

EDITORIALS



Firefighting and Death from Cardiovascular Causes

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Among the approximately 1.1 million firefighters in the United States (of whom about 70% are volunteers and 30% are paid career personnel), about 100 die each year in the line of duty.¹ With the exception of 2001, when 344 firefighters died as a result of the events of September 11 at the World Trade Center in New York City, the number of deaths per year has stayed relatively steady, even though the number of structural fires in the United States has been steadily decreasing. Nearly half of the deaths that occur while firefighters are on duty are related to cardiovascular events, and, in this issue of the *Journal*, Kales et al.² describe an innovative approach to improving our understanding of this risk. Their findings shed light on sudden cardiac events and their prevention, not just for this vital and revered profession, but also for those who may encounter some of the same risks at work or elsewhere.

Firefighting is a high-hazard job, and the work is at times extremely physically demanding. It involves heavy lifting and maneuvering in sometimes awkward and unstable positions while wearing heavy clothing and protective gear in a hot environment.³ In addition, exposure to carbon monoxide and particulate matter in the air is routine, and there is a highly variable risk of exposure to a broad array of other toxic chemicals generated from the smoke of burning materials.

It is not surprising that firefighters face an increased risk of illness and death due to cardiovascular disease during periods of intense physical and even psychological stress at work. However, numerous mortality studies, some of which have shown evidence of an increased risk of some cancers (e.g., brain tumors and leukemia) and non-malignant respiratory diseases, have not shown any consistent evidence of an increased risk of

death from cardiovascular disease.³⁻⁵ Why not? First, firefighters as a group quintessentially show a “healthy worker effect.” That is, by the very nature of their generally high levels of fitness and health (mandated for all entry-level career firefighters and sometimes required for volunteers), they would be expected to have a lower risk of death (particularly due to cardiac events) than the general population. And they do — on average, a firefighter’s risk of dying from coronary heart disease is about 90% (standardized mortality ratio, 0.9) that of others in the general population. Thus, firefighters overall may not have an excess risk of dying from heart disease, or if they do, the excess risk is small. There is some suggestion of the latter, since many working industrial populations have an even lower risk of dying from coronary heart disease (standardized mortality ratio, 0.8) than firefighters as compared with the general population. One would expect firefighters to fare at least as well. Second, the overall mortality remains a definitive but crude measure of the relationship between exposure hazards and health, and most importantly, of the benefits of prevention. So, even if firefighters have little or no excess risk of death due to cardiovascular disease, there are reasons to both understand and try to prevent the cardiovascular events that do occur, including those that occur on the job.

Kales and colleagues build on the observation that cardiovascular events that occur while firefighters are on duty appear to cluster around specific activities (e.g., fire suppression and emergency response) and on their own earlier case-control study suggesting that specific duties are associated with deaths due to coronary heart disease.⁶ In this study, they reviewed data on all deaths that occurred while firefighters were on

duty over an 11-year period (1144 deaths). With the use of all available records, they independently classified these deaths according to cause and firefighting duty at the time of death. What is most compelling about this study is their effort to quantify the excess risk of dying during specific firefighting duties. They calculated odds ratios for death by comparing five specific emergency duties (e.g., fire suppression and alarm response) with nonemergency duties. These comparisons were based on three separate sources of data indicating how much time firefighters typically spend in each of these activities. Measures of the distribution of duty time are variable and imprecise, but the findings of Kales et al. are sufficiently large (e.g., the odds of death from coronary heart disease during fire suppression were 10 to 100 times as high as during nonemergency duties) to overcome concern that the direction of the results is wrong because of misclassification errors. They overcome at least part of the effect of the selection of healthy workers by making comparisons among groups of firefighters. In fact, the selection process according to health that may keep firefighters out of emergency duties without keeping them out of work may, if anything, lead to an underestimation of their odds of death from coronary heart disease.

The authors have not set out to show nor have they shown an overall increased risk of death from coronary heart disease among firefighters. However, they have convincingly shown that such an event is far more likely to occur during specific duties — dramatically so during fire suppression, but also during alarm response and return and physical training. When healthy workers die at work of “natural” causes, their deaths are predominantly from sudden cardiac events. The finding that these events might cluster around or be triggered by specific duties is also not new, so this pattern of increased deaths during emergency duties should not surprise us but should inform us.

Numerous studies over several decades have shown the role of heavy exertion — from snow shoveling to recreational exercise — in triggering sudden myocardial events and the protective role of regular exercise in mitigating them.⁷⁻⁹ This paradox — that regular exertion is good even though an episode may trigger an adverse event — is not a reason to dismiss these findings, but it should call for caution. Relative measures of association may be high because the incidence rate in the

risk period (emergency situations) is high or because the incidence rate in the reference period (nonemergency situations) is low, or both. A physical fitness program may lower the incidence rate during the reference period (nonemergency duties) more than during the risk period, and thus it may increase the odds ratios for death during the risk period, even in a situation in which the overall mortality due to cardiovascular diseases is reduced. The evaluation of a preventive program — a step that naturally follows these findings — should take the overall mortality into consideration.

Firefighters have episodic exposure to extreme levels of physical exertion, and they face occupational hazards that may add to or amplify their risk of death due to cardiovascular causes. These hazards include chemicals (carbon monoxide, fine particulate matter, and other cardiac toxins) and thermal and emotional stress. Moreover, although there has been improvement over time in respiratory protection during active fire suppression, such protection may be abandoned during overhaul (the period immediately after fire suppression), when exposure to fine particulate matter (which has been shown to increase the risk of a sudden myocardial infarction) and other toxic chemicals may be particularly high.¹⁰ Firefighters enter the workforce particularly healthy, but they do not necessarily maintain that attribute over time. There is ample evidence that firefighters are not immune to the hazards of overeating and inadequate regular exercise. For a variety of reasons, including not only the nature of their work but also disability plans and presumptive legislation about work-related health conditions, career firefighters rarely serve as active firefighters after 50 years of age. Volunteer firefighters, in contrast, often serve with fewer entry and ongoing fitness requirements, but they serve until an older age, when most cardiac events occur. In 2005, of 115 deaths that occurred during on-duty activities, 81 (70%) occurred among volunteer firefighters.¹¹

The implications of this study for firefighters are clear. Modifiable risk factors, whether or not they are related to occupation, should be aggressively addressed. We concur with the recommendations of the National Institute for Occupational Safety and Health arising from the Fire Fighter Fatality Investigation and Prevention Programs. First, fire departments should provide mandatory

preplacement and annual medical examinations for all firefighters. These evaluations should include medical clearance for firefighters to wear self-contained breathing apparatuses. Second, wellness and fitness programs should be implemented to reduce risk factors for cardiovascular disease, and third, all firefighters should have annual physical performance evaluations.¹²

For firefighters as well as other workers who may face some of these risk factors for cardiac events, decreasing or eliminating occupational risk factors other than heavy exertion (e.g., chemicals, stress, and shift work) is likely to be of benefit. For all workers, whether or not they have physically demanding jobs, the evidence is clear, and this study provides further support for the idea that virtually all sudden deaths from cardiac causes are secondary to underlying coronary disease. Thus, although at least moderate exercise may mitigate the trigger effects of extreme exertion, minimizing the overall risk involves the usual menu of primary and secondary prevention measures. These measures include promoting healthy behaviors (such as a heart-healthy diet, no tobacco or excessive alcohol, and regular exercise) and modifying conditions (such as hypertension, diabetes, and obesity) that pose additional risks.

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An interview with Dr. Rosenstock can be heard at www.nejm.org.

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Modern Genetics, Ancient Defenses, and Potential Therapies

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Autoimmunity is the reflection of a basic problem confronting all living organisms — how to defend against foreign invasion while maintaining control of the defending forces. The B-cell and T-cell branches of the immune system can exhibit remarkable specificity for invading microorganisms, can adapt to changing threats, and can provide for long-term immunologic memory. At the same time, autoreactivity of B cells and T cells is present in all normal persons, and a complex set of regulatory mechanisms is required to prevent overt destruction of tissue through autoimmunity.

Our current understanding of autoimmunity rests on our knowledge of the immune system. Over the past 50 years, scientists have concentrated on the adaptive immune system, with a major focus on the diversity and specificity of autoantibodies and the ways in which T cells are regulated.¹ Recently, however, high-throughput genetic and genomic studies have begun to focus attention on the innate immune mechanisms in autoimmunity. The report by Jin et al.² in this issue of the *Journal* is one such study.

The innate immune system is a phylogenetical-