

**An Epidemiologic Study of Injuries in Firefighters**

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### Abstract

The risk of disabling injuries and death is very high among firefighters relative to other occupations; however, few epidemiologic studies of injuries in firefighters have been conducted. Studies in other occupations have identified environmental hazards, characteristics of tasks, young age, inexperience, non-use of personal protective clothing and equipment, and heavy alcohol consumption as risk factors for work injury.

For one year, all occupational injuries in Baltimore firefighters were ascertained prospectively. For each case of disabling injury from a fire incident, two matched controls were selected: an uninjured firefighter from the same fire (on-site control) and an uninjured firefighter matched on job title from a different fire (off-site control). In order to increase the accuracy of recall, telephone interviews of cases and matched controls were conducted shortly after the injuries occurred.

Univariate odds-ratios and 95% confidence intervals (CI) were estimated for age, experience, alcohol consumption, use of personal protective clothing and equipment (PPE), characteristics of fires, and specific tasks performed at the fire. Conditional logistic models were used for multivariate analyses.

Significant associations with injury were observed for fire characteristics, age, and specific firefighting tasks. Alcohol consumption was defined in a variety of ways and a number of associations were examined. The only notable finding was a non-significant trend between alcohol consumption and moderately severe and penetrating injuries. Non-significant elevated odds-ratios (ORs) were observed for users of personal protective clothing and equipment (PPE), possibly because use was associated with greater exposure to fire hazards. The findings using on-site and off-site controls were consistent with each other, except that higher odds-ratios for fire characteristics and firefighting tasks were observed when using the off-site controls.

After adjusting for fire characteristics and performing extinguishment, the ORs for younger ages were 0.42 (95% CI=0.23, 0.75) using on-site controls and 0.29 (95% CI=0.13, 0.67) using off-site controls. Using off-site controls, after adjusting for age and performing extinguishment, the ORs for fire characteristics were 2.7 (95% CI=1.41, 5.19), 5.56 (95% CI=1.66, 18.6), and 1.96 (95% CI=0.9, 4.29) for high noise level, large fires, and heavy smoke, respectively. Using off-site controls, the highest risk tasks were extinguishment (adjusted OR=2.23; 95% CI=0.93, 5.32) and ventilation when combined with fire characteristics such as noise (adjusted OR=6.79; 95% CI=1.74, 26.5).

Based on these findings, the most effective method to reduce injuries among firefighters may be to consider in detail the work practices affecting exposure to the types of fires, noted above, associated with high risks.

### List Of Significant Findings

Young age was associated with an increased risk of injury after controlling for other known risk factors.

In general, alcohol consumption was not associated with the risk of injury.

Specific firefighter tasks emerged as the most significant risk factors. The risk of injury was highest for extinguishment and for ventilation.

The fire characteristics most strongly associated with an excess risk included stage of arrival at fire at the size of the fire.

Given resource constraints, in future case-control studies it is recommended that the on-site control be used over the off-site control. The former is logistically easier to ascertain and suitable for a case-control study given that the findings when using these two control groups were similar.

## Final Performance Report

### An Epidemiologic Study of Injuries in Firefighters

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#### 1.0 Importance to Occupational Safety and Health

This study examines personal and environmental risk factors for injuries in firefighters, an occupational cohort at high risk of severe and fatal injuries. Future attempts to intervene to reduce work injuries in this occupation can be guided by knowing the highest risk groups and situations, as well as the most common events associated with injury.

#### 2.0 Objectives

The general purpose of this study was to examine factors possibly contributing to the increased risk of injury in firefighters. While firefighters are at extremely high risk of injury, there are few reported epidemiologic studies of this problem. Specifically, a primary goal of this study was to examine how personal and environmental factors act together in contributing to occupational injuries. The specific questions of interest with respect to disabling occupational injuries in firefighters were to study (1) personal attributes, including age, experience, and alcohol consumption, (2) the effects of environmental factors, including characteristics of fires, firefighting tasks performed, and use of personal protective clothing and equipment, and (3) the relative importance of personal and environmental factors.

#### 3.0 Methodology

Although firefighters are injured at the fire station and during other emergency responses, this study focused only on injuries received at the scene of a fire (fireground) because they are the major cause of disability and death among firefighters (Balanoff, 1976; Safety Sciences, 1982; International Association of Fire Fighters, 1986). During a one year period, all occupational injuries in Baltimore city and Baltimore County firefighters were identified as they occurred. For each case of disabling fireground injury, two firefighters who were uninjured at the time the case was injured were selected as matched controls; one control was selected from the same fire as the case and the other from a similar type of fire incident occurring close in time to that of the case's incident. Each case and control was interviewed as soon after the index fire incident as possible (see questionnaire).

Interviews were completed on a total of 195 cases, 185 on-site controls, and 183 off-site controls.

In addition to the case-control study, the following data collection tasks were also completed: data on all occupational injuries were independently collected from Injury Report Forms and Clinic Slips; and data were abstracted from a random sample of Baltimore City and County fire incident reports with the objective of estimating the risk of injury by type of incident.

#### 4.0 Findings

We report on the case-control analysis which includes information from the injury reports of cases and from the interviews. Analysis is in progress and will continue as other resources external to this grant permit.

##### 4.1 Univariate Analyses

Four factors were carefully examined in the univariate analysis: age, alcohol consumption, the use of personal protective equipment, and firefighting tasks.

The two lowest quartiles of age and number of years as a career firefighter were associated with an excess risk of injury compared to the highest quartile (table 2). For the purpose of multivariate analysis, it was decided that dividing age into two categories, combining the two lower quartiles, and the two upper quartiles was adequate to account for the effect of age on risk.

In general, heavy drinking was not associated with an increased risk of injury using a variety of definitions for alcohol consumption and heavy or problem drinkers (table 4). The exception was a non-significant trend for increases in risk of moderately severe and penetrating injuries with increasing alcohol consumption. Therefore, none of the measures of drinking were included in the multivariate statistical models.

Odds-ratios for the use of personal protective equipment and clothing (PPE) were consistently elevated (table 5); however, in part, this was attributable to firefighters using PPE during more hazardous situations. PPE was not included in the multivariate analyses because the small numbers of discordant case-control pairs precluded meaningful examination of potential associations between PPE and the other risk factors.

A significantly increased risk of injury was observed for the task of extinguishment when comparing cases to the off-site controls (table 6). Non-significant increases in risk were observed for sizing up, salvage, overhaul, and search/rescue, and non-significant decreases in risk were observed for establishing a water supply, ventilation, and

providing medical assistance at a fire. Each firefighting task was analyzed separately for the multivariate analyses.

#### 4.2 Multivariate analyses

The conditional logistic model for matched pairs was used to examine the relationships between risk of injury and age, experience, fire characteristics, and firefighting tasks. The first step in this analysis was developing composite measures for fire characteristics when comparing cases to on-site and off-site controls. The purpose of these composite measures was to control for the effects of fire characteristics when examining the effects of age, experience, and firefighting tasks on injury risk. The composite measures included noise and stage of arrival at the fire when using on-site controls (table 7), and noise, stage of arrival, size of fire, and smoke level when using off-site controls (table 8).

The association between each of the risk factors identified from the univariate analyses were then explored, including age and experience, age and fire characteristics, age and task, and fire characteristics and task. Next, age, fire characteristics, and tasks were combined in statistical models.

In the analysis, the effects of age could not be separated from the effects of experience; thus, age alone was included in the statistical models of multiple variables. Age continued to be an important risk factor for injury even after controlling for fire characteristics and firefighting tasks performed.

When estimating the relative odds for tasks, a correction was introduced to account for the fact that the injury truncates the opportunity for continued exposure in cases. This time at risk problem was resolved by excluding case-control pairs where because of the injury the case did not have an opportunity to perform subsequent tasks that would logically follow in sequence. This relative odds is labeled the time-corrected RO.

The firefighting tasks posing the greatest risk were extinguishment and ventilation combined with fire characteristics such as high noise (see table 9). Adjustment for age did not substantially modify the risk associated with extinguishment and ventilation, but adjusting for fire characteristics diminished the risk from extinguishment. Fire characteristics continued to be strong risk factors for injury after controlling for age and firefighting tasks.

When comparing cases to on-site versus off-site controls the relative odds were quite similar for age, experience, drinking, personal protective equipment, and fire characteristics. On the other hand, the relative odds for extinguishment, salvage, and overhaul were higher when using off-site controls compared to on-site controls.

## 5.0 Conclusions

### 5.1 Risk factors

Age and experience were strongly correlated. As such both variables could not be used in the same statistical models. After controlling for fire characteristics, age continued to be a significant risk factor for injury. The striking age differential for risk of burns is consistent with either increased hazardous exposures or increased risk-taking behavior among younger firefighters. The effect of young age and less experience appeared to last longer than would have been expected from past studies of occupational injuries, which suggests that the effort to control confounding effects from fire characteristics related to hazards was only partially successful. Another possibility is that firefighting differs from other occupations with respect to the duration of the increased risk from young age and a short duration of experience.

Increased alcohol consumption was not consistently associated with an increased risk of occupational injury in career firefighters in Baltimore. This could, in part, be due to differential under-reporting of alcohol consumption among cases and controls, differential rates of job attrition among problem drinkers, or assignment of problem drinkers to less hazardous duties. Alternately, usual drinking habits may be less important in injury than the timing of drinking with respect to work hours, or heavy drinking may not be a risk factor for occupational injury in this population.

Contrary to expectations, the relative odds for users of personal protective equipment and clothing (PPE) were elevated, albeit non-significantly. Statistical power to detect increased or decreased risk from use of PPE was low because of the small number of non-users. It is possible that cases differentially over-reported use of PPE because of fears of adverse consequences. The most likely explanation for the association with injury was that PPE use was an indicator for greater exposure to hazards. SCBAs might be true risk factors for injury: several firefighters reported that the SCBAs contributed to their injuries.

The lack of data on duration of exposure to firefighting tasks precludes accurate estimation of relative risks or attributable risks for specific tasks per unit of time exposed. The lack of data on person-time of exposure to tasks also led to underestimation of the odds-ratios from performance of overhaul, a late stage firefighting task; a correction for exposure opportunity increased the odds-ratio for overhaul.

Some misclassification of tasks, both due to false positive and false negative reports, was apparent. Removing false positive reports did not affect the risk estimated for extinguishment.

The use of off-site controls resulted in a higher odds-ratios

for tasks compared to the odds-ratio estimated when using on-site controls (table 11). This may be due to the possible overmatching on exposure of on-site controls with cases. An alternative explanation is that the use of the on-site control resulted in a more adequate adjustment for the confounding from fire characteristics in relation to hazards.

An important insight gained from this study is the role that firefighting tasks play as both a risk factor and in more precisely determining the extent of exposure to hazards. Moreover, an assessment of tasks in case investigations are valuable for identifying sequences of events leading to injury, and should be interpreted in conjunction with the findings from case-control analyses.

Although the matching factors for the controls included fire characteristics and, presumably degree of hazard, additional indicators of fire characteristics were observed to be the strongest risk factors for injury, including noise level of fire, size of fire, smoke level at fire, and stage of fire upon arrival. Adjustment for age and tasks performed did not diminish the risks associated with fire characteristics. The odds-ratios estimated for fire characteristics were higher when using the off-site controls than the on-site controls, probably because the matching for fire characteristics was more successful in the on-site controls.

Stage of arrival at fire, size of fire, and smoke level probably are indicators of greater exposure to fire hazards rather than direct risk factors for injury. The relationship between risk of injury and size of fire is uncertain because the person-hours of exposure to large fires as compared to smaller fires is unknown; however, it seems highly probable that larger fires do in fact pose higher risks of injury.

## 5.2 Methodological issues

Potential biases in this study may arise from the less than optimal case participation rate (84%), particularly for cases injured when getting on or off fire vehicles and cases who did not lose work time immediately, and the tendency for cases to be interviewed somewhat sooner after the date of injury than controls.

Heterogeneity of injuries: In addition, the injuries in this study were heterogeneous with respect to severity and type and the groupings by severity and type of injury were fairly broad, which may have obscured some relationships between risk factors and specific types of injury. The inclusion of muscular injuries could also be questioned because they may arise from cumulative trauma rather than single fire incidents.

Selecting cases and sampling controls with replacement: Cases and controls were permitted to participate in the study more than once. Consequently, eighty of the matched case-control pairs had members in common and were not independent of each other, including eleven cases who were injured twice during the study. Removing all case-control

pairs with a member who had been interviewed previously did not materially change the odds-ratios nor did excluding cases injured more than once during the study.

Statistical power to detect a 1.5-fold to 2-fold increase in risk for most variables was relatively low because of the small number of discordant matched pairs. Therefore, non-significant as well as significant findings were evaluated for consistency and plausibility.

On-site versus off-site controls: An important methodological contribution from this study is the advantages, disadvantages, and logistical considerations in selecting on-site versus off-site controls. In general, the on-site control may be better suited for studying the effects of personal attributes; however, the findings with respect to personal risk factors were similar using the two types of controls. The lower estimated odds-ratios for tasks from using on-site controls could be due to the division of labor at the fire or to the better control of confounding effects of fire characteristics. The off-site control may be better suited for studying the effects of fire characteristics and tasks, including whether there are interactions between personal and environmental risk factors. From a logistical and cost standpoint, the on-site control is considerably easier and less costly to select.

### 5.3 Suggestions for Further Research:

More refined studies of age effects in firefighters are necessary to determine whether the observed increase in injury risk in younger firefighters is due to more hazardous exposures or behavioral factors. If specific types of high risk behaviors or errors are identified, then specific interventions can be designed and tested. Further controlled trials of several items of personal protective equipment and clothing would also be useful, including protective hoods and light-weight respiratory protection devices. More research is needed on the characteristics of buildings in relation to risk of severe injuries sustained by firefighters, including risk factors for building collapse. The most critical need is for research directed toward the production of more informed decision-making on firefighting tactics, which is also related to a need for research on better methods of communicating information relating to risk. A building collapse scoring system and more extensive pre-planning of firefighting strategies are two ideas which could be further developed and then tested in the context of controlled intervention trials. Undoubtedly, technological research is also crucial for development of safer methods of firefighting.

**Presentations**

Braver ER, Stewart WF, Baker SP, Celentano DD, Howard SR, and Edwards CA: A Case-Control Study of Personal and Environmental Risk Factors for Injury in Firefighters. Poster presentation at the annual meeting of the Society for Epidemiologic Research, Snowbird, Utah, June 13-15, 1990.

Braver ER, Stewart WF, Baker SP, Celentano DD, Edwards CA, Howard SR: Injuries in Firefighters: Do We Really Need a Case-Control Study? Abstract published in the Proceedings of the 116th Annual Meeting of the American Public Health Association, Boston, Massachusetts, November 13-16, 1988.

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1. Balonoff, T. Fire Fighter Mortality Report, Washington, D.C., International Association of Firefighters, 1976
2. Safety Science. A Study of Occupational Injuries and Illnesses Among Firefighters Based on Analysis of Current Injury/Illness Data from 43 Fire Departments, Washington, D.C. Federal Emergency Management Agency, 1982
3. International Association of Firefighters Department of Occupational Health and Safety. 1986 Annual Death and Injury Survey, Washington D.C. International Association of Firefighters, 1986

Table 1

Definition and location of variables on questionnaire, Baltimore firefighters, 1987-1988

Variable	Definitions	Location
Age	1) Age at time of interview.	Q127, p.31
Experience	1) Years as career firefighter.	Q12, p. 2
	2) Number of fires and other incidents attended during week prior to index fire.	Q54, p. 11
Alcohol consumption	1) Total ounces of wine, beer, and liquor consumed in past 4 weeks.	Q27, p. 5
	2) Drinking 5 or more drinks per occasion twice or more in past 4 weeks.	Q28, p. 6
	3) Driving after having "perhaps too much to drink."	Q29, p. 6
Personal protective gear	1) Wearing boots, coat, gloves, helmet, hood, pants, personal alert device, self-contained breathing apparatus (SCBA), using facepiece of SCBA.	Q73-78, pp. 15-16
Firefighting tasks	1) Size-up, search and rescue, establishing a water supply, extinguishing, protecting adjacent areas from fire, ventilation, salvage, overhaul.	Q84, p. 18
	2) Type of vehicle (engine, truck, aerial tower).	Q62, p. 12
	3) Job title (assignment).	Q80, p. 17
Environmental hazards at fire	1) Size of fire, stage of fire at arrival, noise level, smoke level, snow or ice on road, impaired visibility.	Q72, 81-3, Q92-94, pp. 17, 21

Table 2

Matched odds-ratios by quartile\* of age, all injuries combined,  
Baltimore firefighters, 1987-1988

Type of control	Age group	Odds ratio**	95% Conf. limits	b:c***
On-Site	<=31 <sup>§</sup>	1.0	--	
	32-37	1.30	(0.76, 2.22)	19:18
	38-44	0.32	(0.17, 0.61)	6:18
	45+	0.87	(0.47, 1.63)	11:9
Off-Site	<=31 <sup>§</sup>	1.0	--	
	32-37	1.05	(0.60, 1.83)	15:19
	38-44	0.57	(0.29, 1.11)	7:7
	45+	0.48	(0.24, 0.97)	5:9

<sup>§</sup>Reference category.

\*Quartiles based on distribution of combined control data.

\*\*Odds-ratios estimated using method of Breslow and Day (1980) for multiple exposure levels.

\*\*\*b=discordant matched pairs in which the case is exposed;

c=discordant matched pairs in which the control is exposed.

Table 3

Matched odds-ratios by quartile of years of experience as a career firefighter\*, all injuries combined, Baltimore firefighters, 1987-1988

Type of control	Years as FF	Odds ratio#	95% Conf. limits	b:c**
On-Site	<=5 <sup>\$</sup>	1.0	--	
	6-14	1.32	(0.78, 2.22)	20:18
	15-20	0.44	(0.24, 0.82)	9:16
	>=21	0.66	(0.35, 1.23)	9:13
Off-Site	<=5 <sup>\$</sup>	1.0	--	
	6-14	0.91	(0.51, 1.62)	14:17
	15-20	0.52	(0.27, 1.02)	4:9
	>=21	0.34	(0.16, 0.72)	5:10

<sup>\$</sup>Reference category.

\*Quartiles based on distribution of combined control data.

\*\*b=discordant matched pairs in which the case is exposed; c=discordant matched pairs in which the control is exposed.

#Odds-ratios estimated using method of Breslow and Day (1980) for multiple exposure levels.

Table 4

Matched odds-ratios by quartiles of ounces of alcohol consumed during past 4 weeks\*, all injuries combined, Baltimore firefighters, 1987-1988

Type of control	Ounces per 4 weeks	Odds ratio	95% Conf. limits	b:c**
On-Site	0-2 <sup>§</sup>	1.0	--	
	3-15	0.89	(0.49, 1.61)	9:12
	16-38	0.96	(0.56, 1.64)	16:15
	>=39	0.89	(0.50, 1.61)	10:11
Off-Site	0-2 <sup>§</sup>	1.0	--	
	3-15	1.29	(0.74, 2.26)	16:14
	16-38	1.15	(0.65, 2.02)	12:13
	>=39	1.04	(0.58, 1.86)	13:8

\*One can of beer, one glass of wine, and one cocktail are each equal to one ounce of alcohol. Quartiles based on distribution of combined control data.

§Reference category.

\*\*b=discordant matched pairs in which the case is exposed; c=discordant matched pairs in which the control is exposed.

#Odds-ratios estimated using method of Breslow and Day (1980) for multiple exposure levels.

Table 5

Matched odds-ratios for use of personal protective items, all injuries,  
Baltimore firefighters, 1987-1988

Type of control	Protective item	Odds ratio	95% Conf. limits	b:c*
On-site	Boots	0.75	(0.11, 4.43)	3:4
	Coat	1.67	(0.32, 10.73)	5:3
	Gloves	8.0	(1.07, 354.98)	8:1
	Helmet	2.0	(0.29, 22.11)	4:2
	Hood	2.17	(0.77, 6.95)	13:6
	Pants	1.25	(0.27, 6.3)	5:4
	Personal alert device	1.3	(0.73, 2.35)	30:23
	SCBA (wear on back)	1.35	(0.76, 2.42)	31:23
	SCBA (facepiece)	2.25	(0.63, 10.00)	9:4
Off-site	Boots	1.33	(0.23, 9.1)	4:3
	Coat	1.33	(0.23, 9.1)	4:3
	Gloves	---	(1.54, ---)	6:0
	Helmet	3.0	(0.24, 157.49)	3:1
	Hood	2.33	(0.84, 7.41)	14:6
	Pants	1.67	(0.32, 10.73)	5:3
	Personal alert device	1.21	(0.71, 2.08)	34:28
	SCBA (wear on back)	1.42	(0.84, 2.45)	37:26
	SCBA (facepiece)	1.67	(0.68, 4.32)	15:9

\*b=discordant matched pairs in which the case is exposed;  
c=discordant matched pairs in which the control is exposed.

Table 6

Matched odds-ratios for firefighting tasks:  
all injuries combined, Baltimore firefighters, 1987-1988

Type of control	Task	Crude odds ratio	95% confidence limits	b:c
On-site	Sizeup	1.5	(0.93, 2.34)	51:34
	Water	0.89	(0.53, 1.42)	34:38
	Search	1.50	(0.92, 2.47)	45:30
	Protex	1.0	(0.62, 1.72)	34:34
	Exting	1.46	(0.86, 2.51)	38:26
	Vent	1.05	(0.66, 1.66)	42:40
	Salv	0.38	(0.24, 0.71)	21:55
	Over	0.23	(0.15, 0.63)	18:77
	Med	0.38	(0.11, 1.15)	5:13
Off-site	Sizeup	1.77	(1.07, 2.98)	46:26
	Water	1.16	(0.66, 2.07)	29:25
	Search	0.89	(0.53, 1.48)	31:35
	Protex	1.35	(0.85, 2.17)	46:34
	Exting	3.42	(1.67, 5.44)	58:17
	Vent	0.64	(0.38, 1.07)	27:42
	Salv	0.43	(0.27, 0.77)	23:54
	Over	0.30	(0.19, 0.47)	25:83
	Med	0.63	(0.16, 2.17)	5:8

Sizeup is investigating the size and spread of the fire;  
 Water is establishing a water supply for hoses;  
 Search is searching for and rescuing persons in buildings;  
 Protex is protecting adjacent buildings from the spread of fire;  
 Exting is extinguishing the fire;  
 Vent is ventilating the building on fire (breaking windows, etc.);  
 Salv is taking measures to protect property from water damage (salvage);  
 Over is examining/cleaning structure after extinguishment (overhaul);  
 Med is providing medical assistance at scene of fire.

Table 7

On-site controls: matched odds-ratios for fire characteristics, all injuries combined, Baltimore firefighters, 1987-1988

Fire variable	Category	Crude OR	b:c*	Adjusted** OR	95% CI
Stage of fire upon arrival	Controlled or extinguished	1.0 <sup>§</sup>	--	1.0 <sup>§</sup>	--
	Beginning/not under control	3.75	15:4	2.59	(0.82, 8.14)
Size of fire	Small	1.0 <sup>§</sup>	--	#	
	Large	1.89	17:9	#	
Smoke level	Light/med.	1.0 <sup>§</sup>	--	#	
	Heavy	2.09	44:21	#	
Noise	Low	1.0 <sup>§</sup>	--	1.0 <sup>§</sup>	--
	High	2.21	53:24	1.94	(1.18, 3.2)
Visibility	Clear	1.0 <sup>§</sup>	--	1.0 <sup>§</sup>	--
	Obscured	1.53	43:28	0.82	(0.49, 1.36)
Weather	Clear	1.0 <sup>§</sup>	--	1.0 <sup>§</sup>	--
	Snow/Ice	1.0	8:8	0	

\*b= discordant matched pairs in which the case is exposed;

c= discordant matched pairs in which the control is exposed.

\*\* Hazard variables adjusted for each other.

§ Reference category.

0 Variable omitted because not a risk factor for injury.

# Variable omitted from adjustment because inappropriate.

Table 8

Off-site controls: matched odds-ratios for fire characteristics, all injuries combined, Baltimore firefighters, 1987-1988

Fire variable	Category	Crude OR	b:c*	Adjusted** OR	95% CI
Stage of fire upon arrival	Controlled or extinguished	1.0 <sup>\$</sup>	--	1.0 <sup>\$</sup>	--
	Beginning/not under control	5.2	26:5	3.07	(1.09, 8.63)
Size of fire	Small	1.0 <sup>\$</sup>	--	1.0 <sup>\$</sup>	--
	Large	6.55	46:7	4.27	(1.78, 10.27)
Smoke level	Light/med.	1.0 <sup>\$</sup>	--	1.0 <sup>\$</sup>	--
	Heavy	3.87	62:16	2.68	(1.42, 5.05)
Noise	Low	1.0 <sup>\$</sup>	--	1.0 <sup>\$</sup>	--
	High	3.08	74:24	2.57	(1.51, 4.41)
Visibility	Clear	1.0 <sup>\$</sup>	--	1.0 <sup>\$</sup>	--
	Impaired	2.26	61:27	0.96	(0.53, 1.73)
Weather	Clear	1.0 <sup>\$</sup>	--	1.0 <sup>\$</sup>	--
	Snow/Ice	1.0	8:8	#	--

\*b= discordant matched pairs in which the case is exposed;  
c= discordant matched pairs in which the control is exposed.

\*\* Hazard variables adjusted for each other.

\$ Reference category.

# Variable omitted from adjustment because not a risk factor for injury.

Table 9

Age, fire characteristics, and extinguishment: effects of adjusting for each other,  
Baltimore firefighters, 1987-1988

Type of control	Variable	Category	Time*- corr. OR	Adjusted** OR	95% CI
On-site	Age	<=37 years\$	1.0	1.0	--
		>=38 years	0.46	0.42	(0.23, 0.75)
	Noise	Low\$	1.0	1.0	--
		High	2.25	1.95	(1.05, 3.63)
	Stage of fire upon arrival	Controlled or extin- guished\$	1.0	1.0	--
		Beginning or not controlled	6.42	10.72	(1.23, 93.48)
Off-site	Extinguish	No\$	1.0	1.0	--
		Yes	1.53	1.14	(0.59, 2.17)
	Age	<=37 years\$	1.0	1.0	--
		>=38 years	0.37	0.29	(0.13, 0.67)
Noise	Low\$	1.0	1.0	--	
	High	2.91	2.7	(1.41, 5.19)	

Table 9 (Continued)

Type of control	Variable	Category	Time* corr. OR	Adjusted** OR	95% CI
Off-site	Stage of fire upon arrival	Controlled or extinguished\$	1.0	1.0	--
		Beginning or not controlled	#	#	--
	Size of fire	Small\$	1.0	1.0	--
		Large	5.7	5.56	(1.66, 18.6)
	Smoke	Light/med\$	1.0	1.0	--
		Heavy	2.2	1.96	(0.9, 4.29)
	Extinguish	No\$	1.0	1.0	--
		Yes	4.09	2.23	(0.93, 5.32)

\* Corrected for time at risk for injury from extinguishment.

\*\* Best fitting model of age, hazard, and extinguishment adjusted for each other and for time at risk of injury from extinguishment.

\$ Reference category.

# Variable omitted from model because of small numbers.

Table 10

Age, fire characteristics, and ventilation: effects of adjusting for each other,  
Baltimore firefighters, 1987-1988

Type of control	Variable	Category	Time*- corr. OR	Adjusted** OR	95% CI
On-site	Age	<=37 years\$	1.0	1.0	--
		>=38 years	0.44	0.41	
	Noise	Low\$	1.0	1.0	--
High		2.23	2.0	(1.11, 3.6)	
	Stage of fire upon arrival	Controlled or extinguished\$	1.0	1.0	--
		Beginning or not controlled	2.41	4.46	(1.06, 18.69)
	Ventilate	No\$	1.0	1.0	--
Off-site	Age	Yes	1.0	0.79	(0.46, 1.35)
		<=37 years\$	1.0	1.0	--
	Noise	>=38 years	0.35	0.26	(0.11, 0.57)
Low\$		1.0	1.0	--	
	High	2.91	1.17	(0.51, 2.69)	

Table 10 (Continued)

Type of control	Variable	Category	Time*- corr. OR	Adjusted** OR	95% CI
Stage of fire upon arrival	Controlled or extinguished\$	Controlled or extinguished\$	1.0	1.0	--
			#	#	--
Size of fire Smoke	Small\$ Large Light/med\$ Heavy	Beginning or not controlled	1.0	1.0	--
			4.95	7.99	(2.47, 25.79)
			1.0	1.0	--
			2.41	2.45	(1.14, 5.26)
Ventilate	No\$ Yes	No\$ Yes	1.0	1.0	--
			0.63	0.25	(0.1, 0.63)
Noise x	Ventilation&	Ventilation&	--	6.79	(1.74, 26.5)

\* Corrected for time at risk for injury from ventilation.  
 \*\* Best fitting model for age, hazard, and ventilation adjusted for each other and for time at risk of injury from ventilation.  
 \$ Reference category.  
 # Variable omitted from model because of small numbers.  
 & Interaction term.

Table 11

Comparison of results from on-site and off-site case-control pairs,  
Baltimore firefighters, 1987-1988

Variable	Category	On-site ORs		Off-site ORs		Ratio of ORs	
		Crude	Adj.	Crude	Adj.	Crude	Adj.
Age	<=37 years <sup>§</sup>	1.0	1.0	1.0	1.0	--	--
	>=38 years	0.46	0.42	0.41	0.29	1.12	1.45
Experience	<=14 years <sup>§</sup>	1.0	N/A	1.0	N/A	--	N/A
	>=15 years	0.47	N/A	0.47	N/A	1.0	N/A
Drinking	0-2 oz./mo. <sup>§</sup>	1.0	N/A	1.0	N/A	--	N/A
	3-15 oz./mo.	0.89		1.29		0.69	
	16-38 oz./mo.	0.96		1.15		0.83	
	39+ oz./mo.	0.89		1.04		0.85	
PPE	SCBA	1.35	N/A	1.42	N/A	0.95	N/A
Hazard	Noise	2.21	1.95	3.08	2.7	0.72	0.72
	Stage of arrival	3.75	10/72	5.21	N/A	0.72	N/A

Table 12  
 Distribution of fireground injuries by type  
 of event preceding injury,  
 Baltimore firefighters, 1987-1988

Type of Event	n	%
Collapse of building	30	15.4
Flames, heat	30	15.4
Falls	29	14.9
Slips, trips	26	13.3
Contact with sharp objects	19	9.7
Contact with blunt objects	15	7.7
Foreign object in eye	10	5.1
Other*	36	18.5
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TOTAL	195	100.0

\*Includes 32 muscle injuries attributed to over-exertion.



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