

A Retrospective Case-Control Study of Ladder Fall Accidents

H. Harvey Cohen and Lee-jean Lin

Epidemiological techniques have become more sophisticated in recent years as applied to investigating major public health issues such as smoking, heart attacks, and traffic fatalities. This study demonstrates the value of using an epidemiologic approach for identifying risk factors associated with ladder fall accidents occurring on the job. The results of structured interviews with workers recently experiencing ladder falls at work were compared with those of control workers in the same company, who were ladder users but had not had a previous ladder fall, through various univariate and multivariate statistical techniques. In all, 123 case and 142 control subjects were compared in over 200 items classified into four categories of variables: (a) personal but nonoccupationally related (e.g., personality and life stress factors, risk-taking indicators); (b) personal and occupationally related (e.g., job experience, prior on-the-job injuries, job stressors); (c) working condition related (e.g., work schedule, work demands), and; (d) ladder-use related (e.g., hours worked on ladder, surface on which set up, presence of defective condition). The results confirmed the hypothesis that factors temporally closest to the accident event, (i.e., specific ladder use and working condition variables) are stronger predictors of ladder falls than variables further away from the event, namely, individual characteristics. This finding sheds light on the relative value of various types of accident control measures that can be taken since such risk factors are not only the most predictive, but are also those more easily dealt with by companies through various administrative and procedural controls.

Falls, according to the Bureau of Labor Statistics, account for about 20% of all occupational accidents. While most fall accidents occur on nonelevated walking and working sur-

faces, falls from ladders are second only to falls on stairways as the most frequent source of injury involving falls from elevation. Furthermore, such falls from heights are among the most severe. Some recent studies by the lead author and others for the National Institute for Occupational Safety and Health (NIOSH) have addressed the problems of falls on nonelevated walking and working surfaces (Cohen & Compton, 1982) in the course of performing one's job (Cohen, Templer, & Archea, 1985). However, little empirical research has been performed on the causes of ladder fall accidents. In addition to being a means of transit from one place to another, a ladder often serves as a temporary work platform. Being accident-

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free requires adhering to techniques of proper ladder selection, setup, and use. However, existing Occupational Safety and Health Administration (OSHA) and American National Standards Institute (ANSI) standards appear to address issues principally of ladder structural integrity. User performance standards, although accounting perhaps for the majority of ladder fall accidents, have not thus far been adequately addressed. To date, only three studies have looked at user behavior as a basis for ladder fall accident intervention.

Juptner (1976) investigated user behavior on five different rung shapes to find the configuration that would best govern a user's allowable reach extension on a ladder. Wider base, narrower top, rungs attached at a gentle curve to control reach, and rung surface composed of an elastic material to transmit information about foot balance are recommended ladder design features resulting from the study. Studies by Dewar (1976) and Irvine and Vejvoda (1977) concentrated on the relationship between angle of inclination of extension and straight ladder setup and user behavior. Angles of 70° and 71.9°, respectively, were recommended by each study, rather than the 75° angle promulgated by OSHA. In addition, Irvine and Vejvoda (1977) recommended performance criterion adopted by the National Fire Prevention Association (NFPA) to facilitate proper ladder setup instead of relying on user judgment to set up a "proper" angle of inclination. This consists of finding the correct angle of inclination by placing one's feet between the two rails of the ladder and reaching straight out such that a rung can be grasped. When this can be done, the extension or straight ladder is set up at the "proper" angle of inclination.

These studies, although useful, still shed no light on factors contributing to ladder fall accidents. Such an analysis requires use of epidemiological research methods to identify those risk factors predictive of a specified event — in the present case, a ladder fall accident.

Epidemiological techniques have become increasingly more sophisticated in recent years as applied to unravelling major public health issues. The links between smoking and lung cancer, and stress and increased risk of coronary heart disease are but two examples. William Haddon, an authority on accident prevention and research, and others have success-

fully applied epidemiological research designs to the study of traffic accidents. For example, the relationship between blood alcohol level and increased risk of traffic fatalities has been well established. However, epidemiological studies of occupational accidents have been few and limited. One such recent study examined the factors associated with increased risk of falls on stairways found in the workplace (Templer, Archea, & Cohen, 1985). The study, using a prospective case-control methodology, was successful in identifying several stairway designs and use factors that discriminated between persons experiencing and not experiencing fall-related incidents on stairs.

The objective of this study was to identify those factors predictive of occupational ladder fall accidents. It was hypothesized that factors closest to the accident event, i.e., ladder use and working condition variables, would be stronger predictors than variables further away from the event, namely, individual characteristics. If such a finding were found to be true, then the potential for using epidemiological research designs would be demonstrated for not only identifying potential risk factors, but also for the direction productive accident countermeasures should take. The specific epidemiological approach employed was a retrospective case-control research design.

A review of the occupational safety literature suggested a list of factors potentially associated with increased risk of falls from ladders on the job. Factors were grouped according to an ergonomic systems model in an attempt to look at features of the person/equipment/environment interface. These factors included:

1. Personal but nonoccupationally related variables, such as workers' body dimensions and physical characteristics, health problems, smoking or coffee drinking behavior, alcohol consumption, medication and/or drugs use, involvement of life stressors, risk-taking behavior, and personality factors.

2. Personal and occupationally related variables, such as job experience, job satisfaction, prior job accident experience, safety instruction, quality of supervision, involvement of job stressors, and attitude toward "locus" of accident control.

3. Working condition related variables, such as the presence of adverse environmental

conditions, poor housekeeping conditions, presence of obstructions, confinements, traffic congestion, insufficient workspace, work shift, and schedule and pace.

4. Ladder use related variables, such as ladder use exposure, experience with the ladder, choice of ladders, ownership of the ladder, ladder design features, ladder maintenance deficiencies, surface on which ladder was set up, and appropriateness of the ladder, etc.

METHODS

Data Collection Procedures

This study involved interviewing a worker (i.e., case) who had a ladder fall accident at work typically within two to four weeks of the accident and one or two additional workers (i.e., controls) in the same company, who were ladder users but had not experienced such an accident. These workers were then compared on a number of job, ladder use, and personal characteristics. The survey for this study covered several potential risk factors previously illustrated and was entirely of a voluntary nature. The study population consisted of all persons who use ladders in the workplace and, if injured on the job, reported to a hospital emergency room associated with the National Electronic Injury Surveillance System (NEISS). NEISS involves the reporting of all consumer product (including occupationally related) accidents treated at a representative sample of hospital emergency rooms located throughout the United States. Names of ladder accident victims were supplied through a NIOSH interagency agreement with the Consumer Product Safety Commission (CPSC) which operates NEISS.

The in-scope definition included all types of portable ladders used on the job, including straight, extension, step, and job-made. The accident must have involved a slip/trip/misstep or fall from one of the above types of ladders while working on a job, which resulted in a hospital emergency room admission. Any accident incidental to intentional and purposeful ladder use, e.g., struck by falling ladder, cut on ladder part not involving a fall, use of ladder for purposes other than as working platform or means of going from one level to

another, were excluded from the study. The case/control notification and data gathering process is illustrated in Figure 1.

During the 18-month data collection period, approximately 150 accident sites were visited throughout the country, resulting in 123 in-scope cases and 142 control subjects being interviewed. Controls were randomly selected from a pool of ladder users at the case's company who had not experienced a ladder fall accident at home or at work. Identical ladder use survey forms were used during the interviews, except for reference to the critical event that for the case was their ladder fall accident and for the controls was the last time they used a ladder on the job. Only a few companies and ladder fall accident victims declined to participate in the study citing "not wanting to get involved" as the primary reason (even though they were assured that the study was for research purposes only and there were no OSHA compliance or loss control investigative purposes whatsoever).

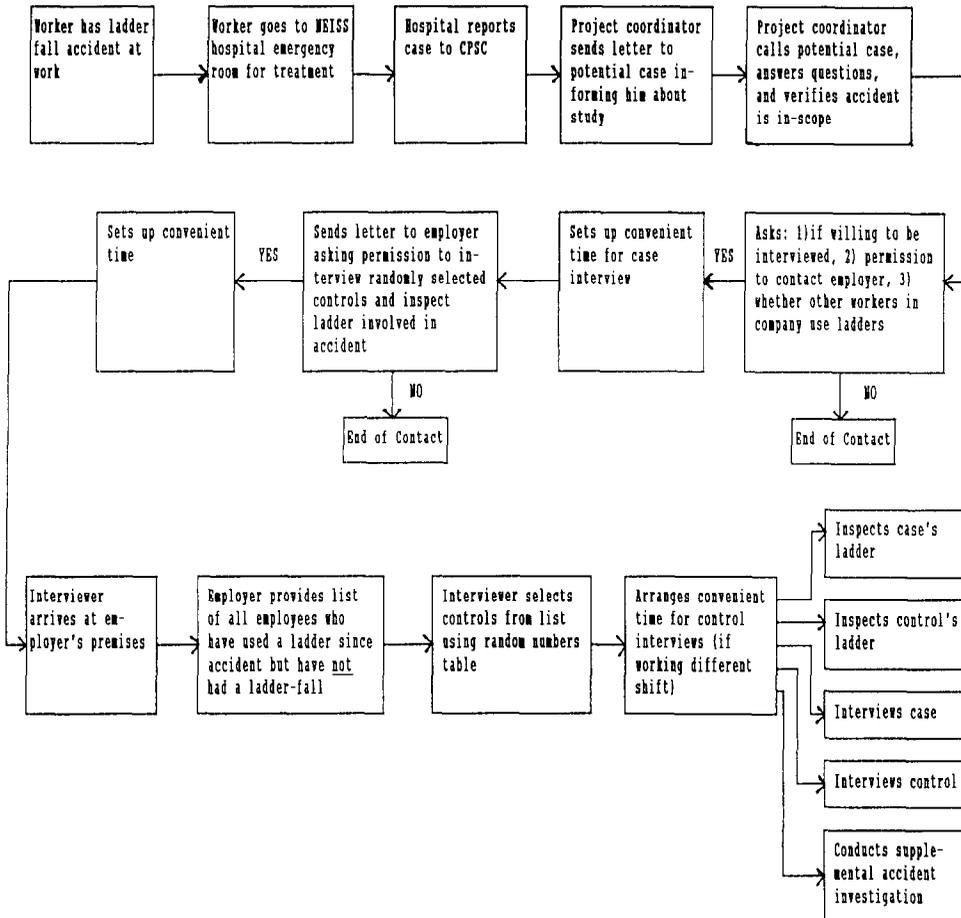
In addition to the survey, the study also involved observation and measurement of certain characteristics of the case's ladder, i.e., the ladder involved in the accident as compared with those of the ladder last used by the controls. A detailed investigation of the ladder fall accident was also conducted in order to obtain information about specific accident events and potential corrective actions. The analysis of such ladder accident scenarios is discussed in the following companion article.

Experimental Design

Much research suggests that accidents are nonrandom events with multiple causes. To help unravel these complex interactions among factors, a combination of univariate and multivariate statistics were employed using the Bureau of Labor Statistics (BMDP) (1985) computer programs.

The univariate analysis techniques used included: (a) Chi-square for both dichotomous and unordered categorical variables, (b) *t*-tests for continuous variables with normal distributions, and (c) nonparametric analyses (i.e., the Wilcoxon and Mann-Whitney Rank Sum tests) for continuous variables with skewed distributions and all ordered categorical variables. The purpose of such univariate

FIGURE 1
CASE CONTROL NOTIFICATION AND ACCESS PROCESS



analyses was to screen out potential risk factors used in subsequent multivariate analyses. The association between a specific independent variable and the dependent variable (i.e., the occurrence of a ladder fall accident) was first evaluated in univariate fashion without considering other variables. Both the odds ratio (i.e., an index of the strength of such an association) and the p -value obtained from univariate analyses served as screening criteria (with p -value equal to or less than .10) for purposes of identifying candidate risk factors.

Certain risk factors might be associated both with other risk factors and with the occurrence of ladder fall accidents. Consequently, stepwise logistic regression was the multivariate analysis technique used to determine the "best" combination of signif-

icant predictive variables (or predictors) of the ladder fall accidents while controlling for the effect of the remaining variables. The logistic equation was fit by the method of maximum likelihood. This analysis technique may be used when the dependent variable is a binary variable coded as 1 or 0 (e.g., the occurrence of a ladder fall accident vs. no accident). The risk factors selected from previous univariate analyses generally fell into four major categories as described previously, namely; (a) personal but nonoccupationally related factors; (b) personal and occupationally related factors; (c) working condition factors; and (d) ladder use factors. Thus, four separate stepwise logistic regression analyses were performed for the four major groups of predictors accordingly. Finally, a summary analysis was

performed to determine the relative impact of the four risk factor groups as predictors of the occurrence of ladder fall accidents. In this way, those factors most predictive of a ladder fall accident could be identified and evaluated for their relative risk. The four risk factor categories could be viewed along a continuum of temporal proximity to the actual ladder fall accident events. Those furthest from the event, namely personal but nonoccupationally related variables, were discussed first, followed by personal and occupationally related variables, working condition related variables, and lastly, ladder use related variables.

RESULTS

Personal but Nonoccupationally Related Variables

Table 1 shows the personal but nonoccupationally related variables which were identified as candidate risk factors based on the initial screening through univariate analyses. A plus (+) sign in Table 1 indicates that the presence of a particular risk factor is associated with a higher probability of the occurrence of

a ladder fall accident while a minus (-) sign indicates that it is associated with a lower probability of such an accident. It was found that the driver's license of a ladder fall accident victim was more likely to have been suspended or revoked than that of a ladder user control subject (Chi-square = 4.81, $p = .03$), which may be indicative of differential risk-taking behavior. The odds ratio also shows that such a negative driving record was found 2.31 times more often among ladder fallers than nonfallers.

Certain life stressors, from the well known Holmes-Rae Scale, such as a change in sleeping habits and social activities, had similar impact on the likelihood of a ladder fall accident (Chi-square = 4.76, $p = .03$; Chi-square = 3.42, $p = .06$). Interestingly, workers with sons or daughters leaving home were much less likely to encounter ladder fall accidents than those with children at home. The risk ratio was about 1 to 3. One explanation is that a person's life may be more stressful when family obligations and financial commitments exist. On the other hand, workers who didn't live with their children were generally older in age (e.g., middle age). Such workers tend to have more on-the-job experience and, there-

TABLE 1
PERSONAL BUT NONOCCUPATIONALLY RELATED VARIABLES

Potential Risk Factors	p-value	Odds ratio*	Mean**
Driver's license suspended or revoked	.03	2.31	+
Involvement of life stressors, i.e. changes in:			
sleeping habits	.03	2.67	+
social activities	.06	2.48	+
son or daughter leaving home	.10	.30	-
Personality factors:			
emphatic in speech v. slow, deliberate speech	.05		case > control
many interests v. few interests outside work or home	.07		case > control

* The odds ratio is calculated only when a variable is dichotomous.

** Mean is calculated only when a variable is continuous. For dichotomous variables "+" indicates risk factors associated with a higher probability of fall accidents whereas "-" is associated with a lower probability of accidents.

fore, lower accident rates. Table 1 also indicates that victims of ladder falls were more likely to be emphatic in speech and have more interests outside work or home — two traits related to so-called “Type A” personality.

Three significant predictors were generated from the six personal but nonoccupationally related risk factors described above by using the stepwise logistic regression analysis. The logistic equations and their predictors for the personal but nonoccupationally related factors were:

$$p = 1 / \{ 1 + \exp [- (0.366(A1) + 0.529(A2) - 0.644(A3) - 0.039)] \}$$

where *p* represents the probability of the occurrence of a ladder fall accident, A1 driver’s license is suspended or revoked, A2 is the involvement of one life stressor (i.e., major change in sleeping habits), and A3 is the involvement of another life stressor (i.e., son or daughter leaving home). This equation indicates that, among all personal but nonoccupationally related risk factors, the probability of a ladder fall accident can best be accounted for by predictors A1, A2, and A3.

Personal and Occupationally Related Variables

Table 2 represents the results of the univariate analysis for personal and occupationally related variables. The odds ratios shown in Table 2 indicate that ladder users with prior on-the-job injuries and/or experiencing major

changes in working hours and conditions were 1.84 and 2.29 times, respectively, more likely to fall as ladder users with no such experiences (Chi-square = 2.67, *p* = .10; Chi-square = 3.74, *p* = .05, respectively). In addition, victims of ladder fall accidents tended to have a shorter length of employment (*U* = 7635, *p* = .06) and were more likely to believe that the occurrence of accidents was not under their own control than workers in the control group (*U* = 9533, *p* = <0.01). It is suspected that the latter may be more a result than a cause of an accident. It is not unusual that personal attitude (toward “locus” of accident control) changes after the accident. The logistic regression equation and the predictors generated from the significant risk factors were:

$$p = 1 / \{ 1 + \exp [- (0.308(B1) + 0.430(B2) - 0.221(B3) + 1.56)] \}$$

where *p* represents the probability of the occurrence of a ladder fall accident, B1 prior accident experience, B2 the involvement of a job stressor (i.e., major change in work hours and conditions), and B3 attitude toward “locus” of accident control.

Working Condition Related Variables

The results of the univariate analysis for working condition related variables presented in Table 3 show significant differences in shift schedule between workers who have and have not experienced ladder fall accidents. Workers on the evening or night shift

TABLE 2
PERSONAL AND OCCUPATIONALLY RELATED VARIABLES

Potential Risk Factors	p-value	Odds ratio*	Mean**
Prior on-the-job injuries	.10	1.84	+
Involvement of job stressor (i.e., major changes in working hours and conditions)	.05	2.29	+
Job experience	.06		control > case
Attitude toward “locus” of accident control	<.01		control > case

* The odds ratio is calculated only when a variable is dichotomous.

** Mean is calculated only when a variable is continuous. For dichotomous variables, “+” indicates risk factors associated with a higher probability of fall accidents, whereas “-” is associated with a lower probability of accidents.

TABLE 3
WORKING CONDITION RELATED VARIABLES

Potential Risk Factors	p-value	Odds ratio*	Mean**
Differences in shift	.02		
Number of hours on the job	<.01		case > control
Uncomfortable working posture	<.01	2.41	+
Control of work flow	.09		case > control
Requirements for strength	.09		case > control
Nature of job (i.e., consider job to be boring)	.07		case > control

* The odds ratio is calculated only when a variable is dichotomous.

** Mean is calculated only when a variable is continuous. For dichotomous variables, " + " indicates risk factors associated with a higher probability of fall accidents, whereas, " - " is associated with a lower probability of accidents.

were found six to seven times more likely to be involved in a ladder fall accident than those on the day shift. Victims of ladder fall accidents also tended to work longer hours than workers in the control group in an average workday ($U=14986$, $p<0.01$). Furthermore, they often were required to work in an awkward or uncomfortable position at the time the accident occurred (Chi-square = 8.33, $p = <0.01$) and did not have much control over the work flow (e.g., planning the order or the way they did their work; $U = 7720$, $p = 0.09$). In addition, ladder fallers were more likely to be assigned a job that required a lot of strength and more often considered their jobs to be boring. The predictors and the logistic regression generated for working condition related factors were:

$$p=1/\{1+\exp[-(+0.697(C1)+0.350(C2)+0.202(C3)-5.11)]\}$$

where p represents the probability of the occurrence of a ladder fall accident, C1 hours at work, C2 uncomfortable or awkward posture, and C3 nature of job (i.e., consider job to be boring).

Ladder Use Related Variables

Univariate analyses for ladder use variables revealed some interesting results as shown in Table 4. It was found that victims of ladder fall accidents often worked longer hours on

the ladder as compared with workers in the control group ($U = 9959$, $p = 0.05$), which indicates that fatigue and greater exposure may play important roles in ladder fall accident causation. Ownership of the ladder was also significantly associated with accident occurrence (Chi-square = 6.05, $p = 0.05$). Most of the ladders used on the job were provided by the company; however, the odds ratio shows that workers who used their own ladders on the job experienced twice as many fall accidents as those who used company ladders. Such a finding may result from the fact that companies are required to conform to certain safety regulations and, therefore, are more likely to perform regular inspection and maintenance on ladders while workers who own their own ladders are more likely to overlook such issues. It was also found that workers involved in ladder fall accidents usually had less experience with ladders and had no choice of appropriate ladders for the job.

With regard to the type of surface on which the ladder was set up, concrete was mentioned most frequently among all workers. However, grass was often the setup surface at the accident site, followed by ceramic tile and wood surfaces. Perceived slipperiness of the surface was also highly associated with ladder fall accidents. The risk is 4.7 to 1 when compared with "non-slippery" surfaces. On the contrary, soft (as opposed to hard) surfaces seemed to have an opposite effect. Soft surfaces tended to be associated with a low probability of lad-

der fall accidents. The use of defective or inappropriate ladders for the job is often hypothesized as a cause of ladder fall accidents. However, it is likely that these two risk factors may be correlated with the ownership of the ladder and whether or not workers have a choice of ladders to use on the job. The logistic regression and the ladder use related predictors generated were:

$$p = 1 / \{ 1 + \exp [- (0.002 (D1) - 0.097(D2)+0.873(D3)-0.814(D4)+1.15)] \}$$

where p represents the probability of the occurrence of a ladder fall accident, D1 time on the ladder, D2 type of surface, D3 characteristic of the surface (i.e., slipperiness), and D4 the use of an unsafe or inappropriate ladder.

Summarized Regression

A summarized stepwise logistic regression was performed for the purpose of quantifying the relative contributions of the four major risk factor categories (i.e., personal but nonoccupationally related risk factors, personal and occupationally related factors, working condition related factors, and ladder use related factors) in predicting the occurrence of a ladder fall accident. In this analysis, the key risk factors in each category were combined and entered into the logistic model. The result of

this procedure was a summarized logistic regression equation:

$$p=1/\{1+\exp[-(0.786(D)+1.29(C)+0.725(B)-2.35)]\}$$

where p represents the probability of the occurrence of a ladder fall accident, D ladder use related factors, C working condition related factors, and B personal and occupationally related factors.

It is interesting to see from this equation that the probability of an accident is accounted for by risk categories related to ladder use, working conditions, and personal/occupational factors; the personal but nonoccupationally related risk category was eliminated mathematically from the stepwise logistic equation. The relative importance of risk categories may be compared in terms of standardized coefficients (i.e., a multiple of the standard deviation of each predictor). Such standardized coefficients show that working condition factors were the "most important," whereas personal and occupationally related factors were the "least important" among the three predictor category of variables in predicting the occurrence of a ladder fall accident.

The quantity exponential of the coefficient may be interpreted as the logistic odds ratio of being involved in a ladder fall accident with one predictor after adjusting for the linear

TABLE 4
LADDER USE RELATED VARIABLES

Potential Risk Factors	p-value	Odds ratio*	Mean**
Hours worked on ladders	.05		case > control
Ladder ownership (condition/responsibility)	.05	2.07	
Experience with ladders	.09		control > case
Choice of ladders	.04	.57	-
Surface on which ladder was set up	.02		
Condition of surface (i.e. slipperiness)	<.01	4.70	+
Characteristics of surface (i.e. softness)	.06	.47	-
Use of defective ladder	.09	2.33	+
Use of an unsafe or inappropriate ladder	<.01	5.11	+

* The odds ratio is calculated only when a variable is dichotomous.

** Mean is calculated only when a variable is continuous. For dichotomous variables, " + " indicates risk factors associated with a higher probability of fall accidents, whereas " - " is associated with a lower probability of accidents.

effects of the remaining predictors. Thus, the logistic odds ratio for the working condition factors was 3.63 while controlling ladder use factors and personal/occupationally related factors. The odds ratios for the ladder use factors and the personal/occupationally related factors were 2.20 and 2.06, respectively. Such ratios are consistent with the "relative importance" of each predictor derived from the standardized coefficients.

DISCUSSION

The results of the study successfully demonstrate the value of using an epidemiologic approach for the purpose of identifying risk factors associated with ladder fall accidents occurring on the job. The results of the statistical analysis are consistent with the hypothesis that factors such as ladder use behavior and work environment have a more significant impact on the occurrence of occupational ladder fall accidents when compared with other factors, such as personal characteristics. The stepwise regression analysis also identified specific interactions of multiple factors involved in occupational ladder fall accidents. Such interactions can serve as guidelines toward the design and implementation of useful countermeasures for accident prevention. Three major risk factor categories (i.e., working condition related factors, ladder-use factors, and personal/occupationally related factors) and their respective roles in the control of ladder fall accidents are discussed in turn.

By examining the working condition related risk factors and predictors in the regression equation, it was found that fatigue may be the common element across most of the risk factors. For example, working long hours, in evening or night shift, or in an awkward and uncomfortable position were problems more likely to be cited by the victims of ladder fall accidents. Such factors tend to make a job more demanding and may result in fatigue and, in turn, the occurrence of an accident. On the other hand, workers who reported getting bored on the job were also more likely to experience a ladder fall. Inattentiveness and carelessness may be the primary contributors here. Tasks with work flow, over which workers have no control, may contribute to

fatigue and inattentiveness. Workload and time constraints may be so demanding that work planning becomes difficult. However, the task may be simple, routine, and perhaps boring. Therefore, planning the way to do the work becomes unnecessary.

Consequently, administrative controls such as work schedule planning and redistribution of the workload should be considered for reducing or eliminating unfavorable working condition related risk factors that contribute to fatigue and inattentiveness.

As to improving working posture, worker on-the-job training may be necessary since workers may have to be in different and constantly changing job sites where permanent modification of the work environment may not be possible. Although training should not be regarded as a panacea for unfavorable working conditions, workers still need knowledge with respect to what procedures to use and what postures to avoid to at least minimize the risk of injury.

Ladder use factors significantly associated with the occurrence of a ladder fall accident were found to be specifically related to ladder maintenance and design, as well as the surface on which the ladder was set up. The last factor is especially important because two out of four predictors shown in the regression equation were surface-related predictors (i.e., the type of surface and slipperiness of the surface). Surfaces typically characterized by low coefficients of friction such as ceramic tile, grass, and wood were more often mentioned in the accident descriptions. Slipperiness can be reduced by cleaning the surface on which the ladder is set up and/or fitting the ladder with functional and well maintained slip-resistant safety feet. If a low coefficient of friction is still a concern after such actions are taken, workers should consider using ladders with safety hooks, having coworkers hold the ladder at the base during use, or perhaps selecting other types of ladders (e.g., step ladders with safety locks instead of straight ladders). Such procedures or alternatives should be disseminated to workers during job training and reinforced regularly to ensure workers' awareness.

Defective or unsafe ladders should be labeled and put out of service immediately. Workers sometimes use such ladders due to

lack of awareness of a problem, or worse, due to a shortage of ladders. Thus, ladders with defective parts which would potentially weaken the strength of the structure should be repaired or discarded immediately.

Personal and occupationally related predictors included prior job accident experience, changes in working hours and conditions, and attitude toward the "locus" of accident control. Such results indicate that employers should avoid frequent changes in workers' schedules and working conditions. Prior job related accident experience may be related to workers' attitude toward safety. Such predictive factors should be analyzed and incorporated into accident prevention programs so that workers can benefit from previous accident experience rather than reinforcing a negative attitude toward accident prevention.

The summarized regression analysis indicates that personal and nonoccupationally related factors, i.e., those factors furthest removed from the accident event, are not significant contributors to the occurrence of ladder fall accidents. Such a result sheds some light on the direction for implementation of a ladder accident prevention program. It indicates that the use of ladders through administrative controls, on-the-job training, and job

design are the most fruitful approaches for control of such accidents as opposed to measures aimed at influencing individual factors (e.g., risk-taking behavior, accident repeaters) or life stress factors which are extremely difficult to implement effectively. It would be extremely beneficial to understanding the most productive approaches for accident control if this finding were shown in subsequent research to be true for occupational accident occurrences other than ladder fall accidents.

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