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Correlates of Work Injury Frequency and Duration Among Firefighters

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This study examined demographic, personality, and economic incentive correlates of workplace injuries suffered by 171 firefighters over a 12-year period. Results showed that female firefighters experienced more injuries than male firefighters. Several Minnesota Multiphasic Personality Inventory (MMPI) scales (Conversion Hysteria, Psychopathic Deviate, and Social Introversion) were positively related to injury frequency. Regression analyses revealed that age, tenure, gender, marital status, type of injury, and wage variables were significant when predicting the duration of injuries as well as an interaction between marital status and gender. Two MMPI scales (Psychopathic Deviate and Schizophrenia) were also significantly related to injury duration. Indemnity cost estimates were calculated. The results underscore the importance of distinguishing the duration of injury from the occurrence of injury.

National statistics show that firefighters are at high risk for injuries while on the job ("1996 U.S. Firefighter Injuries," 1997) because of their exposure to environmental hazards. The risk of a fatal incident for firefighters is also three times greater than for all workers (Clarke & Zak, 1999). Given this relatively high risk of injury, identifying true correlates of injury risk for this occupational group is particularly important. Although enormous effort has been directed to countermeasures ranging from improved protective clothing and equipment to more effective health and safety regulations, we know relatively little about how individual difference factors influence firefighter injuries. Knowledge of personal differences associated with accident occurrences and severity can be applied to job assignment, safety training, supervision, and return-to-work intervention (Hansen, 1991).

Frone (1998) noted several different categories of potential predictors of injuries in his discussion of adolescent workers, including demographics, personality, substance use, health, and employment factors. In the present study, we expanded his model in several ways. First, we differentiated between injury frequency and injury duration as two different outcome variables. Injury frequency refers to the number of injuries suffered by a firefighter within a certain time period; injury duration is time elapsed between date of injury and first-return-to-work date and is commonly used as a proxy for injury severity in the workers' compensation literature (see Butler, 1994; Johnson & Ondrich, 1990). Although these two outcomes of injury are closely related in the sense that duration is only relevant after an injury occurs and that both of them have important cost implications (Butler & Worrall, 1985), theoretically they may have different antecedents. Second, we examined a broader set of demographic, personality, and economic incentive variables affecting workplace injuries among firefighters while controlling for other factors that are also potential correlates of injuries. Third, personality data were gathered at the time of hire and correlated with subsequent injuries over a 12-year period, thus making this a predictive design.

Correlates of Workplace Injury Frequency and Duration

Demographics

Gender, tenure, and age have been found to be associated with the frequency of workplace injuries. Frone (1998) reported that adolescent boys had more work injuries than did adolescent girls and suggested that such observed differences were a result of differential occupational exposure to risk and on-the-job

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substance use among boys and girls. However, adult men typically file fewer claims for workplace injuries than women when controlling for occupation (Butler, Hartwig, & Gardner, 1997; DeBobes, 1986; Hirsch, Macpherson, & DuMond, 1997). For example, DeBobes (1986) noted that women had a 45% greater accident rate than men. This was attributed to the disproportionate amount of external responsibilities that women have to contend with before and after work. In the present study, we examined the injuries of both men and women of the same occupation, in which presumably the exposure to injury risk is the same for both groups. We predicted, on the basis of previous literature, that female firefighters will experience more workplace injuries than male firefighters.

Age is generally related to tenure. As a result, it is inaccurate to discuss tenure's effects on injury without controlling age, and vice versa. In this study, we included age and tenure simultaneously to examine their independent impact on injuries. Frone (1998) presented alternative models in which tenure is related to injuries. One model assumes that tenure is a proxy for experience, and that with more experience, workers are less likely to injure themselves. Alternatively, more experienced and longer tenured employees might be assigned more hazardous tasks and duties, and therefore be more likely to be injured. Previous empirical research shows mixed findings on the nature of the relationship: Cellier, Eyrolle, and Bertrand (1995) reported a negative relationship, whereas Frone (1998) reported a positive relationship. Iverson and Erwin (1997) failed to detect a significant relationship between tenure and injuries. Given the ambiguity of the literature, we made no directional prediction regarding the tenure and injury frequency relationship.

Prior research has shown age to be negatively related to the frequency of work injuries (e.g., Kingma, 1994; Kraus, 1985). A possible reason is that with increasing age, employees maintain a more cautious attitude toward risky behaviors, hence fewer injuries occur (Hirsch et al., 1997). Age, however, was shown to be unrelated to injuries among adolescents for whom the age range was restricted (Frone, 1998). Because the age range represented among the participants in our sample was wide (19–49 years), we predicted a negative relationship between age and workplace injury frequency.

We expected these demographics variables also to be related to the duration of an injury. Prior estimates of workers' compensation duration for workforce populations (not restricted to firefighters) indicate that younger workers have shorter claim duration than do other age groups (Butler et al., 1997; Butler & Worrall, 1985; Johnson & Ondrich, 1990). The biology of aging makes it clear that age is associated with a decline in physical hardiness or recovery speed from tissue damage (Butler et al., 1997); as a result, older workers need more time to recover from the injuries experienced on the job. Therefore, we expected age to be positively related with injury duration. We also tested the impact of tenure on injury duration while controlling for age, but we made no specific prediction of the tenure–duration relationship.

Gender is another commonly studied correlate of injury duration. Johnson, Baldwin, and Butler (1999) found longer indemnity duration for injured female workers. We therefore expected that female firefighters will have longer injury durations. As to marital status, Butler and Worrall (1985) and Worrall, Appel, and Butler (1987) found that married workers had longer recovery periods than nonmarried workers, controlling for gender. Generally, lost wages of injured workers are not fully replaced under workers' compensation (most states have a replacement rate of 67%, i.e., two thirds of the work-time wage loss can be compensated up to a statutory maximum); therefore, there is an economic incentive for workers to return to work earlier. The opportunity cost of remaining out of work is most likely lower, however, for married workers who have a working spouse. Thus, married workers may have less financial incentive to return to work and might tend to stay longer on disability. Consequently, we expect married firefighters to have longer duration periods than unmarried firefighters.

There is also some reason to expect an interaction between marital status and gender on injury duration. Hirsch et al. (1997) showed that workers' compensation claim rates were different according to the marital status and gender of the employee. Although the pattern of results for marital status was similar for men and women, the differences observed among men were small and insignificant, suggesting an interaction. Hirsch et al. (1997) suggested that such differences might occur because of differential income "needs"—those employees with greater needs (e.g., having fewer alternative sources of income) take fewer risks and have a greater incentive not to forgo earnings in the event of minor injuries. Thus, unmarried women are expected to demonstrate a lower injury duration rate than married women, whose spouses are likely to be working. Hence, we predicted an interaction between gender and marital status, specifically that lower injury duration rates

will be observed for unmarried women than for married women but no differences between married and unmarried men.

Personality Constructs

A number of personality constructs have been hypothesized to be related to the frequency of workplace injury, and there is some empirical support for these propositions. For example, Hansen (1991) found considerable support for the proposition that measures of general social maladjustment (e.g., delinquency, sociopathic attitudes, drinking, and authority problems) and measures of neuroticism were related to accidents. Thus, there is reason to believe that the constructs assessed using the Minnesota Multiphasic Personality Inventory (MMPI) may be related to on-the-job injuries. MMPI is the psychometric test most frequently used for screening police officers (Burbeck & Furnham, 1985) and has also been widely used in other high-risk or sensitive jobs such as nuclear power plant workers and firefighters (Kelley, Jacobs, & Farr, 1994). Past studies show that workers' compensation claim samples differ from norm groups on several MMPI scale scores (e.g., Gandolfo, 1995; Hersch & Alexander, 1990; Repko & Cooper, 1983). These studies suffer, however, because they are conditional on employees having already reported a workers' compensation claim, and they fail to establish a direct correlation between MMPI scales and workers' compensation claims. Although no study has directly examined the predictive efficiency of MMPI scale scores with injuries, particular MMPI scales seem logically related to workplace injuries, or at least to the reporting of injuries.

The Hypochondriasis (Hs) scale was developed on a group of patients with neuroses who showed an excessive concern about their health, presented a variety of somatic complaints with little or no organic basis, and rejected assurances that there was nothing wrong with them. High scorers typically see themselves as physically ill and seek medical explanations and treatment for symptoms (Graham, 1993). Worries over their physical health dominate their life and often seriously restrict the range of their activities and interpersonal relations, possibly increasing the risk of injury. Past research supports a positive relation between Hs and workplace injuries (Gandolfo, 1995; Repko & Cooper, 1983).

The Depression (D) scale was developed on psychiatric patients with various depressive reactions or with a depressive episode of a manic-depressive disorder. High scorers tend to feel sad, blue, unhappy, and pessimistic about the future. Several studies have reported that depression was implicated in accident causation (e.g., Craske, 1968; Selzer, Rogers, & Kern, 1968). Iverson and Erwin (1997) suggested the chronic experience of negative emotional status might lead to lapse in attention or higher levels of distractibility, thereby increasing the likelihood of injury at work. High depression scores also indicate individuals who report physical complaints, sleep disturbances, weakness, fatigue, loss of energy, poor concentration, and so on (Graham, 1993). Thus, firefighters who are depressed may be more vulnerable to injuries when fighting fires, which is an extremely physically demanding and dangerous job.

The Conversion Hysteria (Hy) scale was constructed on patients who exhibited some form of sensory or motor disorder for which no organic basis could be established. People with elevated Hy scale scores often feel overwhelmed and tend to develop symptoms when under stress (Graham, 1993). We therefore expected firefighters with higher Hy scores to report more injuries. Past research provides support for this assertion (Gandolfo, 1995; Hersch & Alexander, 1990).

The Psychopathic Deviate (Pd) scale was developed on patients diagnosed as having psychopathic, asocial, or amoral type personalities. High scores on this scale indicate people who have difficulty incorporating the values and standards of society, are rebellious toward authority, tend to act without considering the consequences of their actions, show poor judgment and take risks, and tend to be aggressive (Graham, 1993). Logically then, individuals scoring on the high end of the Pd scale seem more likely to ignore rules and regulations regarding safety and health, resulting in an increased risk of injury. Drivers with various social maladjustment problems such as irresponsibility and authority problems are found to have higher accident rates (McGuire, 1972). Furthermore, high scorers on the Pd scale may rush to complete a task without adequate consideration of the consequences, putting themselves (and others) at a higher risk for error and accidents. Hansen's (1991) review of the literature relating impulsivity to accidents also supports the notion. Additional evidence is provided by Bigos et al. (1991), who found a positive relationship between the Pd scale and workplace injuries.

On the basis of the literature cited above, we expected that the MMPI scales of D, Hs, Hy, and Pd would be positively related to injury frequency. We also examined the relationships of other major clin-

ical MMPI scales against injury frequency but made no specific predictions.

Personality may be more directly related to duration of injuries rather than the number of injuries suffered among firefighters. Once someone leaves the workplace because of injury, work norms are less important. Therefore, the decision to return to work is more likely to be a function of personality factors than the decision to miss work. The absenteeism literature makes just this argument: Attitudes and individual differences are more important when normative constraints on attendance are reduced (e.g., Johns, 1997). Hence, firefighters with elevated MMPI profiles might be more likely to stay off the job longer after an injury. Given the paucity of existing research along this line, we tested the relationships between various MMPI scales and duration of injuries but made no hypotheses regarding the direction for any particular scale and the duration of workplace injuries.

Economic Incentive Factors

We also expected the duration of workplace injuries to be related to economic incentive factors such as workers' wage and potential workers' compensation benefits. In a study of injury duration for workers who reported low-back injuries in Illinois, Butler and Worrall (1985) found that the higher the preinjury wages, the shorter the expected duration of the claim. The model adopted to explain this result was that higher preinjury wage provided more economic incentive for injured workers to return to work. On the basis of this theory and previous literature, we expected the weekly wages of the firefighters prior to their injury to be negatively related to the duration of their injuries.

Although all workplace injuries filed in our sample state had an identical 67% wage replacement rate and were subject to the same statewide maximum payment, the firefighters were sometimes entitled to Injury-on-Duty (IOD) benefits. For firefighters, only lost-workday injuries occurring during a fire emergency run were to be considered as IOD claims and were reimbursed at 100% of lost wages. Other valid injuries, such as those occurred while administering emergency medical aid, are filed as an ordinary workers' compensation claim and lost time is compensated at two thirds of the preinjury wage rate. Butler and Worral (1985) found that the greater the workers' compensation benefits, the longer the duration of the injury. On the basis of this literature, we expected lost-time IOD claims to be longer than lost-time non-IOD claims.

Method

Sample Description

The study was conducted on the basis of data drawn from the fire department of a major midwestern U.S. city. Injury data, personality scores, wage, demographic, and other relevant information were collected from the employees' risk management, medical, and personnel files maintained by the fire department. Workers' compensation data were available starting from 1987. Therefore, we chose January 1, 1987 to December 31, 1998 as the studying period. A total of 194 nonclerical employees were hired during this period, and all of them took the MMPI as part of the psychological evaluation during the application process. Few individuals were screened out because of elevated MMPI profile scores. Complete MMPI scores were available for 171 employees. We based our model estimates on these 171 employees. Statistical tests showed that the sample did not differ from those 23 firefighters with missing MMPI scores in terms of gender, age, and ethnicity. All of the firefighters in the sample worked full time. The majority of the firefighters in this sample were male (83%) and Caucasian (68%). The minority racial breakdowns were as follows: 32 African Americans (19%), 6 Hispanic (4%), 4 Asian Pacific Islanders (2%), and 12 American Indian or Alaskan Native (7%). Compared with the total of 402 employees (including the 208 employees hired before 1987) serving in the fire department on December 31, 1998, the sample contained greater number of female and minority employees, reflecting the recent efforts on the part of the city to employ a more diverse group of employees. Firefighters in this sample occupied a variety of positions: firefighter, fire motor operator, fire captain, battalion chief, and district chief, among others.

The workers' compensation claim records provided information on all injury claims filed by fire department employees from 1987 to 1998. During the 12-year period (1987–1998), 765 claims were filed, of which 1.4% were denied as valid claims. Only those claims that were judged as valid were used in our analyses to represent an injury occurrence. Records with obvious coding errors (e.g., return-to-work date was earlier than injury date) were also deleted, leading to 678 lost-time injuries used for the duration analysis. The per capita injuries experienced for firefighters over the whole sample period ranged from 0 to 15.

Measures

Dependent variables. The two dependent variables of major interest in this article were injury frequency and injury duration. Injury frequency was measured by a simple count of the number of injuries filed for a firefighter for each particular calendar year in which the firefighter was employed. We determined the duration of each injury by calculating the elapse time between an injury and a firefighter's return to work. Almost all claims had been closed by the end of 1998, so most insurance payments had been made. However, four injury claims were still open by the end of 1998.

indicating that the injured workers had not completed their spells on disability and were continuing to receive workers' compensation benefits. These continuing status recipients are usually referred to as *right-censored* (e.g., Butler & Worrall, 1985).

Demographics. Gender was coded as 1 if the firefighter was female and 0 if male. Age and tenure were coded in years. Marital status was coded as 1 if the firefighter was married as of the date of injury and 0 if not married. Data on marital status were available for firefighters who were injured but not for those individuals for whom no injury claims were made. Thus, it was only included in analyses predicting injury duration.

MMPI scales. The MMPI is one of the mandatory screening tests for firefighters in this particular city and has been used for more than 20 years. Until 1991, the first version of the MMPI was administered. Since 1993 (no one was hired in 1992), the MMPI-2 has been administered. Although these two versions differ, the 10 clinical scales are comparable using *T* scores (Graham, 1993). These *T* scores for 9 of the clinical scales were used for our analyses. The Masculinity–Femininity scale was not used because it has opposite interpretation for female and male participants. Longitudinal studies (Costa & McCrae, 1986) demonstrate that individual differences in personality are highly stable in adulthood. Pancoast and Archer (1988) found stability in the MMPI scale scores of normal adult samples across 40 years. R. L. Greene (1990) also found that the validity and clinical scale scores were very stable over 40 years in samples of psychiatric patients. Thus, the fact that the MMPI data for the present study were collected over a 12-year period is unlikely to have much effect on the reported scores.

Economic incentive variables. Data on the weekly wage for each firefighter who filed an injury claim were coded as a continuous variable. This variable was included only in the duration model because the information was only available for individuals who were injured. A dummy variable, IOD, was included in the duration model and was coded as 1 if the injury was approved as an IOD claim, and 0 if otherwise.

Other controls. Race was represented by two dummy variables: White, coded as 1 if the firefighter was Caucasian; and Black, coded as 1 if the firefighter was African American. The omitted ethnic groups include Hispanic, Asian, American Indian, and so on. In the injury duration model, two dummy variables, fire motor operator and fighter, were created to represent the type of position held by the individual firefighter at the time of an injury. The omitted categories include fire captain, chief, trainee, and so on. They served as control for different levels of risk exposure associated with different positions. Six dummy variables were created to represent different types of injuries in duration model. These variables represent injuries due to back sprain, other strains and sprains, burns or exposure to chemicals, fracture or laceration, contusion, and potential exposure to contagious diseases. For both the frequency and duration models, year dummy variables were created for each of the years from 1987 to 1997 (year 1998 was omitted and used as the comparison year) and served as control variables to capture any changes in the state's administration of workers' compensation as well as secular trends in the injury rates and duration that would be not explained by the demographic changes in the workforce.

Estimation Models

The annual injury count per person was used as the dependent variable in the injury frequency model. Because this count variable is clearly discrete and contains a substantial number of zeros and other small values, the negative binomial regression model was used to account for these attributes. The negative binomial regression has been used extensively in statistics and actuarial practice to model the number of insurance claims filed in a year (W. H. Greene, 1997). The estimated regression coefficient for an explanatory variable indicates the percentage change in the expected injury frequency, given a unit change in that explanatory variable. Stata (Release 6.0) was used to estimate the negative binomial regression. Because the data involved nonindependent data points (data were recorded for the same individuals over time), the robust and cluster options were used to adjust the covariance matrix to account for repeated measures across individuals (W. H. Greene, 1997; *Stata Reference Manual*, 1999; *Stata User's Guide*, 1999).

We also estimated injury duration for all firefighters who took time off work because of an injury. Survival analysis, which has its origin in medical statistics, has been widely applied to the study of unemployment spell (Kiefer, 1988) and the duration of nonwork spell due to injury (Johnson & Ondrich, 1990), and has recently been introduced to organizational psychology analyses of turnover and absenteeism (Johns, 1997; Morita, Lee, & Mowday, 1989). Survival analysis is well suited for identifying determinants of injury or nonwork spells. Although most of the injury claims had been closed by 1998, some were still open or right-censored. Right-censored observations represent a problem for ordinary regression models (e.g., Butler & Worrall, 1985) but can be readily modeled by survival analysis. Specifically, we used a Weibull Survival model. This is a commonly used model in the unemployment and workers' compensation literature (e.g., Butler & Worrall, 1985; Heckman & Singer, 1984). The Stata survival analysis program was used, again with the robust and cluster options to deal with the repeated measures aspect of the data. The resulting estimated regression coefficient for an explanatory variable is interpreted similarly to that in the negative binomial model: the percentage change in the expected duration given a unit change in that explanatory variable.

Results

Predicting Injury Frequency

Table 1 reports the means, standard deviations, and intercorrelations for the data used in the negative binomial regression for the frequency of injury data. As can be seen in Table 1, there was an average of 0.62 injuries per individual per year for the 171 firefighters. Inspection of the intercorrelations among these variables and the frequency of injuries suggests the presence of relatively low relationships between these variables and injuries in this sample—only five of the single-order correlations were significant at the .05 level: gender, tenure, the D scale, the Psychasthenia scale, and the Schizophrenia (Sc) scale.

Table 1
Means, Standard Deviations, and Intercorrelations for Frequency Models (N = 1,286)

Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. INJPYR[a]	0.62	0.84	—														
2. Female	0.17	0.37	.095	—													
3. White	0.73	0.44	.041	.088	—												
4. Black	0.14	0.35	−.029	−.094	−.667	—											
5. Age	32.86	5.07	−.040	.074	.120	−.125	—										
6. Tenure	4.64	3.41	−.071	−.024	.096	−.135	.678	—									
7. Hs	49.30	5.25	−.050	−.358	.027	−.140	−.007	.139	—								
8. D	48.16	6.88	−.066	−.199	−.032	−.140	.009	.183	.367	—							
9. Hy	53.97	6.45	−.024	−.236	.221	.233	.083	.282	.653	.234	—						
10. Pd	56.42	7.45	−.019	−.046	.129	−.078	.225	.230	.393	.223	.482	—					
11. Pa	52.61	7.16	−.045	.035	.008	−.150	.056	.185	.350	.152	.418	.416	—				
12. Pt	52.67	6.22	−.068	−.204	.193	−.120	.103	.253	.491	.413	.533	.547	.412	—			
13. Sc	52.78	6.32	−.063	−.082	.141	−.106	.153	.296	.580	.279	.615	.633	.473	.737	—		
14. Ma	55.26	8.70	−.025	.002	−.060	.016	.091	.218	.149	.074	.266	.175	.238	.252	.253	—	
15. Si	42.45	6.59	.002	−.018	−.004	.017	.138	.166	−.135	.405	−.194	−.031	.001	.189	.003	.103	—

Note. Over the 12-year period, each firefighter reported either no injuries or one or more injuries in each year; thus, the sample of 1,286 represented the number of observations or opportunities of injuries. $|r| > .055$, $p < .05$; $|r| > .072$, $p < .01$. Hs = hypochondriasis; D = depression; Hy = conversion hysteria; Pd = psychopathic deviate; Pa = paranoia; Pt = psychasthenia; Sc = schizophrenia; Ma = hypomania; Si = social introversion.
[a] INJPYR = number of injuries per year (1987–1998) per individual. For those years in which the employee did not have an injury, the value of INJPYR is zero.

Table 2 exhibits the results for the negative binomial model in which the natural log of the count of injuries per year per individual was the dependent variable. The impact of demographic and personality variables was estimated. The resulting chi-square was 64.05, indicating that the full model was significant at the .01 level. The pseudo R^2 statistics (see Sheridan, 1992) is .05; thus, a large portion of variance went unexplained.

In support of our hypothesis, female firefighters experienced a greater number of injuries compared with male firefighters ($p < .05$), with female firefighters reporting 33% more injuries than male firefighters. Contrary to our prediction, tenure and age were not significantly related to the frequency of injury in this sample.

Consistent with our predictions, the MMPI scales Hy ($p < .05$) and Pd ($p < .05$) were positively related with injury frequency. However, the MMPI scales of Hs and D failed to show significant relationships to the frequency of injuries. Another scale, Social Introversion (Si), was significantly related ($p < .05$) to the frequency of injuries when a two-tailed test was applied.

Among the year dummy variables, the years 1989 and 1993 were significant; there was a tendency in 1989 to report fewer injuries after controlling for the demographic changes across years, whereas there was a tendency in 1993 to report more injuries. No evidence was found for racial differences in their expected injury rates.

Table 2
Estimates of Negative Binomial Regression for Frequency Model (N = 1,286)

Variable	Unstandardized β	*SE*
Female	.330**	.133
Tenure	−.046	.026
Age	−.009	.014
Hs	.003	.016
D	−.013	.010
Hy	.022*	.013
Pd	.012*	.008
Pa	−.008	.008
Pt	−.012	.014
Sc	−.011	.013
Ma	.004	.006
Si	.020*	.010
α^a	.133	.073
$\chi^2(25)$	64.05	
Prob > χ^2	0.0000	
Pseudo R^2	.05	
Log likelihood	−1,324.5465	

Note. One-tailed tests were performed for female, age, Hs, D, Hy, and Pd. Two-tailed tests were performed for the remaining independent variables. Control variables, including 11 year dummies and two racial dummies, were omitted from the table. Hs = hypochondriasis; D = depression; Hy = conversion hysteria; Pd = psychopathic deviate; Pa = paranoia; Pt = psychasthenia; Sc = schizophrenia; Ma = hypomania; Si = social introversion.

[a] α is the overdispersion parameter. When $\alpha = 0$, the negative binomial model reduces to Poisson model. A likelihood ratio test showed that α was larger than zero and statistically significant in the sample, indicating the Poisson model would have underestimated the variance.

*$p < .05$. **$p < .01$.

Predicting Injury Duration

More information about individual claims was available in the duration model sample than in the frequency model sample. In addition to basic demographics and MMPI scores, the duration model sample also contained data for each record of injury about the injured firefighters' job title, marital status, wage rate, injury types, whether approved for IOD, and so on. Table 3 presents means, standard deviations, and intercorrelations for these variables. Table 4 presents the results of the survival analyses. The resulting chi-square for the overall model was 529.07 and was significant at $p < .01$. The pseudo R^2 statistics was .45, indicating 45% of the variance in injury duration was explained by the model we specified.

Inspection of Table 3 shows that the average length of injury duration for this sample was 10.04 days. Again, the zero-order correlations between the duration of injury and other variables were consistently small—all were under .10, except IOD, which had a correlation of .18 with duration.

Table 4 shows that female firefighters and married firefighters had significantly longer claim durations, consistent with our hypotheses. The interaction between gender and marital status was also statistically significant, but the nature of the interaction was not consistent with our hypothesis. Compared with unmarried male firefighters, married female firefighters had a 38% shorter injury duration, unmarried female firefighters had a 49% longer injury duration, and married male firefighters had a 52% longer injury duration. Tenure showed a significant negative relationship with duration. For each additional year of tenure, injury duration decreased by 27%. Consistent with our hypothesis, age was positively related to injury duration, indicating that older firefighters took more time recovering from injuries. A 7% increase in injury duration accompanied each 1-year increase in age. Also consistent with our

Table 3
Means, Standard Deviations, and Intercorrelations for Duration Models (N = 678)

Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9	10
1. Duration (days)	10.06	56.67	—									
2. Female	0.23	0.42	.026	—								
3. White	0.76	0.43	−.012	.125	—							
4. Black	0.13	0.34	−.001	−.146	−.683	—						
5. Married	0.53	0.50	−.018	−.419	.029	.041	—					
6. Age	32.59	4.98	.005	.013	.198	−.146	.233	—				
7. Tenure	4.42	3.30	−.008	−.010	.111	−.137	.235	.686	—			
8. Fighter	0.80	0.40	−.012	.040	−.042	.029	−.123	−.220	−.481	—		
9. Fire motor operator	0.08	0.27	.032	−.064	.024	.002	.152	.161	.383	−.582	—	
10. Injury on duty	0.20	0.40	.181	.058	−.037	−.006	−.050	.062	.108	−.020	.008	—
11. Weekly wage	670.83	183.15	−.007	.015	.073	−.080	.156	.591	.897	−.571	.361	.109
12. Back sprain/strain	0.12	0.32	.020	.017	.009	−.009	.013	.021	.010	−.042	−.006	.179
13. Other sprain/strain	0.28	0.45	.088	−.007	.002	−.027	.029	.027	.028	.048	−.009	.134
14. Burn/exposure to chemicals	0.10	0.30	−.008	−.027	.028	−.027	.018	−.014	−.041	−.018	−.023	.020
15. Fracture/laceration	0.10	0.30	.006	−.024	−.043	.034	−.016	−.081	−.059	.016	−.003	.022
16. Contusion	0.08	0.27	−.038	.133	−.005	.027	−.072	.072	.044	−.012	−.027	−.081
17. Exposure to contagious disease	0.15	0.36	−.067	−.021	−.048	.044	−.047	.032	.038	−.006	.062	−.178
18. Hs	48.92	5.68	−.018	−.328	.036	−.172	.150	.001	.142	−.120	.056	−.027
19. D	47.54	6.78	−.033	−.208	.076	−.143	.090	−.066	.155	−.133	.103	−.084
20. Hy	53.67	6.45	−.007	−.273	.218	−.227	.187	.102	.318	−.152	.123	.019
21. Pd	56.26	7.52	.014	−.041	.187	−.113	.089	.226	.227	−.096	−.004	.024
22. Pa	52.04	6.78	−.003	.044	.129	−.169	.026	.108	.183	−.054	−.049	.058
23. Pt	52.18	6.44	−.044	−.220	.237	−.103	.156	.032	.223	−.108	.082	−.022
24. Sc	52.24	6.47	−.046	−.073	.192	−.146	.119	.179	.299	−.141	.090	−.007
25. Ma	55.06	7.79	.009	−.006	−.013	.026	.092	.102	.262	−.062	.078	.107
26. Si	42.44	6.31	−.042	−.067	−.002	−.003	.083	.131	.146	−.025	.140	−.082

Note. $|r| > .075$, $p < .05$; $|r| > .099$, $p < .01$. Hs = hypochondriasis; D = depression; Hy = conversion hysteria; Pd = psychopathic deviate; Pa = paranoia; Pt = psychasthenia; Sc = schizophrenia; Ma = hypomania; Si = social introversion.

expectations, IOD injuries significantly increased the duration time, indicating that firefighters whose loss of work time would be fully compensated took more time off. Specifically, an individual who made an IOD claim had injury duration 192% longer than one who made a non-IOD claim. Contrary to our expectation, the injured worker's weekly wage was positively related to disability duration rather than negatively related; however, the magnitude of the impact was rather small.

Two MMPI scales were significant predictors of injury duration. Higher scores on the Pd scale were associated with an increase in injury duration. Interestingly, the higher value of the Sc scale was associated with shorter claim duration. Individuals who score high on this scale are described as isolated, alienated, misunderstood, and unaccepted by their peers, as well as experience a good deal of apprehension and anxiety (Graham, 1993). It is not intuitively obvious why individuals with relatively high Sc scores would experience relatively shorter injury durations.

The data also indicated that the type of injury was related to the duration of injury. Firefighters who reported non-back sprain and strain stayed 68% longer on disability than those with injuries of the types not listed in Table 3, whereas those who reported injury due to exposure to contagious disease returned to work 51% sooner. Other frequently occurring injuries, such as burns, fractures, and lacerations, did not show any significant impact on injury duration. Race did not show significant relationships to the duration of injuries. Finally, injury claims filed in 1988 were found to have 134% longer duration than claims filed in other years.

Impact on Indemnity Cost

Another way to understand the relationships between these variables and injuries is to examine the relative costs of the injuries and the change in costs in relation to the per unit change in the independent variables. On the basis of our sample, the average

11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
—															
.009	—														
.023	−.229	—													
−.014	−.122	−.206	—												
−.038	−.121	−.205	−.109	—											
.051	−.110	−.186	−.099	−.098	—										
.035	−.155	−.262	−.140	−.139	−.126	—									
.104	−.076	.042	.009	−.029	−.029	.018	—								
.097	−.095	.014	.008	.021	−.010	.007	.425	—							
.168	−.045	.035	.022	−.022	−.033	−.007	.671	.271	—						
.085	−.027	.055	−.023	−.051	.015	−.029	.404	.275	.510	—					
.083	−.044	.116	−.055	−.026	−.031	−.048	.342	.233	.419	.484	—				
.095	−.025	.057	−.040	−.033	−.016	−.026	.517	.434	.567	.542	.441	—			
.155	−.030	.028	−.028	−.021	−.003	−.027	.606	.334	.649	.648	.504	.749	—		
.135	.008	.056	.011	−.033	.024	−.087	.125	.016	.344	.236	.273	.286	.317	—	
.039	−.044	.002	−.045	−.017	−.023	.015	−.106	.407	−.195	−.028	.037	.158	.007	−.127	—

indemnity cost (the amount paid to injured employees for lost wages) per injury was $283.43. The average annual indemnity cost per employee can be calculated by taking the product of the number of claims per employee times the average duration (in days) per claim times the average statutory daily benefit. To calculate the impact of a particular independent variable (i.e., the MMPI Pd scale) on annual indemnity cost per employee, we take the derivative of costs (in natural logarithm terms) with respect to that variable:

$$\frac{\partial \ln(\cos t)}{\partial Pd} = \frac{\partial \ln(Frequency)}{\partial Pd} + \frac{\partial \ln(Duration)}{\partial Pd} + \frac{\partial \ln(Benefit)}{\partial Pd}.$$

On the right-hand side of the equation, the first term represents the percentage change in injury frequency in relation to a unit change in the Pd MMPI scale and is exactly estimated by the negative binomial regression for the frequency model. The second term represents the percentage change in injury duration in relation to a unit change in the Pd scale and is represented by the estimated regression coefficient from the survival analysis for the duration model. The third term captures the influence of MMPI on statutory benefits, which is zero (because there is no reason that change in MMPI scores, or change in any of the other demographics, will change the legislated benefit level).

Various demographic and personality variables influenced the amount of indemnity costs through their impacts on either frequencies or duration of injuries, or both. Table 5 lists the demographic and personality variables identified as being statistically significant in the negative binomial regression or the survival regression analysis. The percentage change in indem-

Table 4
Estimates of Survival Analysis for Duration Model (N = 678)

Variable	Unstandardized β	*SE*
Female	.494**	.216
Married	.516**	.168
Age	.074**	.026
Tenure	−.271**	.089
Injury on duty	1.924**	.279
Weekly wage	.003*	.002
Hs	−.014	.021
D	.001	.016
Hy	.047	.025
Pd	.029*	.015
Pa	−.009	.014
Pt	.003	.024
Sc	−.062**	.023
Ma	−.001	.012
Si	−.011	.018
Female × Married	−1.385**	.346
$\chi^2(38)$	529.07	
Prob > χ^2	0.000	
Pseudo R^2	.45	
Log likelihood	−1,187.2894	

Note. One-tailed tests were performed for female, age, married, injury on duty, wage, and Female × Married. Wage and Female × Married were significant but had an unexpected sign. Two-tailed tests were performed for the remaining independent variables. Control variables, including 11 year dummies, two racial dummies, two position dummies, and six injury type dummies were omitted from the table. Hs = hypochondriasis; D = depression; Hy = conversion hysteria; Pd = psychopathic deviate; Pa = paranoia; Pt = psychasthenia; Sc = schizophrenia; Ma = hypomania; Si = social introversion.
* $p < .05$. ** $p < .01$.

nity costs with respect to a unit change in the independent variable is the sum of the relevant negative binomial regression coefficient and the survival analysis coefficient, if both coefficients were available and at least one of them was statistically significant. If an independent variable's information was not available in the negative binomial regression, we used only the coefficient estimated in the survival analysis as a proxy for the percentage change in the indemnity cost caused by that particular variable. The overall change in indemnity costs can be approximated by multiplying the percentage change in the indemnity costs and the average indemnity costs in this sample ($283.43).

Table 5 exhibits the overall impact that the demographic and personality variables have on indemnity costs. As an example, to calculate the overall change in the indemnity cost of unmarried female compared with unmarried male firefighters, we added and multiplied the two regression coefficients from the first column (.330) and second column (.494) by $283.4322, to yield a value of $233.83. Therefore, unmarried female firefighters experienced on average $233.83 more indemnity costs compared with unmarried male firefighters. However, married female firefighters experienced $12.47 lower average injury costs compared with unmarried male firefighters. A 1-year increase in age increased the costs by $18.42, whereas a 1-year increase in tenure decreased costs by $90.13. The four statistically significant MMPI scales also demonstrate some cost impact. With one standard deviation increase on the Hy scale, the costs were increased by only $126.16. If one standard deviation increase on the Pd scale is considered, the costs involved would be $87.38. A one standard deviation increase on the Si scale would also increase the costs by $16.09. But a similar one standard deviation increase on the Sc scale would result in an average decrease in costs by $133.86.

Discussion

This research examined the correlates of two important injury variables among firefighters: the frequency of injuries and the duration of injuries. We extended previous research in predicting workplace injuries in several aspects. First, most of the prior research has either been based on cross-sectional data or used data from individuals who were already injured—both these approaches do not allow for predictive inferences. The present research used data gathered over a 12-year period, while the majority of the explanatory variables were collected before the date of hire, thus allowing for predictive inferences. By using a longitudinal design such as this, causal inferences can be strengthened. Second, we focused on a single occupation, namely, firefighters, hence ruling out extraneous risk factors associated with different occupations. Third, we used injury frequencies and duration of actual workers' compensation claims as the outcome variables. Workers' compensation records may be biased if job-related injuries go unreported (Parker, Carl, French, & Martin, 1994). However, the advantages of using the workers' compensation database are dominant, which include decreasing the potential overreporting problem that accompanies self-reported data and avoiding problems of having participants recall events in the past. Furthermore, using valid injury claim data facilitated the estimates of indemnity costs, because only work-

Table 5
Demographic and Personality Variables' Influence on Indemnity Cost

Variable	% change in injury frequency[a]	% change in injury duration[b]	% change in indemnity cost[c]	Change in indemnity costs[d] ($)
Female	.330**	.494*	.824	233.83
Married	NA	.516**	.516	146.25
Age	−.009	.074**	.065	18.42
Tenure	−.046	−.271**	−.317	−90.13
Hy	.022*	.047	.069	126.16
Pd	.012*	.029*	.041	87.38
Sc	−.011	−.062**	−.073	−133.86
Si	.020*	−.011	.009	16.09
Female × Married	NA	−1.385**	−1.385	−392.55

Note. NA = information on this variable was not available in the negative binomial regression; Hy = conversion hysteria; Pd = psychopathic deviate; Sc = schizophrenia; Si = social introversion.
[a] The estimated coefficients from the negative binomial regression. [b] The estimated coefficients from the survival analysis. [c] The sum of the two regression coefficients in each row if both are available; if the negative binomial regression coefficient is unknown for that variable, then only the value of the survival analysis coefficient is used. [d] Calculated by multiplying the percentage change in indemnity cost (in previous column) with the average indemnity cost per injury in this sample ($283.4322). For Hy, Pd, Sc, and Si, it was further multiplied by each scale's standard deviation, so it was the change in indemnity cost associated with one standard deviation increase in the corresponding Minnesota Multiphasic Personality Inventory scale.
$^{*}p < .05$. $^{**}p < .01$.

ers' compensation claims cause direct costs to the employers.

Main Findings

Predicting injury frequency. Female firefighters experienced more injuries, and this relationship persists even after we have controlled for factors such as age, race, tenure, personality, and secular trends. A reporting bias might also help to explain the different injury rates between male and female firefighters. Within male firefighters, there may be a strong cultural norm for not reporting minor injuries (e.g., it is a sign of weakness). For female firefighters, this norm might be different. Future research should attempt to identify the mediating variables that explain the relation between gender and work injury frequencies.

Consistent with our predictions, the frequency of injuries rose with higher values for the Hy and Pd scales. We formed no hypothesis concerning the Si scale, but it demonstrated a significant positive relationship to the frequency of injury variable. One possible explanation is that individuals who are less likely to engage in interpersonal interactions are more insecure and uncomfortable when working with others (Costa & McCrae, 1992), resulting in a hesitation to call for assistance. Extraversion predicts successful performance in jobs involving interactions with others (Mount, Barrick, & Stewart, 1998). Firefighting is essentially teamwork (Clarke & Zak, 1999). Firefighters perform more safely and effectively if they cooperate well with each other. Therefore, those who are more reluctant to interact with team members may seek less help from coworkers during an emergency, thereby exposing themselves to greater risks. Alternatively, there could be omitted variables that are common causes of both higher Si scores and frequency of injury. Future research should examine why high level of introversion is associated with more injuries.

Predicting injury duration. Among the demographic predictors, older firefighters suffered longer injury duration than did younger firefighters. Tenure was also negatively related to injury duration, indicating that longer tenured firefighters suffered less severe injuries than shorter tenured firefighters. There was a significant interaction between gender and marital status, but in a direction contrary to our hypothesis. Results showed that married female firefighters returned to work the earliest, followed by unmarried male, unmarried female, and married male firefighters. A possible explanation hinges on women's traditional family role: Because of their dual responsibility at work and at home, married female firefighters may be more cautious than unmarried female firefighters and thereby less likely to be exposed to certain injury risks. Alternatively, fire-fighting crews may implicitly assign working mothers to

the least risky tasks when fighting any given fire. Hence, they would be less likely to experience certain types of severe injuries. Future research may include number of dependents in their analysis, which may help clarify the reason why female firefighters, when married, returned to work much sooner.

Consistent with our prediction, IOD claims had longer injury durations than non-IOD claims. However, higher wages did not seem to provide an incentive to return to work early in this study. Wage was positively related to nonwork spell, but the magnitude of this impact was not particularly strong. Firefighters seemed to respond more to the workers' compensation benefits than to wage loss. This is consistent with Butler and Worrall (1985), who also found the benefit coefficient was about double the size of the wage coefficient.

Among the personality predictors, the Pd scale showed a positive relationship with injury duration. Possibly, firefighters who tend to ignore safety rules and regulations not only had accidents more frequently but also suffered more severe injuries. Alternatively, high scorers may also ignore return-to-work rules and abuse injury leave, resulting in longer injury duration periods.

The evidence suggests much could be gained by examining the duration of injury as an important variable distinguished from the occurrence of injury. Thus, researchers might want to differentiate these two outcomes and examine their relative importance to organizations.

Implications

Because workplace injuries are costly, it is important to identify individual risk factors predictive of workplace injury. These factors may help screen out higher risk individuals, provide safety education, and offer accommodations to those who need longer time to recover from injuries.

The MMPI was developed to diagnose a variety of psychological disorders and screen out candidates who would be ill-suited to high-risk or sensitive jobs. The present research provided evidence that several MMPI scales are significant predictors of two dimensions of safety performance among firefighters: the frequency and the duration. Specifically, if applicants with elevated Hy and Si scales are screened out, workers' compensation costs can be cut by reducing the occurrence of injuries. Additionally, if applicants with high Pd scores are screened out, workers' compensation costs can be cut by reducing both the occurrence and the length of injuries.

Although MMPI measures are frequently used for selecting firefighters, police officers, and nuclear power workers (Inwald, 1988; Kelley et al., 1994), they may not be readily available to human resource managers of other occupations, who may adopt some other personality measures such as the Big Five constructs (Barrick & Mount, 1991). Costa, Busch, Zonderman, and McCrae (1986) correlated MMPI factor scales with measures of the Big Five and concluded that Neuroticism, Extraversion, Openness to Experience, and Agreeableness were well represented in the MMPI scales. Cortina, Doherty, Schmitt, Kaufman, and Smith (1992) identified the Pd scale as a measure of the Conscientiousness factor. In the present study, scores on the Pd scale were positively associated with both injury frequency and duration, indicating a more direct measure of Conscientiousness may also predict these two dimensions of safety performance. The Si scale is an obvious measure of Extraversion (Cortina et al., 1992). Our finding that higher Si scores were associated with more injuries suggests that Extraversion predicts the injury frequency dimension of safety performance. Future research could further our understanding of the links between Big Five personality constructs and the frequency and duration dimension of injury performance.

Unlike personality variables, demographic variables are not appropriate for personnel selection purposes; however, identifying high-risk employees provides important information for organizations to manage their employment risks and forecast training and accommodation needs. Adequate health and safety education has been repeatedly shown to be effective in preventing injuries (Hunt, Habeck, Vantol, & Scully, 1993). More safety training and injury-prevention intervention could be provided if the employee demographic composition indicates more injuries are likely to occur. When injuries occur and impairments do result, accommodation might be the employers' best solution for preventing adverse disability outcomes (Hunt et al., 1993). Our study identified individuals who are in most need for accommodation (e.g., older firefighters and firefighters who suffered from injuries of sprains or strains). Accommodations such as light-duty assignments may help them return to work earlier.

Limitations and Direction of Future Research

Our model explained a substantial portion of variance (45%) in the injury duration variable. However, the injury frequency model explained only a small portion of the variance (5%) in the dependent vari-

able, indicating an obvious need for further model development. Inclusion of other constructs, such as employee attitudes and social support, may enhance the explaining power of the model. For example, Sherry (1991) showed that poor person–environment fit is an important correlate of the occurrence of accidents among railroad transportation workers and that employee-perceived peer and supervisory support is associated with decreased accidents. Additionally, some variables used in the injury duration model were not available for the injury frequency model (e.g., marital status and weekly wage); therefore, we could not estimate the impact of these variables on the frequency of injuries. Consequently, our estimates of these variables' overall impact on indemnity cost might be biased in an unknown direction. In our survival analysis, marital status and weekly wage were significant predictors of the injury duration. Future studies should investigate whether they are also related to injury frequency.

Although we focused on firefighters, similar research designs and methodologies could be applied to other occupations. It will be useful to replicate the study in different settings to examine whether the same set of demographic and personality variables predict workplace injuries for other occupations in other places. Another avenue for future research is to extend the dimensionality of the criterion space for including accidents and injuries as an element of the broadly defined job performance (Campbell, McHenry, & Wise, 1990). An important question is how safety performance might fit into the other, more frequently studied individual outcomes: task performance quantity and quality, contextual performance, and work avoidance or withdrawal behavior.

In conclusion, there is much yet to be done investigating the individual differences and on-the-job injury relationship. The knowledge gained in such research may help develop effective interventions for organizations to improve workplace safety and reduce injury-related costs.

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