Injury among a population based sample of career firefighters in the central USA

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ABSTRACT

Background Rates of occupational injuries among firefighters are high because of the physically demanding and variable tasks required by their job. While descriptive data about injuries exist, few studies have explored individual risk factors and their relationship to occupational injury.

Methods The current study presents data from a population-based sample of 462 career firefighters from 11 randomly-selected fire departments in the Missouri Valley region of the USA (Kansas, Missouri, Iowa, North Dakota, South Dakota, Colorado, Wyoming, Nebraska) who participated in a study evaluating risks for negative cardiovascular outcomes and injury. Relationships were examined between injury and demographic characteristics, body composition, fitness, and health behaviours.

Results Participants were most likely to be injured during physical exercise and those who reported regular on-duty exercise had a fourfold increase in risk for exercise-related injury compared with those who did not exercise on duty (OR=4.06, 95% CI 1.73 to 12.24). However, those who exercised were half as likely to sustain non-exercise injuries (OR=0.53, 95% CI 0.32 to 0.85).

Conclusions Findings highlight the benefit of physical training for firefighters despite the risk of injury during exercise.

Firefighting is a dangerous occupation with injury rates exceeding most occupational groups.1 The National Fire Protection Association (NFPA) reported 71 875 firefighter line-of-duty injuries in 2010, with 20.8% of injuries resulting in time away from work.2 Strains, sprains and muscular pain accounted for the largest portion of injuries (51.4%), followed by wounds, cuts, bleeding and bruising (17.3%), and ‘other’ injuries (12.8%).

Poplin et al3 examined a 5-year period of injury reports for Tucson firefighters and found that 32.9% were due to physical exercise, followed by patient transport (16.9%), training drills (11.1%) and fireground operations (10.2%). Sprains and strains were reported as the most common injury (56.2%) followed by lacerations and contusions (15.5%).

Firefighter injuries have significant economic costs. Walton et al4 studied firefighters from 77 municipalities in Illinois who filed worker’s compensation from 1992–1999. They found nearly a third of claims were for overexertion, of which 83% were related to strain or sprain. The average firefighters’ worker’s compensation claim was $5168. Costs of injuries sustained by firefighters nationally were estimated between $830–980 million annually in 1997 dollars.5 Given the high prevalence and associated costs of injuries in the fire service, understanding risk and protective factors for injury is an important topic in occupational health research.

To date, studies examining risk factors for firefighter injury largely focus on environmental context and usually limit their focus to injuries occurring on the fire ground. For instance, Fabio et al6 reported that fires with five or more alarms or those in buildings with more than three stories resulted in a 400% and 250% increased injury risk when compared with fires with fewer alarms or those on a ground floor, respectively. Moore-Merrill et al,7 conducted a retrospective review of 3450 injuries, and found that the leading contributing factors to injury in the line of duty were a lack of situational awareness (37.4% of injuries), lack of wellness fitness (28.6% of injuries) and human error (10.7% of injuries). While information about location and environmental context is useful, little is known about non-occupational risk factors (eg, health behaviours, fitness level, body composition) that may be related to increased injury risk.

We located two studies that examined the relationships between non-occupational risk factors and firefighter injuries. Liao et al8 examined predictors of injury frequency and duration in a 12-year longitudinal firefighter cohort (N=171) and found that age, tenure, gender, marital status, type of injury and wage were significant predictors of injury duration. Those who scored high on the Minnesota Multiphasic Personality Inventory scales associated with conflict, struggle, anger and respect for societal rules were injured more frequently and missed more work. However, all firefighter injuries were combined which limits the ability to look at whether predictors vary by type of injury.

Heineman et al9 explored risk factors associated with fireground injuries in a retrospective case-control study and found that neither age nor experience were significantly related to risk of injury; rather, situational elements (eg, task being performed by firefighter when injured, location of the fire) were the most likely correlates of injury. Additional research that focuses specifically on the most common type of injury (musculoskeletal (MS) injuries) or the most frequent duty type when injured (exercise) will help expand the understanding of the role of non-occupational risk factors.

There is wide agreement that firefighters need to be physically fit to perform their job tasks. However, many departments raised concerns about the potential for high injury rates occurring during exercise.10 11 In addition, little is known about predictors or correlates of exercise injuries among...
The following questions are about injuries you have incurred in the past 12 months. An injury is anything for which you have completed an accident report for the department, reported to workers compensation, or received medical care (by a physician or other medical professional).

Participants were asked 'We would like to ask you a few questions about any injuries you might have sustained while you were working as a firefighter. We are only interested in injuries while on duty regardless of the activity you were performing'. They were asked to indicate the number of injuries they sustained during the 12 months prior to the baseline evaluation, how many injuries resulted in them completing a departmental injury report and/or a report to workers compensation if their department participated in the programme. Firefighters were asked to indicate the injury type and location (ie, on their body), the duty being performed, and the activity (eg, lifting people, overhaul) they were doing while engaged in that duty. Injuries that were identified as 'dislocations, sprains and strains' were considered MS injuries. Injuries that were classified as 'Training' for type of duty and 'Physical training' as activity (as opposed to other training evolutions) were considered exercise injuries. Participants completed a separate description for each injury reported. For each firefighter who indicated an injury, the description of their injuries were reviewed and classified. In many instances, firefighters wrote in a short explanation of their injury rather than classifying it. Two members of the research team reviewed any that were not clearly classified.

In our initial questionnaire development, we conducted a 2-week, test-retest reliability analysis of each survey item. Participant responses (N=36) on the primary injury question ('How many injuries did you have in the past 12 months?') were identical in 89% of the cases, and within one injury 94% of the time (possibly due to injuries in the lag period in some cases). κ for this injury item was highly significant (κ=0.773, p<0.001). Body composition was determined by body mass index (BMI), body fat percentage (BF%) and waist circumference (WC). Height was measured using a portable stadiometer. Weight and BF% were assessed with foot-to-foot bioelectrical impedance (Tanita 300; Tanita Corporation of America, Inc.; Arlington Heights, Illinois, USA). The Tanita 300 demonstrated strong concurrent validity when compared with dual energy x-ray absorptiometry (r=0.94; p<0.001), the ‘gold standard’ of body fat assessment.19 WC was measured with a non-stretchable tape measure based on recommendations from the US obesity guidelines.20 21 BMI was calculated as kg/m². Cut-offs for obesity classification using BMI, BF% and WC were based on current standards.20 21

Estimated maximal oxygen consumption (VO₂max) was determined with a non-exercise model that combined participants’ age, gender, BMI and physical activity assessed with the Self-Report of Physical Activity Questionnaire.22 This non-exercise model has been compared with measured VO₂max and found to be as accurate as submaximal aerobic testing.22–25

Torso strength was assessed with the Jackson Strength Evaluation System, as recommended by the NFPA 1500 Standard on Fire Department Occupational Safety and Health Programme.26 The body weight corrected maximum strength ratio (ie, average of two maximum strength pulls/participants’ body weight) was used for analysis.

Flexibility was assessed using the adjustable sit and reach test, also recommended by the NFPA 1500 standard.26 Averages of the maximum stretch were calculated for analysis.

Tobacco use questions were modelled after those from the Department of Defence Survey of Health Related Behaviours
Among Personnel and the National Household Survey on Drug Abuse. Firefighters who had not smoked 100 cigarettes in their lives were considered non-smokers. Those who smoked 100+ cigarettes in their lives but none in the past 30 days were considered former smokers. Those who had smoked 100+ cigarettes in their lifetime and smoked in the past 30 days were classified as current smokers. Those who indicated they had used smokeless tobacco in the past 30 days were considered former smokeless tobacco users.

Profound alcohol use was measured with the CAGE questionnaire. Response options were yes/no to the following questions: (1) Have you ever felt you should cut down on your drinking? (2) Have people annoyed you by criticising your drinking? (3) Have you ever felt guilty about your drinking? and (4) Have you ever had a drink first thing in the morning to steady your nerves or get rid of a hangover? Affirmative responses were totalled for an overall score range of 0–4. Scores >2 are considered indicative of potential problematic alcohol use.

On-duty sleepiness was evaluated with the Epworth Sleepiness Scale, which asked how likely it was that firefighters were to doze off in a number of situations. Response options were 0–3. Standard cut-offs for excessive daytime sleepiness (Epworth Sleepiness Scale >11) was used.

Depression was assessed with the Center for Epidemiological Studies Short Depression Scale (CES-D 10). Total scores were calculated and those scoring >10 were considered in the range of concern for clinical depression. The CES-D has been found to be highly reliable among the general population (Spearman-Brown, split halves r=0.83) and in patient samples (r=0.90).

Exercise on Duty was assessed with the question ‘Most weeks, I exercise at the fire station or while at work:’ Response options were dichotomised to either Never/Some Days or Most Days/Every Day.

Approach to analysis
All statistical analyses were performed with SPSS V19 (SPSS, Chicago, Illinois, USA) and SAS V9.3 (SAS, Cary, North Carolina, USA). As noted previously, women were excluded due to their lack of representation in our sample (and the national fire service) and our resulting inability to make statistical inferences based on gender differences. The first reported injury was used for firefighters reporting more than one injury. Logistic regression was used to examine associations between all injury, MS injury, and exercise injury and demographic characteristics (those noted in table 1), body composition, fitness and health behaviours. For MS injuries, comparisons were made between those with and without a MS injury in the 12 months prior to baseline data collection. Exercise injuries comparisons were between those who did and did not experience an exercise injury in the 12 months prior to baseline data. Given the concern by fire service management about exercise injury, descriptive data on days missed was tabulated. \( \chi^2 \) analysis was used to determine if there was a difference between exercise and non-exercise injuries with respect to missing shifts from work, which was coded dichotomously as missed any shifts versus missed no shifts. No demographic variables were significantly related to injury, so they were not included as covariates in subsequent models examining associations between body composition, fitness, health behaviours and injury. Given the sampling strategy used in the larger study, the group-level factor ‘department’ was entered into each model as a random effect to determine if parameter estimates were significantly impacted by its inclusion. In no case did the models adjusted for department result in substantively different parameter estimates, thus unadjusted models are presented.

RESULTS
Demographic characteristics of participants are presented in table 1.

Of the 478 male career firefighters who consented to study participation, 462 completed the injury questions on the baseline survey and were included in this report. Among this group, 20.1% reported having one injury, 3.0% reported having two injuries and 1.7% reported having three or more injuries in the previous 12 months. Most injured firefighters (66.1%) completed departmental reports, but only 37.4% reported to workers compensation. MS injuries, such as dislocations, sprains and strains, were the most common type, accounting for 76.3% of injuries, followed by superficial injuries or open wounds (13.0%; see table 2).

Type of duty
Injuries primarily occurred during training (exercise or other training revolutions; 33.3%) or on the fire ground or during

| Table 1 Demographics of firefighters at baseline by injury status |
|-----------------------------|-----------------|-----------------|-----------------|-----------------|
|                             | Not injured N=346 | All injured N=115 | MS injury N=87  | Exercise injury N=30  |
| ---                         |                  |                  |                 |                  |
| Ethnicity (% White)         | 90.0             | 92.0             | 90.6            | 86.0             |
| Age, years (SD)             | 38.1 (10.2)      | 38.8 (9.2)       | 38.9 (8.5)      | 36.7 (9.5)       |
| % Married                   | 73.5             | 70.5             | 72.6            | 75.0             |
| Education                   |                  |                  |                 |                  |
| High School/Some college    | 74.7             | 72.6             | 72.9            | 62.1             |
| College grad/graduate degree| 25.3             | 27.4             | 27.1            | 37.9             |
| Rank (%)                    |                  |                  |                 |                  |
| Firefighter                 | 32.9             | 33.9             | 33.3            | 44.8             |
| Firefighter/paramedic       | 15.9             | 21.4             | 21.4            | 10.3             |
| Driver operator             | 20.2             | 17.0             | 16.7            | 10.3             |
| Company officer (lt, Capt)  | 22.8             | 22.3             | 22.6            | 27.6             |
| Chief (asst, deputy, other) | 7.5              | 4.5              | 4.8             | 6.9              |
| Other                       | 0.6              | 0.9              | 1.2             | 0.0              |
| Years in fire service, years (SD) | 13.9 (9.2) | 14.4 (8.6) | 14.3 (8.5) | 13.7 (8.8) |

| Table 2 Type of injuries incurred by firefighters, baseline |
|---------------------------------------------|-----------------|-----------------|
| Type of injury                             | % of firefighters | % of injuries |
| Dislocation, strain, sprain                | 18.8            | 76.3            |
| Superficial injury, open wound             | 3.2             | 13.0            |
| Concussion, internal injury                | 1.3             | 5.2             |
| Fire/chemical burn, scald, frostbite       | 1.3             | 5.2             |
| Fractures                                  | 0.4             | 1.7             |
| Eye injury                                 | 0.4             | 1.7             |
| Amputation                                 | 0.0             | 0.0             |
| Acute poisoning, infection                 | 0.0             | 0.0             |
| Respiratory injury                         | 0.0             | 0.0             |
| Thermal stress/heat exhaustion             | 0.0             | 0.0             |
| Heart attack, stroke                       | 0.0             | 0.0             |
| Other                                      | 0.2             | 0.9             |
rescue operations combined (27.9%). The remaining injuries happened on scene at non-fire calls (17.1%), during other duties (eg, inspection; 13.5%) and while responding to or returning from a call (8.1%), respectively. The majority of injuries were associated with training and most training injuries (81.1%) occurred during exercise (table 3).

The most common fire ground injuries occurred while advancing or directing hose (50.0%), during overhaul operations (16.7%) and forcible entry (10.0%). Most non-fire emergency injuries resulted from lifting people (77.8%). Among other on-duty, non-emergency injuries, almost half (43.8%) happened during inspecting activities such as truck checks.

Risk factors of all injury
Table 4 presents correlates of all injury, MS injury and exercise injury. None of the demographic variables listed in table 1 were associated with risk of all injury nor were body composition or fitness measures. Smoking status was significantly related to all injury, with former smokers more likely to have experienced an injury compared with never smokers (OR=1.84, 95% CI 1.31 to 2.99). Depressive symptoms were also significantly related to injury, with those scoring in the range of concern for symptoms being more likely to have been injured (OR=2.33, 95% CI 1.33 to 4.08).

Risk factors of MS injury
Similar to the analysis of any injury, no demographic, body composition or fitness measures were significantly related to MS injury. Only scores on the depression scale were significantly related to MS injury, with those scoring in the range of concern being significantly more likely to be injured (OR=1.99, 95% CI 1.08 to 3.66).

Risk factors of exercise injury
No demographic characteristics noted in table 1 were significantly associated with exercise injuries. Estimated VO$_{2\text{max}}$ demonstrated a significant association with exercise injury; each unit increase in estimated VO$_{2\text{max}}$ was related to a 6% per unit increase in exercise injury (OR=1.06, 95% CI 1.01 to 1.12). Strength was also related to exercise injury with an increase in exercise injury for each unit increase in the strength ratio (OR=4.03, 95% CI 1.48 to 10.97). Slightly more than half (54.1%) of firefighters reported exercising at work on most or all days they were on duty. Those who exercised were 4.6 times more likely to have an exercise injury (OR=4.60, 95% CI 1.73 to 12.24). However, those reporting on-duty exercise were approximately half as likely to sustain a non-exercise injury (OR=0.53, 95% CI 0.32 to 0.85). Only 39.3% of those reporting exercise injuries reported any lost duty days while more than half (52.4%) of firefighters with non-exercise injuries missed work, although the difference was not statistically significant ($\chi^2$=1.4, p=0.23).

DISCUSSION
Exercise injuries among firefighters have received a great deal of attention given their frequency.$^3$–$^5$ Firefighters in this study who reported consistent exercise on duty were significantly more likely to suffer an exercise injury. Those with an exercise injury also were stronger and evidenced higher cardiorespiratory fitness than their peers not experiencing an exercise injury. However, firefighters who consistently exercised on duty also were significantly less likely to suffer a non-exercise injury and a lower proportion missed any shifts due to injury. Our findings are consistent with Muto and Sakurai,$^3$ who found that workers who exercised regularly had fewer missed work days due to injury or illness when compared with those who did not report exercise, which is likely due to the protective effects of fitness. Findings have implications for fire service leadership who are working towards increasing programmes and resources for fitness and wellness programmes. While some concern has been expressed about the risk of injuries related to exercise, findings highlight the protective effect exercise has against non-exercise injuries.

Injury rates and type of duty being performed while injured in the present study were similar to those found in existing literature.$^3$–$^4$ Approximately one-third of firefighters’ injuries took place during training and slightly more than a quarter occurred on the fire ground. Fifteen per cent of injuries happened during non-fire calls and the most frequent injury in these environments was the result of lifting patients. Nearly 14% of injuries transpired during non-emergency response activities, often during truck checks.

Firefighters in the range of concern for depressive symptoms were twice as likely to have experienced an injury in the past 12 months. Kim,$^3$ using the National Health Interview Survey, found a 37% increase in injuries among distressed participants when compared with those without distress. However, given the cross-sectional nature of our data, it is not possible to infer a causal direction in the relationship between injury and depression. It is possible that firefighters who were injured were at higher risk for depression because of their injury. Longitudinal research is needed to determine whether depression is predictive of subsequent injury. Similarly, former cigarette smoking was

Table 3 Type of duty conducted when injured*

<table>
<thead>
<tr>
<th>Type of duty</th>
<th>% of injuries N=111</th>
<th>% injuries within category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire/rescue activities</td>
<td>27.9 (n=31)</td>
<td>50.0 (n=15)</td>
</tr>
<tr>
<td>Advancing/directing hose</td>
<td>13.5</td>
<td>16.7 (n=5)</td>
</tr>
<tr>
<td>Overhaul</td>
<td>4.5</td>
<td>10.0 (n=3)</td>
</tr>
<tr>
<td>Forcible entry</td>
<td>2.7</td>
<td>6.7 (n=2)</td>
</tr>
<tr>
<td>Ventilation</td>
<td>1.8</td>
<td>6.7 (n=2)</td>
</tr>
<tr>
<td>Using ground ladders</td>
<td>1.8</td>
<td>6.7 (n=2)</td>
</tr>
<tr>
<td>Rescue</td>
<td>1.8</td>
<td>6.7 (n=2)</td>
</tr>
<tr>
<td>Salvage</td>
<td>1.8</td>
<td>6.7 (n=2)</td>
</tr>
<tr>
<td>Working on aerial ladders</td>
<td>0.9</td>
<td>3.3 (n=1)</td>
</tr>
<tr>
<td>Picking up</td>
<td>0.9</td>
<td>3.3 (n=1)</td>
</tr>
<tr>
<td>Inspecting</td>
<td>0.9</td>
<td>3.3 (n=1)</td>
</tr>
<tr>
<td>Other</td>
<td>1.8</td>
<td>6.7 (n=2)</td>
</tr>
<tr>
<td>On scene, non-fire</td>
<td>17.1 (n=19)</td>
<td>77.8 (n=14)</td>
</tr>
<tr>
<td>Lifting people</td>
<td>12.6</td>
<td>22.2 (n=4)</td>
</tr>
<tr>
<td>Other</td>
<td>3.6</td>
<td>22.2 (n=4)</td>
</tr>
<tr>
<td>Training</td>
<td>33.3 (n=37)</td>
<td>81.1 (n=30)</td>
</tr>
<tr>
<td>Physical training</td>
<td>27.0</td>
<td>5.4 (n=2)</td>
</tr>
<tr>
<td>Lifting people</td>
<td>1.8</td>
<td>5.4 (n=2)</td>
</tr>
<tr>
<td>Advancing/directing hose</td>
<td>1.8</td>
<td>5.4 (n=2)</td>
</tr>
<tr>
<td>Using ground ladders</td>
<td>0.9</td>
<td>2.7 (n=1)</td>
</tr>
<tr>
<td>Rescue</td>
<td>1.8</td>
<td>5.4 (n=2)</td>
</tr>
<tr>
<td>Picking up</td>
<td>1.8</td>
<td>5.4 (n=2)</td>
</tr>
<tr>
<td>Lifting people</td>
<td>1.8</td>
<td>5.4 (n=2)</td>
</tr>
<tr>
<td>Responding/returning</td>
<td>8.1 (n=9)</td>
<td>43.8 (n=7)</td>
</tr>
<tr>
<td>Other on-duty</td>
<td>13.5 (n=15)</td>
<td>50.0 (n=8)</td>
</tr>
<tr>
<td>Inspecting activities</td>
<td>6.3</td>
<td>6.3 (n=1)</td>
</tr>
<tr>
<td>Picking up objects</td>
<td>6.3</td>
<td>6.3 (n=1)</td>
</tr>
<tr>
<td>Other</td>
<td>7.2</td>
<td>50.0 (n=8)</td>
</tr>
</tbody>
</table>

*Percentages may not add to 100 because personnel could select more than one category.
found to be related to increased risk of all injury which is consistent with research in other occupational groups.\textsuperscript{35, 36}

Limitations to the current study include the use of self-reported injury data. While collecting injury data this way has been found to be more sensitive than workers compensation claims or medical records,\textsuperscript{37} particularly for less severe injuries, self-reports presents a different picture of injury than other assessment methods. For instance, the NFPA\textsuperscript{2} reported that nearly half of all injuries happened on the fire ground, but these injury data come from fire departments. Data collection at the department level is likely less sensitive to less severe injuries that do not result in lost duty days or medical care. In addition, it is possible that data collection missed firefighters who were on light duty detail or missing from work due to injury. In addition, generalisability of the study is limited to the Missouri Valley region of the country. Additional research should focus on reproducibility in other geographical areas.

Despite the limitations, our study has a number of strengths including the population-based sample from 11 randomly selected fire departments across the central USA. In addition, the assessment protocol included measured weight, body composition, strength and flexibility and a strong and sensitive measure

\begin{table}[h]
\centering
\caption{Logistic regressions, all injury, musculoskeletal (MS) injury and exercise injury and non-occupational risk factors}
\begin{tabular}{lccc}
\hline
 & All injury & MS injury & Exercise injury \\
 & Comparison with all not injured & Comparison with all not having MS injury & Comparison with all not having exercise injury \\
\hline
\textbf{Body composition} & & & \\
Obesity, BMI defined (%) & & & \\
Normal weight & – & – & – \\
Overweight & 1.13 (0.64 to 2.01) & 1.15 (0.60 to 2.21) & 0.87 (0.34 to 2.22) \\
Obese & 1.01 (0.55 to 1.86) & 1.18 (0.60 to 2.33) & 0.63 (0.22 to 1.81) \\
Obesity, waist circumference (%) & & & \\
Under 40 inches & – & – & – \\
Over 40 inches & 1.04 (0.66 to 1.65) & 1.17 (0.71 to 1.93) & 1.13 (0.51 to 2.47) \\
Obesity, body fat defined (%) & & & \\
Not obese & – & – & – \\
Obese & 0.90 (0.59 to 1.38) & 0.94 (0.59 to 1.51) & 0.63 (0.29 to 1.36) \\
\textbf{Fitness} & & & \\
\textbf{VO}_{2}\textit{max} (ml/kg/min) & & & \\
1.00 (0.98 to 1.03) & 1.00 (0.97 to 1.03) & 1.06 (1.01 to 1.12) \\
Maximum torso strength & & & \\
1.01 (0.54 to 1.91) & 1.08 (0.53 to 2.18) & 4.03 (1.48 to 10.97) \\
\textbf{Flexibility} & & & \\
Max reach (cm) & 0.97 (0.90 to 1.04) & 0.97 (0.89 to 1.05) & 1.07 (0.94 to 1.21) \\
\textbf{Exercise on duty} & & & \\
Not regular exercisers & – & – & – \\
Regular exercisers & 0.84 (0.55 to 1.28) & 1.03 (0.64 to 1.64) & 4.60 (1.73 to 12.24) \\
\textbf{Health behaviours} & & & \\
\textbf{Smoking} (%) & & & \\
Never/experimental & – & – & – \\
Former & 1.84 (1.31 to 2.99) & 1.58 (0.93 to 2.69) & 1.33 (0.58 to 3.06) \\
Current & 1.04 (0.54 to 2.02) & 0.81 (0.38 to 1.76) & 0.75 (0.21 to 2.63) \\
\textbf{Smokeless tobacco use} (%) & & & \\
Not current user & – & – & – \\
Current user & 1.19 (0.70 to 2.04) & 0.74 (0.38 to 1.41) & 1.39 (0.57 to 3.35) \\
\textbf{Alcohol} (%) & & & \\
Two or less on CAGE questionnaire & – & – & – \\
More than two on CAGE questions & 1.15 (0.59 to 2.23) & 1.38 (0.68 to 2.80) & 0.51 (0.12 to 2.20) \\
\textbf{Daytime sleepiness} (%) & & & \\
<11 on Epworth Sleepiness Scale & – & – & – \\
>11 on Epworth Sleepiness Scale & 1.74 (0.97 to 3.10) & 1.66 (0.89 to 3.12) & 1.43 (0.52 to 3.92) \\
\textbf{Depression} (%) & & & \\
<4 CESD-10 & – & – & – \\
>4 on CESD-10 & 2.33 (1.33 to 4.08) & 1.99 (1.08 to 3.66) & 1.78 (0.69 to 4.58) \\
\hline
\end{tabular}
\end{table}

Note: Because no univariate models evidenced a significant relationship between demographic characteristics and risk of injury, only unadjusted models are presented. BMI, body mass index.
of injury. Findings of the current study confirm and expand the literature on firefighter injury with a large, population-based sample using well-validated outcome measures to examine non-occupational risk factors associated with injury. Despite the disproportionately high rates of injury during exercise, findings also highlight the protective effect of fitness in defending against non-exercise injuries. Based on these findings, injury prevention efforts should focus on increasing fitness and appropriate training among firefighters as a means of decreasing on-duty injury.

What is already known on this topic?

- It is well recognized that firefighting is a dangerous profession with high rates of injury. In particular, exercise on duty has been identified as an activity that results in a high number of injuries.

What this study adds?

- By examining the relationship between duty exercise, exercise injuries and non-exercise injuries, we are better able to understand the impact of on-duty exercise to injury rates.

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Contributors

All authors meet the conditions for authorship including: (1) substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; (2) drafting the article or revising it critically for important intellectual content; and (3) final approval of the version to be published.

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Competing interests

None.

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http://injuryprevention.bmj.com/content/early/2013/03/15/injурyprev-2012-040662.full.html

These include:

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