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Seasonality and Coronary Heart Disease Deaths in United States Firefighters

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Abstract

United States firefighters have a high on-duty fatality rate and coronary heart disease is the leading cause. Seasonality affects the incidence of cardiovascular events in the general population, but its effects on firefighters are unknown. We statistically examined the seasonal and annual variation of all on-duty coronary heart disease deaths among US firefighters between 1994 and 2004 using the chi-square distribution and Poisson regression model of the monthly fatality counts. We also examined the effect of ambient temperature (apparent as well as wind chill temperature) on coronary heart disease fatalities during the study span using a time-stratified, case-crossover study design. When grouped by season, we observed the distribution of the 449 coronary heart disease fatalities to show a relative peak in winter (32%) and relative nadir in spring (21%). This pattern was significantly different (p=0.005) from the expected distribution under the null hypothesis where season has no effect. The pattern persisted in additional analyses, stratifying the deaths by the type of duty in which the firefighters were engaged at the time of their deaths. In the Poisson regression model of the monthly fatality counts, the overall goodness-of-fit between the actual and predicted case counts was excellent ($\chi_4^2 = 16.63$; $p = 0.002$). Two distinct peaks were detected, one in January-February and the other in August-September. Overall, temperature was not associated with increased risk of on-duty death. After allowing for different effects of temperature in mild/hot versus cold periods, a 1°C increase was not protective in cold weather, nor did it increase the risk of death in warmer weather. The findings of this study reveal statistical evidence for excess coronary heart disease deaths among firefighters during winter; however, the temporal pattern coronary heart disease deaths was not linked to temperature variation. We also found the seasonal pattern to be independent of duty-related risks.

Keywords

Coronary Heart Disease; Seasonality; Chronobiology; Firefighters; Temperature

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Introduction

Recently, seasonal effects on cardiovascular morbidity and mortality have received increased attention. Several studies have observed a winter peak in cardiac mortality and myocardial infarction (Spencer et al., 1998; Gonzalez et al., 2004; Phillips et al., 2004; Manfredini et al., 2005; Biedrzycki & Baithun, 2006). Various plausible explanations for this apparent pattern have been proposed, including the effects of colder weather, influenza, air pollution, and photoperiod on cardiovascular disease. In particular, independent investigations from different climates have observed increases in cardiovascular events associated with declines in ambient temperatures (Bull & Morton, 1978; Kunst et al., 1993, Danet et al., 1999; Panagiotakos et al., 2004; Cagle & Hubbard, 2005).

Firefighters are of particular interest as they may be exposed to extremes of temperature during both routine and emergency duties. Moreover, among United States (US) firefighters, coronary heart disease (CHD) causes 40-45% of all on-duty deaths (Washburn et al., 1998; Tridata Corporation, 2002; Fahy, 2005). This is twice the proportion of on-duty cardiovascular deaths among police officers (Tridata Corporation, 2002) and four times the proportion among emergency medical service workers (Maguire et al., 2002). Predisposing medical and occupational factors for CHD among firefighters have been reviewed elsewhere (Guidotti, 1992; Melius, 2001; Kales et al., 2003). Consistent evidence is now emerging that certain working conditions can trigger cardiovascular events in firefighters with underlying disease (Kales et al., 2003, 2007; Holder et al., 2006). For example, because the relative risk of CHD death is increased during certain emergency duties, and emergency responses tend to be most frequent between 12:00 and 00:00 h, on-duty CHD mortality among firefighters does not follow the expected 24 h pattern of a 06:00 to 12:00 h peak as observed in the general population. In fact, 67 to 77% of on-duty cardiovascular deaths among firefighters occur between 12:00 and 00:00 h (TriData Corporation, 2002; Kales et al., 2003). Many studies have focused on the effects of weather and season in the general population; however, few, if any, previous investigations have examined these effects in occupational settings. In this paper, we used data from a national repository of US firefighter deaths to examine the relationship between seasonality and temperature and the risk of on-duty CHD mortality.

Methods

Study Population

Since January 1, 1994, the United States Fire Administration, a branch of the Federal Emergency Management Agency, has provided narratives for all reported US firefighting fatalities. From these publicly available summaries, we examined all deaths between January 1, 1994 and December 31, 2004 (Tridata Corporation, 2002; United States Fire Administration, 2001-2004). These include all firefighters who died while on-duty, who became ill on-duty and later died, or who died within 24 h of an emergency response or training. We excluded fatalities that occurred during the first 48 h of the September 11, 2001 terrorist attacks. The Human Subjects Committee of the Harvard School of Public Health determined that our study of this publicly available data was exempt from IRB review and the conduct of the analysis of the data respected the guidelines stipulated by the Journal (Touitou et al, 2006).

Based on the narrative reports, each fatality was classified as a cardiovascular or non-cardiovascular incident. We then excluded those cases in which death occurred more than 24 h following the on-duty incident, or in which death resulted from a cardiovascular problem other than coronary heart disease (certain arrhythmias, stroke, aneurysm, genetic cardiomyopathy, etc.). All fatalities classified by this process as being due to coronary heart disease were then selected for further study. Data on age, sex, job status (professional or volunteer), date, cause, and mechanism of death, and city and state of the fire department were extracted from these records.

Firefighters' duties at time of death

Based upon the narrative for each fatality, deaths were classified according to the specific duty performed during the onset of symptoms or immediately preceding sudden death. These categories were: fire suppression, alarm response, alarm return, training, emergency medical services or other non-fire emergencies, and non-emergency duties. Briefly, a fatality was classified as associated with fire suppression if it occurred while fighting a fire or at the scene of a fire after fire suppression. Alarm response included responses to emergency incidents including false alarms. Alarm return included all events occurring during the return from incidents and those following within several hours of an emergency call. Physical training included any job-related physical fitness activities, physical abilities testing, and/or any type of simulated or live fire, rescues, emergency, or search drill. We grouped together emergency medical services, rescues, and other non-fire emergencies into another separate category. Finally, we classified all of the following activities as non-emergency duties: administrative and fire station tasks, fire prevention, inspection, maintenance, meetings, parades, and classroom activities.

Meteorological data

We assessed the effect of ambient temperature on the risk of on-duty CHD death for all cases occurring between 1994 and 2000. We obtained daily mean ambient temperature, barometric pressure, dew point, and wind speed from the National Weather Service station closest to the location of each death for the day of death and control days (see below). We calculated the apparent temperature, an index of human discomfort, as:

$$AT = -2.653 + 0.994(Ta) + 0.0153(Td^2),$$

where AT is apparent temperature (°C), Ta is ambient temperature (°C), and Td is dew point (°C) (Steadman, 1979; Kalkstein & Valimon, 1986; O'neill et al., 2003). We calculated wind chill temperature as:

$$WT = 35.74 + 0.6215(Ta) - 35.75(V^{0.16}) + 0.4275(Ta)(V^{0.16}),$$

where WT is wind chill temperature (°F), Ta is ambient temperature (°F), and V is wind speed (mph) (National Weather Service, 2006). Wind chill temperature was subsequently expressed in degrees Celsius.

Data Analysis

We assigned season by the month of death as: winter (January to March), spring (April to June), summer (July to September), or fall (October to December). We examined the seasonal and monthly distribution of deaths using the chi-square distribution comparing observed to expected events under the null hypothesis that deaths are evenly distributed over each season/month.

Annual variation in the occurrence of on-duty fatalities were evaluated by fitting the data with the following Poisson regression model:

$$E(Y)=\exp(\alpha+\beta_1\sin(2*\pi*Month/12)+\beta_2\cos(2*\pi*Month/12)+\beta_3\sin(2*\pi*Month/6)+\beta_4\cos(2*\pi*M/6)$$

where E(Y) is the expected case count during a given month, α is an intercept term, and each β_i represents a regression coefficient for a function of month. The model was fit allowing for Poisson over-dispersion. Model goodness-of-fit was assessed using the likelihood ratio test comparing the full model to a model fit only with an intercept term. The result of the likelihood ratio statistic was compared against a χ^2 distribution with 4 degrees of freedom.

We used a bi-directional, time-stratified, case-crossover study design to assess the effect of changes in daily mean temperature (either apparent or wind chill temperature) on the risk of death from CHD for deaths 1994 to 2000. In this design, each subject's exposure on the day of the case-defining event (case period) is compared with his or her own exposure during one or more control days (control periods) when the subject did not become a case (Mittleman et al., 1995). We selected control days according to the time-stratified approach (Levy et al., 2001) comparing exposure (either apparent or wind chill temperature) on the day of the fatality to the same exposure variables occurring on all other days of the same calendar month falling on the same weekday as the death. Since there is perfect matching on measured and unmeasured time-invariant subject characteristics, confounding by chronic risk factors is eliminated. By choosing control days close to the date of each death, we also avoided confounding by season and other long-term time trends (Schwartz et al., 2003).

We hypothesized that the effect of temperature change would differ according to average temperatures. That is, an increase in temperature during a mild or hot period would be more detrimental, while it would be protective in a cold period. To evaluate this hypothesis, cases were classified as having occurred during a mild/hot month if the median temperature among the control days was > 5°C and during a cold month otherwise. We performed conditional logistic regression, stratifying on each death, to obtain odds ratio estimates and 95% confidence intervals associated with a 1 °C increase in temperature. We performed analyses using SAS v9.1 (Cary, NC) and reported all p-values based on two-sided tests, with p-values <0.05 considered evidence of statistical significance.

Results

A total of 449 on-duty CHD deaths were identified among US firefighters between 1994 and 2004 (Table 1). Age at death ranged from 23 to 90 yrs, the median being 52 yrs. Over 75% of on-duty fatalities were older than age 45 yrs and less than 10% were older than 70 yrs. Fire suppression was the most frequently reported last job duty.

On-duty CHD deaths were not evenly distributed throughout the year (Figure 1). When fatalities were grouped by season, we observed a relative peak in winter (32%), a relative deficit in spring (21%), 24% in summer, and 23% in the fall. This pattern showed a statistically significant difference (p=0.005) from the expected distribution under the null hypothesis where season has no effect.

To further evaluate the annual variation in on-duty CHD deaths, we fit a Poisson regression model to the monthly fatality counts. Actual and predicted case counts are shown in Figure 1. The overall goodness-of-fit of the model was excellent $\chi^2_4 = 16.63$; $p = 0.002$). The results indicate the presence of two distinct peaks in on-duty deaths, one in January-February and the other in August-September.

Additional analyses stratifying the deaths by the type of duty in which the firefighters were engaged at the time of their deaths revealed the seasonal pattern was statistically similar (p=0.930) for both strenuous and non-strenuous duties (Figure 2). Additionally, when we compared the distribution of deaths associated with fire suppression to that for all other duties, the winter peak was similar (33% and 32% of fatalities, respectively). The overall seasonal pattern approached statistical divergence (p=0.087), however, because of a spring nadir (15%) and smaller summer peak (30%) for fire suppression-associated fatalities, whereas the frequency of deaths associated with all other duties combined was similar for spring, summer, and fall.

In order to determine whether the annual distribution was related to temperature variation, we examined the association of temperature change with risk of death for the period 1994 to 2000 (Table 2). Overall, there was no significant association between either apparent or wind chill temperature and the risk of on-duty CHD death. Since the effects of temperature might differ by the daily mean value, we examined cases occurring during mild/hot months and cold months separately. In this analysis, we observed a statistically significant 5.1% (95% CI 0.3-10.2%) *increase* in risk associated with a 1°C increase in apparent temperature during the cold months only. Thus, the results do not support the hypothesis that an increase in temperature during a mild or hot period is detrimental, nor that a similar increase in a cold period is protective.

Discussion

Our study is unique in that we examined the impact of seasonality and temperature upon work-associated CHD fatalities in a specific professional group, firefighters. We found statistically significant seasonal patterns for the incidence of CHD death that we could not attribute to temperature. Regardless of how the deaths were stratified, a winter peak was observed, with about one-third of fatalities occurring during the three-month span of January through March.

Our findings of a winter peak in firefighters' CHD fatalities are in general agreement with those of several other previous studies finding a relative excess of cardiovascular events in the winter (Beard et al., 1982; Spencer et al., 1998; Gonzalez et al., 2004; Phillips et al., 2004; Manfredini et al., 2005; Nayha, 2005; Biedrzycki & Baithun, 2006). The annual distribution we observed and fitted with our Poisson regression model also agrees with another investigation suggesting a “V” or “U” shape with the second peak occurring during summer (Donaldson & Keating, 1997).

Our findings of a spring nadir and smaller secondary excess in summer are in variance with several other studies of the general population finding summer nadirs (Spencer et al., 1998; Gonzalez et al., 2004; Manfredini et al., 2005). A possible explanation for our findings regarding summer is the additional heat stress associated with emergency responses in hotter weather, especially among firefighters dressed in full turnout gear for fire suppression. This personal protective equipment can weigh about 50 pounds, and includes a helmet. Additional heat stress can be expected from use of a self-contained breathing apparatus and exposure to direct and radiant heat of a fire. In fact, we did observe the largest secondary summer excess with fire suppression-associated deaths, which are expected to expose firefighters to additional heart stress. In our case-crossover analysis, however, we did not find evidence that an increase in ambient temperature during warmer weather increased risk.

Another difference between our findings and those of several other studies regarding seasonality is that we observed fewer deaths than expected in December. One plausible explanation is that older, senior firefighters take precedence over younger firefighters in obtaining vacation requests during the December holidays, effectively lowering the number of more vulnerable firefighters exposed to on-duty risks. Another possible explanation is simple chance variation.

Notably, in this study, we found that seasonal effects were largely independent of the type of duty firefighters performed. This finding is remarkable because we have consistently found that the risk of an on-duty CHD event varies widely across duties, presumably because of marked differences in the cardiovascular demands of different job tasks (Kales et al., 2003, 2007; Holder et al., 2006). For example, fire suppression, which represents only about 1 to 5% of the annual professional time of firefighters, accounts for about one-third of CHD deaths in firefighters and is associated with roughly 10 to 100 times higher risk of CHD events relative to non-emergency duties. In this investigation, we found the same seasonal pattern consistently superimposed on the larger effects of duty. Elsewhere, for the same span of 1994 to 2004, we determined separately for each of the four seasons the duty-specific odds ratios for CHD death for each duty relative to non-emergency duty (Kales et al., 2007). The resulting point estimates for each duty in each season remained similar in magnitude and close to the range of our original confidence intervals where all cases were pooled regardless of season. Thus, we believe the greatest risk of on-duty CHD death occurs during fire suppression activities carried out in winter.

Our study does have several limitations. First, while our design regarding the effect of temperature controls for “time-invariant” confounders, one cannot assume the firefighters were necessarily exposed to the elements to the same extent on the days preceding their fatal event as they were on the day of death; nor can one assume the firefighters were performing similar duties. Second, our sample size was underpowered to isolate the effect of temperature indices, especially given that the fatalities under study varied with respect to important variables: region, season, and type of duty performed. Third, we could not account for 24 h variation or any association with shift work in this study because this information was not available. Although the seasonal pattern of CHD death among firefighters largely follows that of the general population, the overall 24 h pattern among firefighters is markedly different. We do not know, however, whether this 24 h pattern varies by season. Finally, despite a diligent search, we were unable to find data on the seasonal variation in emergency calls. Thus, we cannot rule out the possibility that our findings reflect differences in the rates of emergency responses by season.

We could not attribute our findings of a relative winter excess in firefighter CHD fatalities to colder temperatures. Nonetheless, previous studies support that during winter, a cluster of adverse physiologic changes occur, including increases in plasma viscosity, serum lipids, coagulation factors, and blood pressure, which can all promote thrombosis (Manfredini et al., 2005). Given the expected changes in physiology accompanying winter and the current findings that deaths attributable to heart disease are more common in winter, fire service authorities and unions should take note and possibly prioritize preventive measures to the span preceding winter. It may be beneficial to explore the effects of more aggressive physical conditioning and risk-factor management leading up to and during the winter season, as well as educate firefighters of the greater winter risk. Further research would be needed, however, to determine the efficacy of such measures.

In conclusion, we found statistical evidence for excess on-duty CHD deaths among US firefighters during winter; however, we did not find evidence linking this pattern to the effects of ambient temperature variation. We also found the seasonal pattern to be independent of duty-related risks. Future research is required to determine the underlying causes of the observed seasonal pattern and whether preventive strategies can mitigate seasonal peaks. In order to better control for temperature and potential seasonal variation in job tasks, such investigations ideally should employ larger sample sizes and focus on groups with fairly consistent job duties and durations of exposure to the outside elements across the seasons and day-to-day.

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References

Beard CM, Fuster V, Elveback LR. Daily and seasonal variation in sudden cardiac death, Rochester, Minnesota, 1950-1975. Mayo Clin Proc. 1982; 57:704–706. [PubMed: 7132431]

Biedrzycki O, Baithun S. Seasonal variation in mortality from myocardial infarction and haemopericardium. A postmortem study. J Clin Pathol. 2006; 59:64–66. [PubMed: 16394282]

Bull GM, Morton J. Environment, temperature and death rate. Ageing. 1978; 7:210–224.

Cagle A, Hubbard R. Cold-related cardiac mortality in King County, Washington, USA 1980-2001. Ann Hum Biol. 2005; 32:525–537. [PubMed: 16147400]

Danet S, Richard F, Montaye M, Beauchant S, Lemaire B, Graux C, Cottel D, Marecaux N, Amouyel P. Unhealthy effects of atmospheric temperature and pressure on the occurrence of myocardial infarction and coronary deaths. A 10-year survey: the Lille-World Health Organization MONICA project (Monitoring trends and determinants in cardiovascular disease). Circulation. 1999; 100:E1–E7. [PubMed: 10393689]

Donaldson GC, Keating WR. Early increases in ischemic heart disease mortality dissociated from and later changes associated with respiratory mortality after cold weather in southeast England. J Epid Community Health. 1997; 51:643–648.

Fahy R. Sudden Cardiac Death: U. S. Firefighter Fatalities due to Sudden Cardiac Death 1995-2004. National Fire Protection Association Journal. 2005; 99:44–47.

Gonzalez Hernandez E, Cabades O'Callaghan E, Cebrian Domenech J, Lopez Merino V, Sanjuan Manez R, Echanove Errazti I, Valencia Martin J. Bertomeu Martinez V for the PRIMVAC study investigators. Seasonal variations in admissions for acute myocardial infarction. The PRIMVAC study. Rev Esp Cardiol. 2004; 57:12–19. [PubMed: 14746713]

Guidotti TL. Human factors in firefighting: ergonomic, cardiopulmonary, and psychogenic stress-related issues. Int Arch Occup Environ Health. 1992; 64:1–12. [PubMed: 1399009]

Holder JD, Stalling L, Peeples L, Burress JW, Kales SN. Firefighter heart presumption retirements in Massachusetts: 1997-2004. J Occup Environ Med. 2006; 48:1047–1053. [PubMed: 17033504]

Kales SN, Soteriades E, Christoudias SG, Christiani DC. Firefighters and on-duty Deaths from coronary heart disease. Environmental Health 6. 2003; 2:14.

Kales SN, Soteriades E, Christophi CA, Christiani DC. Emergency duties and deaths from heart disease among firefighters in the United States. N Engl J Med 2007. 2007; 356:1207–1215.

Kalkstein L, Valimon K. An evaluation of summer discomfort in the United States using a relative climatological index. Bull Am Meterol Soc. 1986; 67:842–848.

Kunst AE, Looman CWN, Mackenbach JP. Outdoor air temperature and mortality in the Netherlands: a time-series analysis. Am J Epidemiol. 1993; 137:331–341. [PubMed: 8452141]

Levy D, Lumley T, Sheppard L, Kaufman J, Checkoway H. Referent selection in case-crossover analyses of acute health effects of air pollution. Epidemiology. 2001; 12:186–192. [PubMed: 11246579]

Maguire BJ, Hunting KL, Smith GS, Levick NR. Occupational fatalities in emergency medical services: a hidden crisis. Ann Emerg Med. 2002; 40:625–632. [PubMed: 12447340]

Manfredini R, Boari B, Smolensky MH, Salmi R, Gallerani M, Guerzoni F, Guerra V, Maria Malagoni A, Manfredini F. Seasonal variation in onset of myocardial infarction-a 7-year single-center study in Italy. Chronobiol Int. 2005; 22:1121–1135. [PubMed: 16393712]

Melius J. Occupational health for firefighters. Occup Med. 2001; 16:101–108. [PubMed: 11107227]

Mittleman M, Maclure M, Robins J. Control sampling strategies for case-crossover studies: An assessment of relative efficiency. Am J Epidemiol. 1995; 142:91–98. [PubMed: 7785679]

Nayha S. Environmental temperature and mortality. Int J Circumpolar Health. 2005; 64:451–458. [PubMed: 16440607]

National Weather Service. [Accessed 5/5/2006] Wind Chill. Available at: http://www.nws.noaa.gov/om/windchill/windchillglossary.shtml

Panagiotakos DB, Chrysohoou C, Pitsavos C, Nastos P, Anadiotis A, Tentolouris C, Stefanadis C, Toutouzas P, Paliatsos A. Climatological variations in daily hospital admissions for acute coronary syndromes. Int J Cardiol. 2004; 94:229–233. [PubMed: 15093986]

Phillips DP, Jarvinen JR, Abramson IS, Phillips RR. Cardiac mortality is higher around Christmas and New Year's than at any other time: the holidays as a risk factor for death. Circulation. 2004; 110:3781–3788. [PubMed: 15596560]

Schwartz, J.; Zanobetti, A.; Bateson, TF. Special report. Vol. 7. Boston, MA: Health Effects Institute; 2003. Morbidity and mortality among elderly residents in cities with daily PM measurements. Revised analyses of time-series studies of air pollution and health; p. 25-58.

Spencer FA, Goldberg RJ, Becker RC, Gore JM. Seasonal distribution of acute myocardial infarction in the second National Registry of Myocardial Infarction. J Am Coll Cardiol. 1998; 31:1226–1233. [PubMed: 9581712]

Steadman R. The assessment of sultriness. (1979). Part I: A temperature-humidity index based on human physiology and clothing science. J Appl Meteorol. 18:861–873.

Tridata Corporation. Firefighter Fatality Retrospective Study (April 2002). Prepared for Federal Emergency Management Agency, United States Fire Service, National Fire Data Center; Arlington, VA: 2002.

Touitou Y, Smolensky MH, Portaluppi F. Ethics, standards, and procedures of animal and human chronobiology research. Chronobiol Int. 2006; 23:1083–1096. [PubMed: 17190696]

United States Fire Administration. [accessed 11/04/2006] Firefighter Fatalities. 2001, 2002, 2003, 2004. Available at: http://www.usfa.fema.gov/fatalities/

Washburn AE, LeBlanc PR, Fahy RF. 1997 Firefighter Fatalities. National Fire Protection Association Journal. 1998; 92:50–62.

Abbreviations

CHD	Coronary Heart Disease
US	United States
IRB	Institutional Review Board
AT	Apparent Temperature
Ta	ambient temperature
Td	dew point
WT	Wind chill Temperature
V	wind speed

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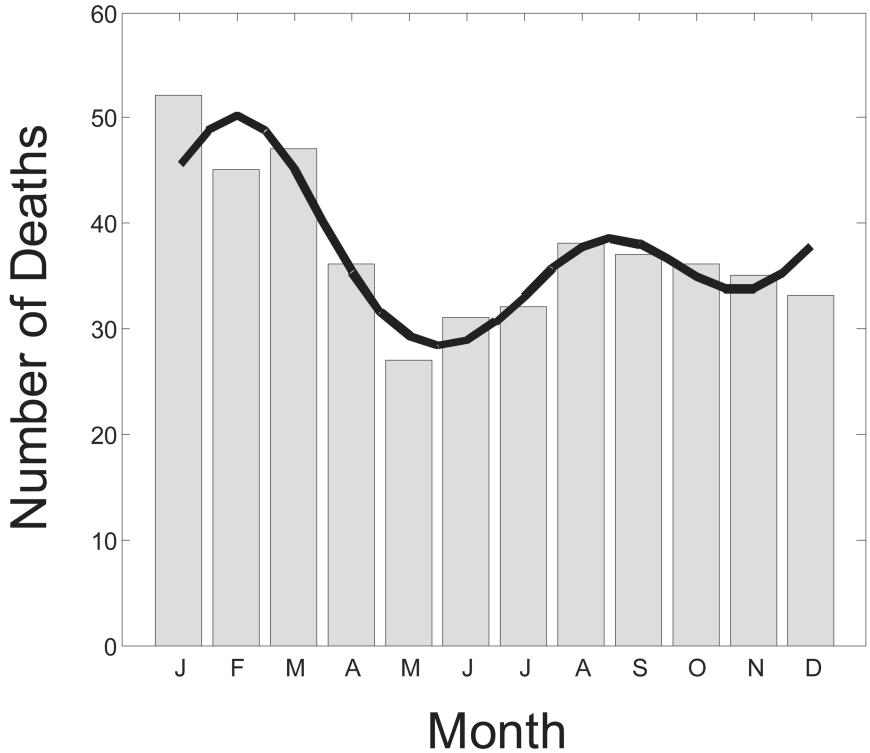

Figure 1.
Distribution of on-duty coronary heart disease deaths among US firefighters. Bars represent actual number of deaths occurring in each calendar month. The dark curve represents the number of deaths predicted by a multivariable Poisson regression model including sine and cosine terms. Legend: y-axis, number of deaths; x-axis, calendar month of death, January through December.

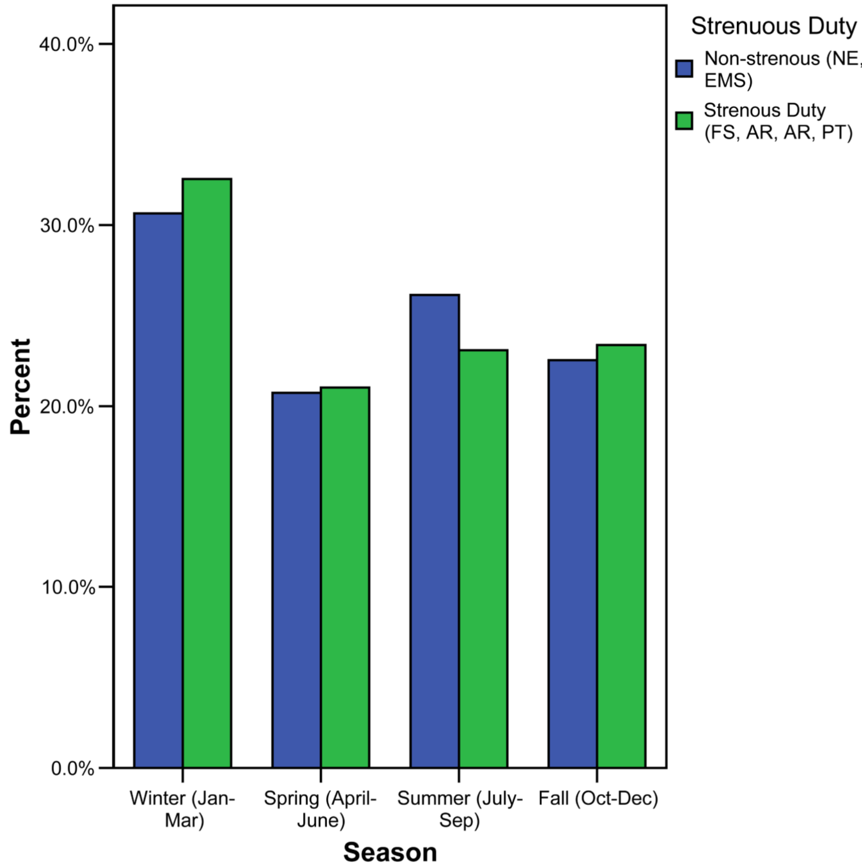

Figure 2.

Seasonal Distribution of On-Duty Coronary Heart Disease Deaths among United States Firefighters, by duty type. Legend: y-axis, percent of fatalities; x-axis, season of death. Blue bars represent non-strenuous duty at time of death (non-emergency duty or non-fire emergencies). Green bars represent strenuous duty at time of death (fire suppression, alarm response or return, or physical training).

Table 1

Characteristics of on-duty CHD deaths among US firefighters, 1994-2004.

	On-Duty CHD Fatalities (n=449)
Age, mean ± SD	53.0 ± 11.0
Male, n (%)	442 (98.4)
Employment Status, n (%)	
Volunteer	281 (64.9)
Professional	148 (34.2)
Last Job Duty, n (%) *	
Fire suppression	144 (32.1)
Alarm response	60 (13.4)
Returning from alarm	78 (17.4)
Physical Training	56 (12.5)
Non-fire emergencies	42 (9.4)
Non-emergencies	69 (15.4)

* Non-fire emergencies and Non-emergencies were considered “non-strenuous duty”.

Table 2

Relative risk (95% CI) of on-duty CHD death among US firefighters associated with a 1°C increase in apparent temperature or wind chill temperature, 1994-2000.

Outcome	All Cases 1994-2000 (n=283)	Month[b]		P_{homo}
		Mild/Hot (n=172)	Cold (n=111)	
Apparent Temperature	1.012 (0.983, 1.042)	0.989 (0.953, 1.026)	1.051 (1.003, 1.102)	0.044
Wind Chill Temperature	1.009 (0.983, 1.034)	0.980 (0.941, 1.020)	1.028 (0.995, 1.063)	0.066

[b]Cases were classified as occurring during a mild/hot month if the median temperature of the control spans for that case was > 5°C and during a cold month otherwise.