controlling for the effects of height of fall and surface landed on (see Tables 25 and 26). Additionally, there was no single-order correlation between age and HAQ ($r = .024$; $p = .701$).

Again using a two-step multiple regression, age did not contribute toward the variance in number of lost days from work after controlling for the effects of height of fall and surface landed on, although the unique contribution of age approached statistical significance (see Tables 27 and 28). A single-order correlation, conducted prior to the multiple regression analysis, did not demonstrate a statistically significant association between age and number of lost work days ($r = .056$; $p = .372$). The fourth hypothesis was not supported.

The fifth hypothesis stated that, when controlling for age, height of fall, and surface landed on, the following unique variables would contribute to injury severity: union status, Safety Climate Measure score, size of work group, length of time at job site, Decision Latitude score, and Psychological Job Demands score (see Tables 29 and 30). There were statistically significant associations between the HAQ scores and union status ($r = .213$; $p = < .001$), and the HAQ and Safety Climate Measure scores ($r = .183$; $p = < .01$), but there were no statistically significant correlations between the HAQ scores and the other variables.

Using a two-step multiple regression, the effects of age, height of fall, and surface landed on were controlled at Step 1. The following variables were entered simultaneously at Step 2: union status, Safety Climate Measure score, size of work group, length of time at job site, Decision Latitude score, and Psychological Job Demands score. The following variables provided a statistically significant, unique contribution to the total variance in

Table 25

Pearson Product Moment Correlations Among the Dependent Variable (HAQ) and Height of Fall, Surface Landed On, and Age (n = 255)

	HAQ	Height	Surface landed on	Age
HAQ	1.000	.377***	.134*	.038
Height		1.000	.088	-.141*
Surface landed on			1.000	.120*
Age				1.000

Note. $*p < .05$; $**p < .01$; $***p < .001$. HAQ = Health Assessment Questionnaire.

Table 26

Hierarchical Multiple Regression Analysis: Dependent Variable—Functional Limitation (HAQ)—and Effect of Age When Controlling for Fall-Related Variables (n = 255)

Step	Source	Step R^2 change	df	Beta	sr^2	F	p
1	Fall-related variables	.153	2, 252			22.69	< .001
	Height		1, 252	.368	.134	40.02	< .001
	Surface landed on		1, 252	.102	.010	3.04	.082
2	Age	.006	1, 251	.081	.006	1.88	.171

Note. Overall R^2 = .159 ($F_{(3, 251)}$ = 15.81; p = < .001). HAQ = Health Assessment Questionnaire.

Table 27

Pearson Product Moment Correlations Among the Dependent Variable (Days Lost From Work) and Height of Fall, Surface Landed On, and Age ($n = 255$)

	Days lost	Height	Surface landed on	Age
Days lost	1.000	.323***	.034	.061
Height		1.000	.088	-.141*
Surface landed on			1.000	.120*
Age				1.000

Note: *$p < .05$; **$p < .01$; ***$p < .001$.

Table 28

Hierarchical Multiple Regression Analysis: Dependent Variable—Days Lost From Work—and Effect of Age When Controlling for Fall-Related Variables (n = 255)

Step	Source	Step R^2 change	*df*	Beta	sr^2	*F*	*p*
1	Fall-related variables	.104	2, 252			14.65	< .001
	Height		1, 252	.322	.103	28.98	< .001
	Surface landed on		1, 252	.006	< .001	.010	.921
2	Age	.012	1, 251	.110	.012	3.29	.071

Note. Overall R^2 = .116 ($F_{(3, 251)}$ = 10.95; p = < .001).

Table 29

Pearson Product Moment Correlations Among the Dependent Variable (HAQ) and Select Independent Variables (n = 247)

	HAQ	Age	Height	Surface landed on	Union	Safety score	Number in group	Time at site	Decision latitude	Job demands
HAQ	1.000	.033	.372***	.126*	.223***	.182**	.014	-.070	-.006	-.079
Age		1.000	-.139*	.127*	-.172**	-.068	.124*	.112*	.083	-.046
Height			1.000	.076	.149*	.116*	-.009	-.105	.106*	.039
Surface landed on				1.000	-.107*	-.126*	.054	.115*	.130*	-.113*
Union					1.000	.275***	-.121*	-.062	-.072	.025
Safety score						1.000	-.035	-.076	-.312***	.399***
Number in group							1.000	.056	-.054	-.013
Time at site								1.000	.054	.019
Decision latitude									1.000	-.141*
Job demands										1.000

Note. *$p < .05$; **$p < .01$; ***$p < .001$. HAQ = Health Assessment Questionnaire.

Table 30

Hierarchical Multiple Regression Analysis: Dependent Variable—Functional Limitation (HAQ) and Effect of Independent Variables When Controlling for Fall-Related Variables and Age (n = 247)

Step	Source	Step R^2 change	*df*	Beta	sr^2	*F* change	*p*
1	Fall-related variables and age	.154	3, 243			14.69	<.001
	Age		1, 243	.074	.005	1.50	.221
	Height		1, 243	.376	.137	39.41	<.001
	Surface landed on		1, 243	.088	.008	2.176	.142
2	Other variables	.071	6, 237			7.64	<.001
	Union		1, 237	.158	.022	6.59	.010
	Safety Climate Measure		1, 237	.172	.021	6.37	.012
	Number in group		1, 237	.023	< .001	0.15	.695
	Time at site		1, 237	-.034	.001	0.33	.567
	Decision Latitude		1, 237	-.018	.000	0.08	.772
	Job Demands		1, 237	-.149	.018	5.58	.019

Note. Overall R^2 = .225 ($F_{(9, 237)}$ = 7.64; p = < .001). Health Assessment Questionnaire.

HAQ scores: union status, Safety Climate Measure score, and Psychological Job Demands score. The Psychological Job Demands scores did not demonstrate a statistically significant, single-order correlation with those of the HAQ (r = -.079; p = .108); however, when the effects of potentially confounding variables such as age, height of fall, and surface landed on were controlled, Psychological Job Demands scores uniquely explained an additional 1.8% of the variance ($F_{(1, 237)}$ = 5.58; p = < .019). The fifth hypothesis was partially supported.

The sixth hypothesis stated that the HAQ scores and ISS would be statistically significantly and positively associated with the number of days lost from work. This was found to be true, supporting the sixth hypothesis. The correlation between the HAQ score and days lost from work was r = .518 (p = < .001), and between the ISS score, the correlation was r = .428 (p = < .001).

Regression Models

Testing of the above hypotheses required four multiple regressions—one simultaneous multiple regression and three two-step multiple regressions. A simultaneous multiple regression model was used to determine how much variance in injury severity, as measured by the HAQ score, was explained by five variables found to have statistically significant, single-order associations with the HAQ score. Table 24 details the results of this multiple regression analysis. Five independent variables were entered into the equation simultaneously. One categorical variable, surface working from, with four levels, was represented in the multiple regression by a set of three dummy-coded variables: Surface 1, Surface 2, and Surface 3, with *ground* serving as the reference level. The R^2

for the entire model was .206 ($F_{(7, 247)}$ = 9.141; p = < .001), indicating that approximately 21% of the variance in injury severity (HAQ) was accounted for by the combination of these variables. Four of the variables provided a significant, unique contribution to the model: height of fall (R^2 change = .068; $F_{(1, 247)}$ = 21.16; p = < .001), surface landed on (R^2 change = .017; $F_{(1, 247)}$ = 5.24; p = < .023), union status (R^2 change = .020; $F_{(1, 247)}$ = 6.16; p = < .014), and Safety Climate Measure score (R^2 change = .014; $F_{(1, 247)}$ = 4.46; p = < .036). Being a nonunion member and having a higher Safety Climate Measure score were associated with greater injury severity.

A two-step multiple regression was used to determine how much variance in HAQ scores was explained by age, after controlling for the effects of other variables (see Tables 25 and 26). The first set of variables entered into the model were height of fall and surface landed on. This first step accounted for 15% of the variance ($F_{(1, 252)}$ = 22.69; p = < .001). Age was entered at the second step. Although the overall model was significant (R^2 = .159; $F_{(3, 251)}$ = 15.81; p = < .001), age did not provide a statistically significant, unique contribution to the variance in HAQ scores above and beyond height of fall and surface landed on (R^2 change = .006; $F_{(1, 251)}$ = 1.88; p = .171).

A two-step multiple regression was used to determine how much variance in days lost from work was explained by age after controlling for the effects of height of fall and surface landed on (see Tables 27 and 28). The first set of variables entered into the model were height of fall and surface landed on. This first step accounted for approximately 10% of the variance ($F_{(2, 252)}$ = 14.65; p = < .001). Age was entered at the second step. Although the overall model was significant (R^2 = .116; $F_{(3, 251)}$ = 10.95; p = < .001), age did not provide a statistically significant, unique contribution to the variance in HAQ scores (R^2 change = .012; $F_{(1, 251)} = 3.29$; $p = .071$), although the effect of age approached statistical significance.

A two-step multiple regression, once again, was used to determine how much variance in injury severity was explained by the individual variables: union status, Safety Climate Measure score, size of work group, length of time at job site, Decision Latitude score, and Psychological Job Demands score after controlling for the effects of age, height of fall, and surface landed on (see Tables 29 and 30). The overall model was significant, explaining approximately 22% of the variance in HAQ scores ($F_{(9, 237)} = 7.64$; $p = < .001$). The following variables provided a statistically significant, unique contribution to the total variance in HAQ scores: union status ($sr^2 = 0.22$; $F_{(1, 237)} = 6.59$; $p = .010$), Safety Climate Measure score ($sr^2 = 0.21$; $F_{(1, 237)} = 6.37$; $p = .012$), and Psychological Job Demands score ($sr^2 = 0.18$; $F_{(1, 237)} = 5.58$; $p = .019$). Although the Psychological Job Demands scores did not demonstrate a statistically significant, single-order correlation with HAQ scores ($r = -.079$; $p = .108$), it uniquely explained an additional 1.8% of the variance in HAQ scores when the effects of potentially confounding variables were controlled. This phenomenon, referred to as *suppression*, can occur when the interrelationship between the independent variables obscures the relationship between an independent variable and the dependent variable (Cohen & Cohen, 1983).

Summary of Major Findings

The sample consisted of 255 adults, predominantly males, with a mean age of 34 years. The majority of the sample was White, and most had a high school education. The participants were experienced in construction and their particular trade. The mean height of the fall was 9.23 feet and more than half of the sample worked in residential construction. Many worked for small to midsize companies and in small groups at the work site. A full range of trades was represented including carpenters, roofers, painters, drywallers, laborers, and electricians. More than one quarter of the sample were union members.

The functional limitation scores (HAQ) were more normally distributed than the ISS, as expected. There were no statistically significant differences in means among the trades for either score, but the highest HAQ scores were reported by drywallers and plasterers; the lowest by electricians. Activities proving the most difficult for participants during the first week following their falls included heavy chores, dressing, and bending to pick up items from the floor.

Ironworkers fell from the greatest heights, and electricians from the lowest heights. There were 518 injuries reported, including 99 spinal sprains and strains, 50 lower extremity sprains and strains, 40 upper extremity fractures, 21 lower extremity fractures, 14 head injuries with 5 skull and facial fractures, and 24 open wounds to the upper and lower extremities including tendon and nerve lacerations. Thirty-two individuals were hospitalized and 41 required surgery. During the 11-week study period, 17 participants (8%) were deemed permanently disabled and unable to continue working in the construction trades. Another six voluntarily switched careers or quit their jobs following their injury. Fifteen workers were fired or laid off after they fell.

The Safety Climate Measure elicited worker perceptions of the safety conditions on their job site. In many categories, slightly over half reported favorable conditions such as being reminded of dangerous work practices or having regular job safety meetings.

Sixty percent stated that supervisors could do more to make the job safer, and only 20% received regular praise for safe conduct.

Supervisor and coworker support was evident, indicating a high level of social support. Most workers reported that their job required a high level of skill, offered them opportunities to learn, make decisions, and develop their own special abilities. However, workers also described their jobs as requiring a great deal of physical effort, involving rapid and continuous activity, and pressured with regard to time. Job security was tenuous. Although approximately one half reported that their job was regular and steady, half also reported that they were somewhat or very likely to lose their job in the next year. One third had been laid off within the last year.

A simultaneous multiple regression with five independent variables (see Table 24) explained 21% of the variance in injury severity as measured by functional limitation (HAQ). Independent variables making significant unique contributions to the variance in injury severity were height of fall, surface landed on, union status, and Safety Climate Measure score. All independent variables were positively associated with the dependent variable. Injury severity, as measured by ISS and HAQ, was significantly positively associated with the number of lost work days.

CHAPTER FIVE

DISCUSSION

Introduction

This chapter presents the interpretation and significance of the study, followed by a discussion of its strengths and limitations. Implications for nursing are highlighted, and suggestions for future research are proposed.

The purposes of this study were to (a) describe the experience of a sample of California construction workers who sustained injuries from falling during an 11-week study period; (b) elucidate the determinants of injury severity, as measured by the Health Assessment Questionnaire (HAQ); (c) evaluate the utility of the HAQ as a measure of functional limitation in an injured population; (d) assess the relationship between two measures of injury severity and days lost from work; and (e) evaluate the utility of using Doctor's First Reports (DFR) for research purposes.

This study confirms the significance of nonfatal falls in construction workers by evaluating the injury experience of more than 255 workers who fell during an 11-week study period in California. During this time, an additional 370 workers fell and were injured seriously enough to seek medical treatment. This figure does not represent all the construction falls during that time period, only those meeting inclusion criteria. This study expands knowledge surrounding fall-related occupational injuries by measuring the injury severity and functional limitations associated with the falls, as well as the lost work time experience of the participants, which was notable.

Despite the existence of widespread regulation and codes of practice in the construction industry, the rate of lost-time injuries and the lost work time per injury rate have remained fairly constant over the years. Some contractors and employers, such as the Army Corps of Engineers, have substantially lowered their injury rates, indicating that dramatic change is possible. A proposal for universal safety and health standards for construction has been developed. Developers of the proposal believe that, if fully implemented, it is technologically and economically feasible to reduce the number of construction deaths to < 3 cases per 200 million hours worked, and the number of injuries to < 1 case per 200,000 hours worked (Ringen et al., 1995b). Data from this study highlight the physical and economic toll exacted on workers injured from falls. Those interested in effecting change within the construction industry will need to demonstrate a commitment to implementing uniform performance standards in both large and small company settings, so the injury rate over the next two decades will be a cause for celebration, not despair.

Interpretation and Significance of Study Results

The construction industry employs approximately 5–6% of the workforce in the United States, and accounts for more than 30% of Workers' Compensation expenditures, making workplace injuries a major issue for the construction industry. In 1994, the average Workers' Compensation premium for the construction industry was $28.62 per $100 of payroll (Ringen, Pollack, Finklea, Melius, & Englund, 1995; Weeks & McVittie, 1995). Health and safety issues in construction are complex. Construction is a large industry comprised of many small employers. It is rarely a source of steady employment

so workers tend to have several employers each year. In addition, the physical site and its environment may change daily, hence construction workers become the primary caretakers of their own safety (Ringen, Seegal, & Englund, 1995).

Height of Falls

Injured workers fell, on average, approximately nine feet, with the majority of falls occurring in residential settings. Thirty-eight participants fell 15 feet or more. This figure is significant since, in most circumstances, current Occupational Safety and Health Administration (OSHA) standards require fall protection for workers working at heights 15 feet or greater. The intent of this study was to evaluate injury severity, not causation, thus it would be difficult to determine how many of the workers who fell from 15 feet or more were covered by these provisions. A new proposed OSHA standard requires fall protection at heights of six feet or more under specific conditions (U.S. Department of Labor, OSHA, 1994). In this study, 118 of the sample workers (46%) fell from heights of six feet or more; however, it is unknown how many of them would have been covered by the new ruling. Falling from greater heights was associated with both greater injury severity and functional limitations.

The new six foot regulation has not been implemented in California because of widespread opposition to specific provisions of the standard. The ongoing resistance to regulatory oversight, in construction and other industries, contributes to the complexity of achieving meaningful and sustained reductions in injury rates. On the other hand, there are a substantial number of codes of practice that "detail measures for controlling the physical environment for almost every conceivable situation in construction" (Weeks & McVittie, 1995, p. 397). Existent knowledge of how to control physical hazards is evident, but clearly implementation is not uniform. Many construction contractors and employers demonstrate injury rates below the national average for all industries, but these tend to be large companies with significant financial resources. In a report conducted by Meridian Research under contract to OSHA, the following characteristics of worker protection programs were seen as critical to breaking the cycle of injury, death, and spiraling medical costs within the construction industry: management commitment, employee involvement, work-site analysis, hazard prevention and control, and safety and health training. One of the biggest challenges within the construction industry will be the manner in which these prevention measures can be integrated in an industry comprised of numerous small employers with unpredictable work schedules and a mobile workforce.

Although prevention measures were not addressed in this study, detailed descriptions of how the falls occurred were obtained. In some situations, workers fell under somewhat mundane circumstances, while in others, the events were more dramatic. Workers slipped on slippery, dusty, wet, and steep surfaces, while on the ground or at heights. They tripped over work materials, equipment, and on uneven surfaces, and they fell through unmarked or unsecured openings. Workers fell off ladders while reaching, leaning, and hammering, or when ladders slipped or buckled. At times, ladders and scaffolds became entangled in ropes or painting lines and were pulled or knocked over. Mechanical equipment failure, defective equipment, or improperly erected equipment were responsible for a number of falls. In addition, workers walked, tripped, or slipped off roofs, or were knocked off by equipment or materials.

Although the mechanism of falls was diverse, it was clear from many of the participant descriptions of events surrounding their fall, that relatively simple hazard control measures may have prevented some of the injuries. Examples of such measures include: perimeter protection for roofs and floor edges, correct ladder placement and anchorage, guarding of floor openings, comprehensive housekeeping activities, inspection and maintenance of ladders and aerial lifts, proper scaffold erection, and modified work practices (Ellis, 1993; Weeks & McVittie, 1995).

Injury Severity Measures

The mean HAQ score for participants in this study was 1.46 (standard deviation [SD] = .75), and the scores were fairly normally distributed (see Figure 2). The HAQ score was moderately correlated with lost days from work, explaining approximately 27% of the variance in lost days from work.

The HAQ was developed to evaluate functional limitations in rheumatic diseases, but proved to be an efficient tool with this population of injured workers as well. One participant commented that the choice of activities reviewed in this instrument reflected all those he had tried and found difficult to accomplish. The mean scores in populations with rheumatic diseases have been reported as follows: rheumatoid arthritis (mean = 1.34; SD = .02), osteoarthritis (mean = .62; SD = .03), systemic lupus erythematosus (mean = .55; SD = .07), and systemic sclerosis (mean = .92; SD = .05). In patients with rheumatoid arthritis, disability appears to increase by approximately 0.1 units for several years, then rises more slowly. In arthritic populations, the HAQ appears to be sensitive to small changes in function, making it a valuable tool for sequential administration. It has been used successfully in longitudinal studies when completion was required at 6-month intervals (Fries et al., 1980; Spitz & Fries, 1987).

These comparisons suggest that, during the first week following their falls, the participants in this study sample were more functionally limited than those in earlier studies with chronic arthritic conditions. However, the research involved a single, retrospective administration of the instrument. It is unknown how the HAQ scores would have differed had the instrument been administered, for example, one week following the injury and at subsequent intervals. Also, the self-help devices required by participants differed from those typically used for arthritis patients. Splints, ace bandages, and braces were mentioned more often than dressing devices and long-handled appliances.

The Injury Severity Score(s) (ISS) were, as expected, clustered towards the lower end of the scale (see Figure 1). As mentioned earlier, only two occupational health studies have utilized the ISS (Mitchell et al., 1993; Wong, 1994), and only one (Mitchell, 1993) measured the association between days lost from work and the ISS. In the Mitchell study, no association was found between lost days from work and the ISS, while in this study, a low association was discovered (Munro et al., 1986). In both the Mitchell and the current study, the maximum Abbreviated Injury Scale score was three, but in the current study, the ISS range was wider (range = 21) than that of the Mitchell study (range = 8). Since the ISS has been used so seldom in occupational studies, it is unknown whether it will prove to be an effective tool for measuring occupational injury severity and/or subsequent disability. It is more likely that a combination of measures will prove more beneficial in measuring severity and predicting return to work. Scales such as the Injury Impairment Scale (Association for the Advancement of Automotive Medicine, 1994) and the

Functional Capacity Index (U.S. Department of Transportation, National Highway Traffic Safety Administration, 1994), may also show promise in evaluating occupational injury severity. The Functional Capacity Index is currently still in the developmental stage.

Although the ISS is the most broadly used tool for measuring injury severity, it is not without limitations. For example, it does not provide a comprehensive summary of injuries in all body regions, or in a single body region. The calculation provided by the ISS is based on the three body region Abbreviated Injury Scale scores. If a participant had injuries in more than three body regions, those injuries would not contribute to the final score. Additionally, if a person sustained two equally severe injuries in one body region (i.e., bilateral calcaneal fractures or bilateral radial fractures), only one of the injuries would be entered into the ISS calculation (Linn, 1995). Consequently, in this study, a summary count of injuries per event was provided to more fully explain the breadth of injuries suffered. The impact of injuries not included in the ISS are possibly more accurately reflected in the HAQ scores.

Nature of Injury

Kisner and Fosbroke (1994) evaluated all nonfatal injuries in construction from 1981–1986, including those caused by overexertion, struck by object, struck against, and falls. The authors used the Supplementary Data System of the Bureau of Labor Statistics, which collects Workers' Compensation reports from 30 states; however, they only used data from those 15 states submitting figures for all 6 years. Each claim was coded using only the primary injury for which the claim was filed (S. Kisner, personal communication, 1996). The primary nature of injuries, as found in their study, were as follows:

sprain/strain (34%); cut, laceration, or puncture (17%); fracture (11%); contusion (9%); abrasion (7%); and other (22%). In the current study, the percentage spreads between the primary nature of injuries differed: sprain/strain (45%); cut, laceration, or puncture (9%); fracture (23%); contusion (15%); abrasion (1%); and other (7%). Not surprisingly, these variations, especially the percentage of fractures in this sample, suggest that injuries sustained from falls are more serious than those sustained from all other types of incidents.

Predictors of Injury Severity

In this study, only five of the *a priori* independent variables demonstrated single-order correlations with injury severity, as measured by the HAQ score. They were height of fall, surface landed on, union status, Safety Climate Measure, and work surface. Being a nonunion member and having a higher Safety Climate Measure score (i.e., indicating increased safety risk) were positively correlated with higher injury measures. In a simultaneous multiple regression, these variables explained approximately 21% of the variance and all, with the exception of work surface, contributed uniquely to the explained variance in HAQ scores, albeit the contributions were small (1.4–6.8%). In a hierarchical multiple regression where age, height of fall, and surface landed on were controlled, Psychological Job Demands scores also contributed uniquely to the explained variance (1.8%).

Bivariate correlations among the independent variables revealed the following statistically significant relationships. Older workers were more likely to be union members and to have fallen from lower heights, though both correlations were very small. Lower safety scores (i.e., indicating a higher degree of safety) were associated with being a union member, having more decision latitude, and lower psychological job demands; however, again, these correlations were in the low range.

It was surprising that some variables showed no single-order correlations with either ISS or HAQ scores, especially surprising when analyzing the age component. Age has been identified as a risk factor for fatal falls and has been hypothesized to contribute significantly to injury severity. In their analysis of fatal falls, Agnew and Suruda (1993) demonstrated a trend of decreasing average height of fatal falls with increasing age.

It was not surprising that height of fall and surface landed on contributed to the explained variance in injury severity, but it was unexpected that they uniquely explained such a small percentage of the variance. Other factors such as length of time at site or in trade, or size of work group, which are hypothesized to be associated with the occurrence of injuries, also showed no statistical correlation with HAQ scores. In the current study, it had also been thought that some activity-related or employer-related factors might influence injury severity, but this was not found to be so.

The highest injury rates seem to occur at smaller sites and among the self-employed, and size of work group has been shown to have a curvilinear relationship with the occurrence of injury (Guastello & Guastello, 1987; Marsh, 1994; Ringen, Englund, Welch, Weeks, & Seegal, 1995a; Toscano & Windau, 1994). In this study sample, no statistical correlations were seen between injury severity (HAQ score) and number of employees in the company, at the site, or in the work group. However, union status was positively correlated with injury severity. It has been hypothesized that union sites are safer than nonunion construction environments. This is plausible, though unproven, since union workers receive more education through their unions and apprenticeship training programs. Safety language is frequently negotiated into union contracts, and union jobs tend to be larger, increasing the likelihood of an on-site, dedicated safety manager (Ringen et al., 1995b). In a study conducted by Dedobbeleer, Champagne, and German (1990), it was determined that construction worker safety performance was significantly related to union membership, but when the effect of the age component was removed from the equation, there were no significant differences between union and nonunion workers. Union workers were more experienced, enjoyed more stable employment, and had access to more safety training than nonunion workers, all factors potentially leading to increased safety performance.

In the current study, union status demonstrated a low correlation with the Safety Climate Measure scores ($r = .225$; $p = < .001$) (Dedobbeleer & Beland, 1991). The Safety Climate Measure scores also uniquely contributed to the explained variance in injury severity (1.4%). As mentioned earlier, the correlation between union status and Safety Climate Measure scores is most likely explained by five items where perceptions of union and nonunion members differed: (a) supervisors' interest in worker safety, (b) how often workers were made aware of dangerous work practices and conditions, (c) instruction on safety policies when hired, (d) regular job safety meetings at work, and (e) how much risk taking was perceived as part of the job.

Job Content Questionnaire

Construction occupations are highly skilled trades and tend to provide workers with far greater freedom in decision making than other blue collar occupations; however, this is coupled with intermittent and unpredictable work schedules (Ringen et al., 1995b).

These facts were confirmed by participant responses to the Job Content Questionnaire. Participants viewed their jobs as highly skilled, but psychologically and physically demanding. Job security was tenuous, as expected. It is thought that job insecurity may favor risk taking, thereby impeding healthful behavior. The health of construction workers may be further compromised by the intermittent nature of their work, leaving them at risk of being uninsured (Ringen et al., 1995b; Ringen, Pollack, et al., 1995).

Work Disability

In this study, work disability, as measured by days lost from work, was notable. The mean number of lost work days was 44 (approximately 2 months), and the median was 10 days (2 weeks). During the study period, 10% of the sample (n = 27) left construction work because they were determined to be permanently disabled from their injury or because they chose not to return to construction work following their fall. Several others who remain temporarily disabled, are likely to be unable to return to construction work. For those permanently disabled, the injury type varied from low back and knee sprains to multiple fractures. In the construction arena, a seemingly simple injury such as a knee or shoulder sprain, has the potential of being permanently disabling if the worker is unable to safely perform critical elements of the job (i.e., climbing ladders or carrying heavy tools or equipment).

Work disability is a highly complex phenomenon. Biological, environmental, and social factors are influential, as are individual personal attributes. The inability to work is obviously paramount to income production and may affect access to health care, as well as potentially depriving an individual of social interaction and a sense of independence and self-worth (Greenwald et al., 1989). Data on work disability in other chronic disease situations indicate that the process of discontinuing work is complex, involving interactions between functional impairments, demographic variables, and multiple job characteristics, including physical demands and control over work schedule and pace (Gillen, Lallas, Brown, Yelin, & Blanc, 1995; Yelin, Greenblatt, Hollander, & McMaster, 1991; Yelin, Henke, & Epstein, 1986; Yelin, Henke, & Epstein, 1987). Others have found, however, that disease-related factors were more important predictors of disability in certain conditions (Greenwald et al., 1989; Reisine, Grady, Goodenow, & Fifield, 1989).

Return to work following a disabling illness or injury is no less complex. Loss of employment is a devastating consequence of illness or injury, and the factors associated with return to work are poorly understood (Straaton, Maisiak, Wrigley, & Fine, 1995). Psychosocial factors have been identified as more important determinants of ability to return to work than physical factors (Gallagher et al., 1995); however, determinants seem to vary depending on the illness or injury of study. When severe injuries occur, such as electrical injuries, long-term morbidity may be high and return to work unlikely (Hussman, Kucan, Russell, Bradley, & Zamboni, 1995). On the other hand, while burn severity has been identified as an important predictor of return to work in several studies, Wrigley, Trotman, Dimick, and Fine (1995) demonstrated that social and demographic factors such as ethnicity, failure to accept personal blame, and prior employment were more important predictors of securing subsequent employment than injury severity. Receipt of Social Security Disability Insurance was found to be inversely associated with return to work in patients with musculoskeletal disorders (Straaton et al., 1995), whereas receipt of

Workers' Compensation was found to be an important positive predictor of return to work in seriously burned patients (Wrigley et al., 1995). In patients recovering from hip replacement surgery, blue collar work and less education negatively influenced the ability to obtain gainful employment (Suarez et al., 1996). In patients suffering from traumatic brain injury, performance intelligence tests emerged as the most significant predictor of work return. Injury severity, as measured by the Glasgow Coma Scale, length of coma, and computerized tomography results was not related to the ability of this population to return to work (Ip, Dornan, & Schentag, 1995).

When serious injuries occur, or when inadequate treatment complicates recovery, both physical and psychological barriers need to be addressed if the worker is to be successfully returned to his or her prior job role (Rogers, 1994). Work disability and return to work, as they relate to the construction industry, are largely unexplored. The physical rigors inherent in construction, combined with its intermittent nature, make the rehabilitation of seriously injured workers very difficult. The transient nature of the work also makes it relatively easy for employers to be selective in who they hire, making it difficult for injured workers to secure employment following rehabilitation.

Doctor's First Reports

This study provided a unique opportunity to access injured workers via reporting mechanisms of the Department of Industrial Relations (DIR). A DFR must be submitted to the DIR on every individual treated by a health care provider for an occupational injury (see Appendix H). As stated earlier, approximately 21,000 reports are submitted weekly. Prior to this study, DFRs had never been used for injury research, though they have been

used for occupational disease research. They are a rich source of information, but access to the data does not come without complications.

The DIR does not have the capacity for electronic submission of reports; therefore, hard copies of all reports are submitted. Although key information must be reported, providers are free to submit information on standardized forms or individually designed forms. Consequently, this makes case retrieval difficult when sorting through thousands of forms that are visually disparate. Additionally, a few providers routinely used outdated forms that did not include the patient's phone number, complicating outreach to potential participants.

Identical DFRs for the same person was a fairly common occurrence, as were duplicate forms with similar or updated information. This necessitated careful cross-checking procedures to insure that duplicate introductory packets were not distributed. The demographic information section of DFRs may be completed by health care personnel, as well as by the injured workers. Since DFRs are primarily a notification system, key information needed for research purposes may not be included or, if the forms were completed in haste, not accurate. In addition, the quality of the copies sent to DIR is highly variable, with some completely illegible. Health care practitioners complete the clinical findings and treatment sections. At times, these are blank, instructing the reader to refer to the dictated or emergency department reports; rarely are these supplementary reports attached to the DFR.

In summary, DFRs are an extremely rich source of information for occupational injury surveillance and research. However, since they were not designed for such purposes, administrative difficulties associated with their use are common. These

difficulties are not insurmountable, but careful planning is essential and added expense may be involved.

Strengths of the Study

This study was population based, introducing a data collection system never before used for an occupational injury study. During an 11-week period, every construction worker whose injury was reported to the Department of Industrial Relations was invited to participate. Subjects were interviewed in either English or Spanish; only five potential participants were excluded due to language difficulties. Languages the interviewers were unable to accommodate included Chinese, Korean, Ukrainian, and Portuguese.

The study included representatives from all trades in union and nonunion settings. Inclusion of nonunion employees was important because access to these workers, especially in construction, has historically been difficult. The ethnicity of the sample population in this study was similar to the ethnic representation of construction workers statewide, and the representation of trades closely paralleled those practiced in California. Data specific to construction laborers was not available because these figures are combined with those also relating to nonconstruction laborers.

These findings confirm the importance of nonfatal falls within the construction industry; more than 625 workers were treated for fall-related injuries during an 11-week period in California. These findings were expanded by adding the dimension of injury severity, not previously addressed in other studies. Injury severity was measured by a proven and accepted instrument used widely in trauma settings. A proxy measure of injury severity, functional limitations, provided useful information about the degree to which workers are disabled from work-related falls during their first week of recovery. Previous documentation indicating use of the HAQ to measure functional limitations from injuries could not be found in the literature. The HAQ was moderately correlated with days lost from work and, hence, could prove useful to occupational health practitioners developing and implementing return to work programs.

Limitations of the Study

The study population was overwhelmingly male; therefore, the study may not be generalizable to women in the construction trades. Statistics regarding ethnicity and other demographic information related to construction laborers was not available, so it is unknown whether the percent of laborers in this study was representative of the number of construction laborers in California. Participants appeared to be more seriously injured than nonparticipants, thus the results may be reflective of more seriously injured workers, limiting the generalizability of the results to those more severely injured.

Most importantly, this study was limited by a less than optimal response rate. The number of participants lost to follow up was much higher than anticipated. In addition, conducting studies related to occupational safety and health issues can be complicated if workers are fearful of employer reprisal, of losing their Workers' Compensation benefits, or are currently involved in legal negotiations.

The study was retrospective in design; participants were interviewed an average of 73 calendar days following their injury. It is possible, though unlikely, that participants may have had difficulty recalling the details of their injuries or their worksite because of this interval. On the other hand, this sample of construction workers proved to be very good historians. Descriptions of the events surrounding their falls were detailed, and answers requiring measurements (e.g., height of fall and weight of tool bags) were provided without hesitation. Missing data were rare and tended to occur because a participant preferred not answering a question for personal reasons. The only question that presented a minimum of recall difficulty was, "When you were hired by your present employer, were you given instructions on the safety policy and safety requirements of the company?" Eight participants (3%) did not answer this question, mostly due to recall difficulties.

Submission of the DFR is dependent on several mechanisms: A health care practitioner must complete the report and submit it to the Workers' Compensation carrier, and the carrier must forward the information to the Department of Industrial Relations. Each of these mechanisms offers ample opportunity for delays in submission. Also, the extensive review of DFRs indicated that certain carriers may have "batched" their claims, meaning that during specific weeks, certain trades may have been overrepresented, depending on the type of businesses insured by the carrier.

Midway through the study, one participant suggested that we ask workers the following question, "What could have been done to make the workplace safer?" The addition of such a question would have greatly contributed to our ability to analyze the site work practices and individual reasons for the fall incidents, as well as injury severity.

Implications for Nursing

Occupational health nurses are not typically involved in the day-to-day occupational health and safety matters of construction workers. Construction workers, for the most part, are employed by small companies. Their work is transient and intermittent. The role of occupational health physicians and nurses has been limited to activities surrounding medical surveillance for lead and asbestos exposure and treatment of acute injuries. Not one construction employer in the United States employs an occupational health physician (Ringen, Pollack, et al., 1995).

This is unlike the situation in Europe where well-developed occupational safety and health programs for the construction industry have been instituted for years. Bygghälsan, a joint union-employer organization in Sweden, was established in the 1960s to provide comprehensive services to construction workers, as well as employers. Bau-Berufsgenossenschaften, of Germany, provides comprehensive primary medical and nursing care, as well as acute care and rehabilitation services for traumatic injuries. In urban areas of France, large occupational health centers for the construction trades operate under joint labor and management agreements (Ringen, Pollack, et al., 1995).

Although occupational physicians and nurses have played a minimal role in the construction industry in this country, there are some indications that this may change in the future. An increasing number of regulations in the construction industry require periodic medical surveillance of workers. The provision of increased preventive medicine services through managed care plans may mean that more construction workers are seen more frequently by primary care providers. Finally, Workers' Compensation reform may provide the opportunity for occupational health professionals to play a more active role in the construction industry through the development of return to work protocols and more objective disability determinations (Ringen et al., 1995b).

Injured construction workers are likely to be treated in emergency departments, urgent care centers, or through primary care practitioners. Consequently, occupational health nurses are unlikely to interact with construction workers unless the nurses are employed by an organization providing contract services to small employers. Even then, they may only see these workers as part of routine medical surveillance activities or treatment of acute injuries. Though limiting, these interactions may provide occupational health nurses the only opportunity to offer quality education to these workers on safety practices, general health promotion, and trade-specific information regarding health risks such as noise, lead and other chemical exposures, and dermatitis. Wallerstein and Rubenstein (1993) recommend that education programs be conducted routinely as part of screening programs. Additionally, it is important that nurses practicing in emergency departments and primary care settings be educated about occupational safety and health issues so that they are capable of relating to and addressing the unique needs of these workers.

The need for safety and health education among construction workers, especially nonunion workers employed by small companies, must be emphasized. Union workers have greater access to such education through their unions and apprenticeship training programs. Training of workers tends to be infrequent and often provided by coworkers. The necessity for and effectiveness of periodic retraining is often overlooked in company safety programs. Rogers (1994) summarized a report issued by the American Society of Safety Engineers regarding injuries and job safety training. In this report, 73% of workers who were injured in ladder incidents (N = 1,419) had never received safety training related to the job they were performing when they were injured.

Nurses are viewed as being able "to communicate effectively with workers" (Ringen et al., 1995b, p. 449). Those who have contact with construction workers should familiarize themselves with the work practices and risks associated with this industry so they are better able to counsel workers in safety and health matters such as fall protection and the use of hearing protection. In addition, even occupational health nurses who have minimal contact with construction workers, can potentially influence work practices through their knowledge of regulations and standards, as well as through their advocacy for worker health and safety (Rogers, 1994).

Nurses who work in case management and rehabilitation settings can assist injured workers during their recovery and in their return to work by advocating for part-time and modified-duty programs (Rogers, 1994). Although many construction employers do not have the capacity for light-duty assignments, creative solutions are always possible. In Hamilton, Ontario, employers and unions negotiated to develop a rehabilitation center for injured construction workers that incorporated an early return-to-work program (Ringen, Pollack, et al., 1995).

For nurses working in research and government settings, there is ample opportunity to pursue issues affecting construction workers. As an example, Lusk, Ronis, and Kerr (1995) developed and implemented an excellent hearing protection program for construction workers in Michigan. This program was especially important because construction workers, at high risk for noise-induced hearing loss, are not covered by hearing protection standards. In other government programs, such as the state-based Fatality Assessment and Control Evaluation programs of the NIOSH, nurses develop recommendations and prevention strategies for occupational fatalities frequently seen in the construction industry.

Future Directions for Research

This investigation provided descriptive and analytic information regarding nonfatal falls and associated injury severity in construction workers. Very little descriptive or analytic research has been conducted with a focus on the construction industry. Exploration into finding innovative ways of enhancing surveillance activities would also be beneficial, although surveillance has indeed improved dramatically. Despite the lack of detailed descriptive data and more sophisticated analytic information, it is well known that construction work is extremely hazardous. It would seem prudent, therefore, to direct research primarily toward preventing fatal and nonfatal injuries within this risky industry. Surveys, such as the Meridian Report, emphasize that large construction companies with comprehensive worker-protection programs, share certain elements in common: management commitment, employee involvement, work-site analysis, hazard prevention and control, and worker safety and health training. The lacking information is whether or not these same components would assist smaller companies in reducing their numbers and rates of occupational injuries. Intervention research, or impact assessment studies (Goldenhar & Schulte, 1994), would be of great value in determining which programs are effective in smaller companies, as well as being economically and logistically feasible.

How to measure injury severity and its relationship to return to work has been problematic for occupational health practitioners. The findings of this study suggest that using a functional limitation score, rather than an ISS, may be more useful in predicting return to work. Functional limitation scores determine the degree of disability, while injury severity measures evaluate anatomical or physiological damage. Use of the HAQ was successful with this study population; however, it would need to be evaluated in other similar and dissimilar samples to more conclusively determine its utility in evaluating disability from occupational injury. Additionally, it might be fruitful to administer the HAQ sequentially in the early stages following injury to assess whether it is as sensitive to detecting minor patient status changes as it has proven to be in those with rheumatic disorders.

Understanding why workers are injured at work, and how physical hazards and behavior interact, is not well understood. In this study, adding several questions designed to elicit the worker's perspective on the incident would have been helpful. When such questions are included, however, they need to be worded in ways that do not suggest fault or blame.

Factors contributing to injury severity, functional limitations, and return to work are poorly described and have not been studied to any degree in construction workers. In this study, only 21% of the variance in injury severity was explained by the independent variables; hence research into other related factors may uncover additional pertinent data. The human response to injury varies, as does the impact of disability on the workers themselves as well as their families. Both areas deserve exploration. Increasing knowledge surrounding the financial aspects of disability, as well as the psychological and emotional dimensions, may be helpful to occupational safety and health practitioners in their efforts to assist individuals in returning to work, or other productive activities if return to work is not possible.

One of the challenges of working in the construction industry is that the restructuring of work practices cannot be accomplished in individual workplaces, nor with individual workers. Construction workers are employed by many contractors throughout their lifetime; therefore, industry-wide changes are required (Ringen et al., 1995b). Because this industry is so complex, this challenge will not be accomplished easily. Multidisciplinary research addressing engineering controls, education and training, product design, human behavior, and administrative issues, offers the best chance of achieving meaningful and sustained results for these workers.

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APPENDIX A

RISK FACTORS FOR OCCUPATIONAL INJURY

SUMMARY OF 32 STUDIES

Appendix A

Risk Factors for Occupational Injury: Summary of 32 Studies

Factors identified as being potential predictors of occupational injury in 32 "high quality" epidemiologic studies from 1970-1992. Veazie, Landen, Bender, Amandus (1994). Epidemiologic research on the etiology of injuries at work. Annual Review of Public Health, 15, 203-221.

Numbers in parentheses indicate the number of studies in which this risk factor was evaluated, and the number of studies in which this factor was found to be statistically significant at the $p < 0.05$ level. For example, (12/8) = evaluated in 12 studies and found to be statistically significant in 8 studies.

Human Factors

Ethnic group (1/0)
Age (12/8)
Marital status (3/0)
Years education (2/0)
Height (1/0)
Weight (2/1)
Gender (3/2)
Number of children (1/0)
Job title/tasks (9/6)
Experience (7/4)
Unaccustomed to job (1/0)
Worked other jobs (1/0)
Years worked (3/1)
Hearing loss (2/1)
Left-handed (1/0)
Sports in leisure (2/0)
Somatic complaints (1/0)
Prior injury (3/1)
Reaction time (1/0)
Simple motor speed (1/0)
Hand-eye coord. (1/1)
Body sway test (1/1)
Coordination (1/1)
Involuntary control (1/1)
Cardiovasc. disease (1/0)
Medication use (1/0)
Fatigue (1/1)
Job satisfaction (2/1)
Confidence/coworkers (1/0)
Mechanical aptitude (1/0)
Perceived safety risk (1/1)
Sleep pattern (1/1)
Year of hire (1/1)
Supervisory position (1/1)
Safety high priority (1/1)
Feel accidents preventable (1/1)
Lack of time (1/1)
Low value on safety (1/1)
Morale (1/1)
PPE not available (1/0)
PPE not used (1/1)
PPE thought inadequate (1/0)
Glove type (1/0)
Helmet use (1/1)
Ear plugs (1/1)
SCBA use (1/1)
Glasses used (2/1)
Alcohol consumption (4/1)
Drugs (2/0)
Smoking (2/0)
Blood loss (1/1)
Duration of surgery (1/1)
Vascular procedures (1/1)
Abdominal procedures (1/1)
Perceived HIV/HBV risk (1/0)
Previous laminectomy (1/0)
Vision poor (1/0)
Acute illness (1/0)
Chronic illness (1/0)
Previous traffic accident (1/0)
Intelligence (1/0)
Expectancy reaction (1/1)
Personality inventory (1/0)
Attention level (1/1)
Stable behavior (1/1)
Hand performance test (1/1)
Impeded movement (1/1)

Job Content Variables

Job change during week (1/0)
Unusual task (1/1)
Unusual material used (1/0)
Department (1/0)
Number job changes/year (1/1)
Shift (2/1)
Hour of day (3/2)
Hours worked (7/4)
Alternating shift (3/0)
Number days/shift tour (1/1)
Rapid change in shift (1/0)
Lack of lunch break (1/0)
Resting/napping (2/1)
Time off before shift (2/1)
Slept during shift (1/0)
Volume of work (2/1)
Absent previous day (2/0)
Driving pattern (1/1)
Location of job (4/3)
Mining method (1/0)
Change in job location (2/1)
Prior training (1/1)
Flexibility/work schedule (1/1)

Work Environment Factors

Seniority, pay grade (1/0)
Manager age (1/0)
Manager experience (1/1)
On/off duty (1/1)
Overtime (1/0)
Safety incentives (1/1)
Lack/training material (1/1)
Cooperative supervisor (1/1)
Cooperative staff (1/1)
Management style/discipline (1/1)
Management style/supervision 1/1)
Management style/criticism (1/1)
Management style/enforcement (1/1)
Replacement crew members (1/1)
Work group size (1/1)
Ergonomic stress level (1/1)
Survivability of accident (1/0)
Noise (1/1)
Slippery surfaces (1/0)
Improper equipment used (1/1)
Stairway design factors (1/1)
Season (1/1)
Power equipment (1/0)
Geographic area (1/0)
Road type (1/1)
Truck type (1/1)
Vehicle weight (1/1)
Equipment failure (1/1)
Load of truck (1/0)
Truck carrier type (1/1)
Power steering (1/1)
Steering violation (1/1)
Deceleration during crash (1/1)
Parachute type (1/0)
Circumstances of injury (3/3)
Number of vehicles (1/1)
Poisson process (1/0)
Defective material used (1/1)
Environmental annoyance (1/1)

APPENDIX B

SELECT RISK FACTORS FOR OCCUPATIONAL INJURY

Appendix B

SELECT RISK FACTORS FOR OCCUPATIONAL INJURY

Authors/Year	Risk Factor Evaluated	Study Design	Subjects/Total Number of Cases	Results
Agnew & Suruda (1993)	Age	Secondary Data Analysis	4179 death certificates (NTOF); 996 OSHA records (IMIS)	Rate of fatal falls for all male workers higher for workers aged 45 and older. Significant correlation (r=0.28, p<.00001) between decreasing height and increasing worker age. 11.4% variance attributable to age in total injury incidence rate; 10.7% in temporary disability rate; 39.6% in permanent disability rate; 79.5% in the fatality rate.
Cohen & Lin (1991)	Work conditions, environmental factors	Case-control	123 cases; 142 controls	Logistic OR 3.63 for working conditions, OR=2.20 for ladder use factors, OR=2.06 for personal, occupational factors. Did not evaluate age.
Hunting et al., (1991)	Solvents, environmental factors	Cohort	2480 person weeks of data	OR=1.54 (95% CI, 1.34-1.82) for each 10% increase in average weekly exposure to environmental hazards in painters.
Bureau of Labor Statistics (1986)	Self-reported risk factors for injury in laborers	Survey	3700 injured laborers, 27 states	Nearly 50% reported hazardous working conditions contributed to injury. Slippery ground (14%), lack of sufficient space (13%) weather (8%), cluttered work (8%), fast pace (20%), heavy weight (20%). 30% aware of job hazards that contributed to injury.
Helmkamp & Bone (1987)	Experience & training	Cohort	Navy personnel, 35,322 who experienced an injury, 1977--1983	On-duty: RR=4.7 (95%CI: 3.4, 6.5) for falls with <1 mo experience, RR=1.7 (95% CI: 1.2, 2.5) for 1 mo, RR=0.6 (95%CI: 0.4, 0.9) for 2 mos. Off-duty: RR=3.6 (95%CI: 2.7, 4.7) for falls with <1 mo experience, RR=2.3 (95% CI: 1.6, 3.2) for 1 mo, RR=1.3 (95%CI: 0.9, 1.8) for 2 mos.

Authors/Year	Risk Factor Evaluated	Study Design	Subjects/Total Number of Cases	Results
Heineman, Shy, Checkoway (1989)	Injury risk factors associated with SCBA use	Case-control	Firefighters, 75 cases, 144 controls	Falls weakly associated with unaccustomed positions (unadjusted) (OR=1.4 (95% CI: 0.4, 4.8, same fire controls) and OR=1.9 (95%CI, 0.5, 7.6, similar fire controls). When adjusted for multiple risk factors, an on-duty injury in past 12 months was associated with falls, OR=5.5 (95%CI, 1.0-30.0)
Guastello & Guastello (1987)	Work group size	Cohort	Metal foundry and mill workers, 435 workers in 79 work groups	Work group size correlated with DV, log of accident rate over 10 months. Approximately 4.1% of the explained variance (r=0.21, p=0.04) in the DV was explained by group size, & 8.6% when a quadratic was added. Scattergram revealed a breakpoint at a group size of approximately 15.
Bureau of Labor Statistics (1984)	Risk factors for falls from elevations	Survey	All industries (N=744)	17% reported activity as loading/unloading, 13% were operating, repairing, cleaning, or installing equipment. Movement at time of fall: 28% were climbing up or down, 13% were walking, 11% stepping from one surface to another, 28% lifting, carrying, or moving objects, 24% using tools or equipment. 17% fell from scaffolds, 14% from roofs.
Dedobbeleer & German (1990)	Union status & safety performance	Cross-sectional	384 union & non-union workers at 9 sites	Safety performance significantly related to safety performance, but not when adjusted for age. Union workers more often have safety equipment available (NS when age-adjusted) & attend safety meetings. Discriminant function correctly classified 78% with: safety training, age, knowledge of safety, re-employment by same employer, perceptions of coworker's safety attitude, & control over one's own safety.

Authors/Year	Risk Factor Evaluated	Study Design	Subjects/Total Number of Cases	Results
Hertz & Emmett (1986)	Risk factors for occupational hand injury	Case-control, matched pair	Municipal employees, 124 matched pairs	Unadjusted: Age <25 yrs (OR=3, 1.03-10.63), experience <2yrs (OR=2.75, 0.81-11.88), >9hrs sleep night before (OR=2.67, 1.19-6.35), >9hrs sleep on average (OR=4, 1.45-13.71). Adjusted: performance on nontypical task (OR=10.9), use of defective equipment (OR=37.4), >9hrs sleep (OR=4.5), age<25 yrs (OR=4.4). Individual & joint effects using conditional logistic regression. Stepdown approach.
Moll van Charante & Mulder (1990)	Perceptual acuity and occupational accidents	Case-control	Male shipyard workers, 300 cases & 300 matched controls	Alcohol consumption, hearing loss >20dB, loud noise >82dB(A) found to be safety hazards. Risks attributable to noise & hearing loss together accounted for 43% of injuries.
Mueller, Mohr, Rice, & Clemmer (1987)	Factors affecting injury	Incidence density cohort study	1,023 workers	Injuries categorized as minor (first aid), medical, & lost time (≥ 72 hours). Used standardized residuals to control for differences in injury rates between jobs. Both rate of job change and rate of transfer has significant effects on rate of injury; this effect remained when age was controlled for.
Kilburn, Warshaw, & Hanscom (1992)	Hearing loss & balance dysfunction	Case control	78 ironworkers (ages 22-79, mean 53.3) & 128 histology technicians (ages 26-69, mean 44.2)	Most ironworkers showed hearing loss at frequencies below 3000 Hz. Sway speeds were significantly faster with eyes open (1.05, SD 0.39 cm/s) *v* (0.91, SD 0.22) & eyes closed (1.66, SD, 0.82) *v* (1.31, SD 0.51). Coefficients for sway speed with eyes closed & hearing loss (L) ear were significantly correlated at 500 to 8000 Hz.

Authors/Year	Risk Factor Evaluated	Study Design	Subjects/Total Number of Cases	Results
Pratt, Marvel, Darrow, Stallones, May, & Jenkins (1992)	Injuries in dairy farmers	Cohort	600 farmers & farm workers on 201 dairy farms	Injured workers were older ($p \leq 0.01$), worked more hours ($p \leq 0.001$), & had heavier workloads ($p \leq 0.001$). Growing & harvest seasons had most injuries, more than 2/3 occurred in the p.m. Those working >60 hours/wk, with >30 acres under tillage/worker, had RR=2.78 (CI not provided).
Eyssen, Hoffmann, & Spengler (1980)	Manager's attitudes	Cross-sectional	87% of 1056 managers completed questionnaire; construction & maintenance workers in a telephone company	Length of service variable explained 46% of variation in injury rates in "outside" districts and 37% in "inside" districts. After adjustment for manager's length of service, perceived high risk & greater priority given to safety, correlated with lower injury rate. Those who felt others had safety responsibility had higher rates, also heavy workload, excessive paperwork, lack of training materials, lack of colleague cooperation. Overall, 90% of variation between districts in injury rate was explained by managers' attitudes towards safety, social environment at work, and length of service.
Lauridsen & Tonnesen (1990)	Aspects of shift work	Cohort	Offshore drilling, 1980-1987, 3200 injuries	Period between 5.5 & 7.5 hours worked & last half-hour worked had a significantly lower injury rate. Injury rate during meal breaks 9% higher than average, & coffee breaks 26% higher. Between 12 am - 6 am, significant increase in number of injuries compared to 6 pm - 12. During crew change over days increases also seen.

APPENDIX C

HADDON'S TEN COUNTERMEASURE STRATEGIES

Appendix C

HADDON'S TEN COUNTERMEASURE STRATEGIES

1) Prevent the creation of the hazard in the first place.

2) Reduce the amount of the hazard brought into being.

3) Prevent the release of the hazard that already exists.

4) Modify the rate or spatial distribution of release of the hazard from its source.

5) Separate, in time or in space, the hazard and that which is to be protected.

6) Interpose a material barrier to separate the hazard and that which is to be protected.

7) Modify relevant basic qualities of the hazard.

8) Make what is to be protected more resistant to damage from the hazard.

9) Begin to counter damage already done.

10) Stabilize, repair, and rehabilitate the object of the damage.

From: Haddon, W. (1980). The basic strategies for reducing damage from hazards of all kinds. Hazard Prevention, September-October, 8-12.

APPENDIX D

HADDON'S MATRIX FOR INJURY PREVENTION

Appendix D

HADDON'S MATRIX FOR INJURY PREVENTION

PHASES	FACTORS			
	Human	Vehicle/Agent	Physical Environment	Sociocultural Environment
Pre-Injury				
Injury				
Post-Injury				

APPENDIX E

CONSENTS, INTRODUCTORY LETTERS,

AND MEDICAL RELEASE FORMS

Appendix E

University of California, San Francisco
California Department of Health Services, Occupational Health Branch

CONSENT TO PARTICIPATE

Nonfatal Falls in Construction Workers: Predictors of Injury Severity
Participant Interview

A. Purpose and Background:

Marion Gillen (Project Coordinator) is a candidate for a PhD degree at the University of California, San Francisco, in the Department of Mental Health, Community and Administrative Nursing. Dr. Julia Faucett is her advisor. In partial fulfillment of the degree requirements and, in conjunction with the California Department of Health Services, she is conducting a study among construction workers who have fallen and were injured. The findings of this study will be used to help nurses and physicians understand the range of injuries that occur when construction workers fall and what factors contribute to how seriously workers are injured when they fall. You are being asked to participate in this study because you are a construction worker who has fallen at work.

B. Procedures:

If you agree to participate in the interview, the following will occur:

1. You will be contacted be telephone about one week after receiving the information letter and consent form to see if you have any questions about the study. You are free to call the Project Coordinator collect before that time at (415) 647-7439. At that time, an appointment will be made for the telephone interview.

2. You will sign the consent form and return it to the Project Coordinator in the self-addressed stamped envelope. The interview will take between 35-45 minutes to complete.

3. During the telephone interview, you will be asked various questions concerning your fall, the injuries you may have received, and working conditions at your place of employment.

4. Following the telephone interview, you will receive a very brief second call to determine the date you returned to work, if you have not returned to work at the time of the first telephone call. The second call will take approximately 2 minutes.

All of these procedures will be completed while you are in your own home or a place of your choosing to receive the telephone call.

C. Risks/Discomforts:

1. Some of the questions you may be asked may be personal, stressful, or of a sensitive nature to you. You can choose not to answer any question if you prefer.

2. If you choose, you can stop the discussion at any time.

3. **Confidentiality:** Participation in research may involve a loss of privacy however, your records will be handled as confidentially as possible. Only Ms. Gillen and her assistant(s) will have access to your records. **Your employer will not be contacted for any reason whatsoever in regard to this interview.** No individual names will be used in any reports or publications that may result from this study. On very rare occasions, research records have been subpoenaed, but this is very unlikely to occur.

D. Benefits:

There will be no direct benefit to you from participating in this study. However, the information that you provide may help the researchers better understand factors which affect how seriously workers are injured from falls.

E. **Costs:** There will be no costs to you as a result of taking part in this study.

F. **Reimbursement:** You will be reimbursed $25.00 for for your time and inconvenience. You will receive a check six to eight weeks after completion of the interview.

G. Questions:

If you have further questions, you may call Ms. Gillen collect at (415) 647-7439, Dr. Faucett at (415) 476-3221, and Dr. Osorio at (510) 450-2400.

If you have any comments or concerns about participation in this study, you should first talk with the investigator, Ms. Gillen. If for some reason, you do not want to do this, you may contact the Committee on Human Research, which is concerned with the protection of volunteers in research projects. You may reach the committee office between 8:00 and 5:00, Monday through Friday, by calling (415) 476-1814, or by writing: Committee on Human Research, Box 0962, University of California, San Francisco/San Francisco, CA 94143.

H. Consent:

I have been given a copy of this consent to keep. I have talked to Ms. Gillen, Dr. Faucett or Dr. Osorio about this study and have had my questions answered.

Participation in Research is Voluntary. I am free to decline to be in this study, or to withdraw from it at any point.

If I agree to participate I should sign below.

_______________ ____________________________________

Date Signature of Study Participant

____

Name (Please Print)

_______________ ____________________________________

Date Signature of Person Obtaining Consent

10/09/95

Universidad de California, San Francisco
Departamento de Servicios de Salud de California, División de Salud Ocupacional

CONSENTIMIENTO PARA PARTICIPAR
Caídas no mortales de los trabajadores de construcción
Pronósticos de la severidad de la lesión
Entrevista de participante

A. Propósito del proyecto:

Marion Gillen (Coordinadora del proyecto) es un candidato para un diploma de doctorado en la Universidad de California San Francisco, en el Departamento de Enfermería. Dra. Julia Faucett es su asesora. Para cumplir en parte con los requisitos de su diploma, y junto con el Departamento de Servicios de Salud de California, hace un estudio sobre los trabajadores de construcción que se han caído y se han lastimado. Se utilizarán los resultados de este estudio para ayudar a enfermeras y médicos a entender la gama de lesiones que ocurren cuando los trabajadores de construcción se caen y cuáles factores contribuyen a la severidad de sus lesiones cuando se caen. Pedimos que usted participe en este estudio porque es un trabajador de construcción que se ha caído en el trabajo.

B. Procedimientos:

Si usted da su permiso para participar en la entrevista, ésto es lo que sucederá:

1. Se comunicará con usted por teléfono aproximadamente dos semanas después de recibir la carta y el formulario de consentimiento para ver si tiene preguntas acerca del estudio. Se puede llamar a la Coordinadora de proyecto por cobrar antes de éso al (415) 647-7439. En este momento, se hará una cita para la entrevista por teléfono.

2. Si tiene interés en participar en el estudio, usted firmará el formulario de consentimiento y enviarlo a la Coordinadora del proyecto en el sobre incluido. La entrevista tomará entre 45 minutos hasta una hora (35-45 minutos).

3. Durante la entrevista por teléfono, se le hará preguntas sobre su caída, las lesiones que haya tenido, y las condiciones de trabajo en su lugar de trabajo.

4. Después de la llamada, recibirá una segunda llamada para determinar la fecha en que volvió al trabajo, si no ha vuelto al trabajo durante el periodo de la entrevista. La segunda llamada tomará aproximadamente dos minutos.

Todos estos procedimientos se harán cuando está en su casa, o en otro lugar que usted desea para recibir las llamadas.

C. Posibles riesgos de participación:

1. Algunas de las preguntas pueden ser de tipo personal, sensitivo o causarle tensión. **Puede decidir no contestar cualquier pregunta, si así desea.**

2. Si así desea, puede terminar la entrevista en cualquier momento.

3. **Confidencialidad:** Su participación en el estudio puede incluir una pérdida de intimidad, sin embargo se tratará con sus archivos de la manera más confidencial posible. **No se comunicará con su patrón por ninguna razón con respecto a esta entrevista.** No se usarán nombres de individuos en cualquier informe o publicación como resultado de este estudio. En muy pocas ocasiones se han citado estos archivos para la corte, pero es muy poco probable que ésto ocurra.

D. Beneficios:

No habrá ningún beneficio directo para usted por su participación en este estudio. Sin embargo, la información que usted provee puede ayudar a los investigadores a entender mejor los factores que afectan la severidad de las lesiones de trabajadores que se han caido.

E. Costos: No habrá ningún costo para usted por haber participado en este estudio.

F. Recompensa: Usted recibirá $25 por su participación. Recibirá un cheque dentro de seis u ocho semanas después de terminar la entrevista.

G. Preguntas:
Si tiene más preguntas, puede llamar a Sra. Gillen por cobrar al (415) 647-7439, Dra. Faucett al (415) 476-3221, y a Dra. Osorio al (510) 450-2400.

Si tiene comentarios o preocupaciones sobre su participación en este estudio, debe hablar primero con la investigadora, Sra. Gillen. Si por alguna razón no quiere hacer ésto, puede comunicarse con el Committee on Human Research, lo cual se trata de la protección de los voluntarios en los proyectos de estudio. Puede comunicarse con su oficina entre las 8:00 am y las 5:00 pm, de lunes a viernes al llamar al (415) 476-1814, o al escribir al: Committee on Human Research, Box 0962, University of California San Francisco, San Francisco, CA 94143.

H. Consentimiento:
He recibido una copia de este consentimiento. He hablado con Sra. Gillen, Dra. Faucett o Dra. Osorio y he recibido respuestas a mis preguntas.

La participación en este estudio es voluntaria. Tengo la libertad de rehusar a participar en este estudio, o de dejar de participar en cualquier momento.

Si doy mi permiso para participar, debo firmar abajo.

____________________	______________________________
Fecha	Firma del participante en el estudio
	______________________________
	Su nombre y appelido (en letra de molde, por favor)
____________________	______________________________
Fecha	Firma de la persona que obtiene el consentimiento

School of Nursing
Department of Mental Health, Community and Administrative Nursing
San Francisco, California
94143-0608
415/476-1504
FAX: 415/476-6042

UCSF
University of California, San Francisco...A Health Sciences Campus

Dear

We are conducting a research study about injuries received by construction workers who fall. This research is designed to help us to understand the range of injuries that occur when workers fall. We are interviewing approximately 300 construction workers, some of whom have received minor injuries and some who have been more seriously injured. As a student at the University of California, San Francisco School of Nursing, I am conducting the study with my advisor, Julia Faucett, RN, PhD, and staff of the Occupational Health Branch of the California Department of Health Services. We obtained your name from a report that your doctor was required by law to submit to the state.

We are writing to you to ask you to participate in a 35-45 minute interview over the telephone. You will be sent a check for $25 for your time after the interview is completed. We will call you in approximately one week to set up an appointment for the interview. If you are unable to participate, please return the enclosed postcard immediately, and we will not contact you again. *Your participation in this study is voluntary.*

We will not call your employer for any information whatsoever and your employer will not know about your involvement in the study. All information is reported in summary form and you will never be identified in any reports. Any answers you give us will be kept confidential as far as is possible under the law.

The interview questions will concern your type of work, the injuries you received, and the environment in which you work. In order to be interviewed, you will need to: 1) *sign and return* the enclosed consent form; 2) when we call you, make an appointment for a telephone interview; 3) use a set of index cards during the interview (these will be mailed later); and 4) after the interview, *sign and return* an additional consent form allowing us to review your medical records from the day you fell.

The information you provide during the interview will be important in understanding how severely workers are injured from falls and what factors may determine how seriously they are injured. We hope you will participate. If you wish to contact us about the study, please feel free to call me collect at (415) 647-7439, or the Principal Investigators, Dr. Julia Faucett, at (415) 476-3221, or Dr. Ana Maria Osorio, at (510) 450-2400.

Sincerely,

Marion Gillen, RN, MPH
Project Coordinator

School of Nursing
Department of Mental Health, Community and Administrative Nursing
San Francisco, California
94143-0608
415/476-1504
FAX: 415/476-8042

University of California, San Francisco...A Health Sciences Campus
UCSF

Estimado

Estamos haciendo un estudio sobre las lesiones que los trabajadores de construcción tienen cuando se caen. Este estudio fue diseñado para ayudamos a entender la gama de lesiones que ocurren cuando los trabajadores se caen. Estamos entrevistando a aproximadamente 300 trabajadores de contrucción, algunos de los cuales que han tenido lesiones menores, y otros que han tenido lesiones más graves. Como estudiante en la Universidad de California, Escuela de Enfermería de San Francisco, dirigo el estudio con mi asesora, Dra. Julia Faucett, RN, PhD, y el personal de la División de Salud Ocupacional del Departamento de Servicios de Salud de California. Obtuvimos su nombre de un informe que su médico tuvo que dar al estado de acuerdo con la ley.

Le escribimos para pedir que usted participe en una entrevista por teléfono de 35-34 minutos. Después de terminar la entevista le enviaremos un cheque por $25 en agradecimiento por su participación. Le llamaremos dentro de una semana aproximadamente para hacer una cita para la entrevista. Si usted no puede participar, favor de enviamos inmediatamente la tarjeta postal incluida, y no le contactaremos otra vez. *Su participación en este estudio es voluntaria.*

No llamaremos a su empleador por ningún tipo de información y su empleador no sabrá nada sobre su participación en el estudio. Toda la información se reporta en forma de resumen y nunca se le identificará en cualquier informe. Todas las respuestas que usted nos dé se tratarán de la manera más confidencial posible de acuerdo con la ley.

En la entrevista le preguntaremos sobre su tipo de trabajo, las lesiones que usted tuvo, y el ambiente en que usted trabaja. Para ser entrevistado, usted tendrá que: 1) firmar y enviar el formulario de consentimiento incluido; 2) cuando le llamamos, hacer una cita para una entrevista por teléfono; 3) usar las tarjetas durante la entrevista (se las enviaremos por correo más tarde); y 4) después de la entrevista, firmar y enviar otro formulario de consentimiento que nos permitirá revisar sus archivos médicos del día que usted se cayó.

La información que usted provee durante la entrevista será importante para entender qué tan severamente se lastiman los trabajadores a causa de las caídas y cuáles factores pueden determinar qué tan severamente se lastiman. Esperamos que usted participe. Si usted desea ponerse en contacto con nosotras con preguntas sobre el estudio, favor de llamarme por cobrar al (415) 647-7439, o a las Investigadoras principales, Dra. Julia Faucett, al (415) 476-3221, o a la Dra. Ana Maria Osorio, al (510) 450-2400.

Atentamente,

Marion Gillen, RN, MPH
Coordinadora del Proyecto

STATE OF CALIFORNIA—HEALTH AND WELFARE AGENCY PETE WILSON, GOVENOR

DEPARTMENT OF HEALTH SERVICES
OCCUPATIONAL HEALTH BRANCH
2151 Berkeley Way, Annex 11, Third Floor
Berkeley, CA 94704
(510) 540-2115
FAX (510) 540-3472

AUTHORIZATION TO RECEIVE MEDICAL INFORMATION

EXPLANATION:
This authorization to receive medical information is requested by the California Department of Health Services, Occupational Health Branch, and the University of California. All information released to the Department will be held in strict confidence. It will not be shared with any other agency, your employer, or union. It may be referred to as part of a statistical summary, but with no personal names or identification attached.

AUTHORIZATION:
I hereby authorize (your health care provider) ______________________________

Address: ____

City, State, Zip: ______________________________ Phone: __________

to furnish Ana Maria Osorio, M.D., of the Department of Health Services, any and all records concerning medical history, results of medical examinations,

services rendered and treatment given to __________________________ whose birth date
(your name)
is ____________________ on ____________________ for the following injury
(birth date) (dates of service)

____________________________ for purposes of review.

DURATION:
This authorization will become effective immediately and will remain in effect as long as necessary for Dr. Osorio to fully review these records.

I understand that my agreeing to release this information is voluntary and that the Department of Health Services will treat this information as confidential, in exactly the same way my physician does.

SIGNATURE OF PATIENT:

Signed: ______________________________ Date: ______________

Name of Patient: *(please print)* ______________________________

Address: ____

City, State, Zip: ____

NOTE: The California Department of Health Services complies with the terms of the Confidentiality of Medical Information Act of 1980, Section 56 of the California Civil Code and the CDHS Committee for the Protection of Human Subjects.

STATE OF CALIFORNIA—HEALTH AND WELFARE AGENCY PETE WILSON, GOVENOR

DEPARTMENT OF HEALTH SERVICES
OCCUPATIONAL HEALTH BRANCH
2151 Berkeley Way, Annex 11, Third Floor
Berkeley, CA 94704
(510) 540-2115
FAX (510) 540-3472

AUTORIZACIÓN PARA RECIBIR INFORMACIÓN MÉDICA

EXPLICACIÓN

A petición del Departamento de Servicios de Salud de California, División de Salud Ocupacional, y la Universidad de California, se presenta esta autorización para recibir información médica. Toda la información divulgada al Departamento se tratará de la manera más confidencial. No se la compartirá con ninguna otra agencia, su empleador, ni el sindicato. Puede que esta información esté incluida como parte de un resumen estadístico, pero sin ningún nombre o información personal adjunto.

AUTORIZACIÓN

Por la presente doy autorización a (proveedor de los servicios de salud)____________________

Dirección: ____

Ciudad, Estado, Código postal: ________________________ Teléfono: ____________

para dar a Ana Maria Osorio, M.D., del Departamento de Servicios de Salud cualquier y todos los archivos sobre la historia médica, los resultados de los exámenes, los servicios y tratamiento dado a,

____________________________ cuya fecha de nacimiento es _______________
(su nombre y apellido) (fecha de nacimiento)

en ______________________ para la siguiente lesión con el fin de revisar estos archivos
(fechas de servicio)

____.

DURACIÓN:

Esta autorización entrará en vigor inmediatamente y estará en vigor el tiempo necesario para que le Dra. Osorio pueda revisar completamente estos archivos.

Entiendo que doy mi consentimiento voluntariamente de dar esta información y que el Departamento de Servicios de Salud tratará esta información de manera confidencial, exactamente en la misma manera que mi médico.

FIRMA DEL PACIENTE:

Firmado: ____________________________________ Fecha: ____________________

Nombre del paciente: *(en letra de molde*, por favor): __________________________________

Dirección: ____

Ciudad, Estado, Código postal: ____

NOTA: El Departamento de Servicios de Salud de California cumple con los términos del Acta de Confidencialidad de Información Médica de 1980, Sección 56 del Código Civil de California y el Comité para la Protección de los Seres Humanos en Experimentos.

APPENDIX F

CONSTRUCTION SAFETY ASSOCIATION OF ONTARIO

Appendix F

Construction Safety Association of Ontario

74 Victoria Street Toronto Ontario M5C 2A5 • (416) 366-1501 • Fax No (416) 366-0232 • Watts No 1-800-387-0847

December 15, 1994

Ms. Marion Gillen, RN, MPH
635 San Bruno Ave,
San Francisco, California 94107,
U.S.A.

Dear Ms. Gillen

Re: Injury Coding

Thank you for your interest in our coding system. We are pleased to provide you with the sections you requested and permission to use them in your academic endeavours. The conditions described in your letter of November 25/94 are satisfactory to us.

We wish you well in your endeavours and look forward to seeing a copy of your final work.

If you have any questions, please do not hesitate to contact me.

Yours truly,

D. J. McVittie

Douglas J. McVittie,
Manager,
Technical Services

DJMc:cd

Note: We are moving to new facilities effective January 2/95. A copy of the new address and phone number is enclosed.

APPENDIX G

SAFETY CLIMATE MEASURE

Appendix G

ITEMS FROM THE SAFETY CLIMATE MEASURE - MODIFIED VERSION*

1. How important do you think the workers' safety practices are to the management of your company? Are they...*
   1 - very important
   2 - somewhat important
   3 - not too important
   4 - not at all important

2. How much do supervisors and other top management seem to care about your safety?
   1 - They do as much as possible to make the job safe
   2 - They are concerned about safety but could do more to make the job safe
   3 - They are really only interested in getting the job done as fast and cheaply as possible

3. How often does the foreman make you aware of dangerous work practices and conditions? *
   1 - regularly
   2 - occasionally
   3 - seldom
   4 - never

4. How often does the foreman praise you for safety conduct? *
   1 - regularly
   2 - occasionally
   3 - seldom
   4 - never

5. When you were hired by your present employer, were you given instructions on the safety policy, safety requirements of the company?
   1 - yes
   2 - no

6. Are there regular job safety meetings at your present job?
   1 - yes
   2 - no

7. How often is the proper equipment for your tasks available at your job site?
   1 - always
   2 - most of the time
   3 - occasionally
   4 - rarely
   5 - never

8. How much control do you feel you have yourself over what happens to your safety on the job?
   1 - almost no control
   2 - almost total control
   3 - primary control but luck is a factor
   4 - little control, mostly a matter of luck

9. Is taking risks part of the job?
   1 - very much
   2 - somewhat
   3 - not at all

10. How likely do you think it is that you might be injured on the job in the next 12-month period? Would you say it is?*
    1 - very likely
    2 - somewhat likely
    3 - not very likely
    4 - not at all likely
    5 - don't expect to be working

* = Indicates that question was modified.

From: Dedobbeleer, N., & Beland, F. (1991). A safety climate measure for construction sites. Journal of Safety Research, 22, 97-103.

APPENDIX H

DOCTOR'S FIRST REPORT

Appendix H

STATE OF CALIFORNIA

DOCTOR'S FIRST REPORT OF OCCUPATIONAL INJURY OR ILLNESS

Within 5 days of your initial examination, for every occupational injury or illness, **send two copies of this report to the employer's workers' compensation insurance carrier or the self-insured employer.** Failure to file a timely doctor's report may result in assessment of a civil penalty. **In the case of diagnosed or suspected pesticide poisoning, send a copy of** this report to Division of Labor Statistics and Research, P.O. Box 420603, San Francisco, CA 94142-0603, and notify your local health officer by telephone within 24 hours.

			PLEASE DO NOT USE THIS COLUMN
1. **INSURER NAME AND ADDRESS**			
2. **EMPLOYER NAME**			Case No.
3. Address No. and Street City Zip			Industry
4. Nature of business (e.g., food manufacturing, building construction, retailer of women's clothes)			County
5. **PATIENT NAME** (first name, middle initial, last name)	6. Sex ☐ Male ☐ Female	7. Date of Birth Mo. Day Yr.	Age
8. Address No. and Street City Zip		9. Telephone number ( )	Hazard
10. Occupation (Specific job title)		11. Social Security Number	Disease
12. Injured at No. and Street City		County	Hospitalization
13. Date and hour of injury or onset of illness Mo. Day Yr. Hour ______ a.m. ______ p.m.		14. Date last worked Mo. Day Yr.	Occupation
15. Date and hour of first examination or treatment Mo. Day Yr. Hour ______ a.m. ______ p.m.		16. Have you (or your office) previously treated patient? ☐ Yes ☐ No	Return Date/Code

Patient please complete this portion, if able to do so. Otherwise, doctor please complete immediately. Inability or failure of a patient to complete this portion shall not affect his/her rights to workers' compensation under the California Labor Code.

17. **DESCRIBE HOW THE ACCIDENT OR EXPOSURE HAPPENED** (Give specific object, machinery or chemical. Use reverse side if more space is required.)

18. **SUBJECTIVE COMPLAINTS** (Describe fully. Use reverse side if more space is required.)

19. **OBJECTIVE FINDINGS** (Use reverse side if more space is required.)
   A. Physical examination

   B. X-ray and laboratory results (State if none or pending.)

20. **DIAGNOSIS** (if occupational illness specify etiologic agent and duration of exposure.) Chemical or toxic compounds involved? ☐ Yes ☐ No

   ICD-9 Code ___ ___ ___ . ___ ___

21. Are your findings and diagnosis consistent with patient's account of injury or onset of illness? ☐ Yes ☐ No If "no", please explain.

22. Is there any other current condition that will impede or delay patient's recovery? ☐ Yes ☐ No If "yes", please explain.

23. **TREATMENT RENDERED** (Use reverse side if more space is required.)

24. If further treatment required, specify treatment plan/estimated duration.

25. If hospitalized as inpatient, give hospital name and location Date admitted Mo. Day Yr. Estimated stay

26. **WORK STATUS**—Is patient able to perform usual work? ☐ Yes ☐ No
   If "no", date when patient can return to: Regular work ____/____/____
   Modified work ____/____/____ Specify restrictions ________

Doctor's Signature ____________ CA License Number ________
Doctor Name and Degree (please type) ____________ IRS Number ________
Address ____________ Telephone Number (   )

FORM 5021 (REV 4) 1992

Any person who makes or causes to be made any knowingly false or fraudulent material statement or material representation for the purpose of obtaining or denying workers' compensation benefits or payments is guilty of a felony.