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CARDIOVASCULAR RISK FACTORS IN STRUCTURAL FIREFIGHTERS

Firefighting is an inherently dangerous and stressful occupation requiring a high level of cardiovascular fitness. However, each year, thousands of structural firefighters are injured or die in the line of duty, with sudden cardiac death (SCD) remaining a leading cause of on-duty fatalities. In 2023, the National Fire Protection Association (NFPA) reported 89 firefighter deaths in the United States, 48 of which were attributed to SCD (7). For every on-duty sudden cardiac death, approximately 17 non-fatal cardiovascular events occur (40). Factors contributing to this risk include obesity, poor nutrition, environmental and thermal stress, sleep deprivation, and a sedentary lifestyle (see Figure 1). This review examines the multifaceted causes of cardiovascular risk among firefighters and suggests potential interventions to mitigate these dangers.

CARDIOVASCULAR RISK FACTORS IN FIREFIGHTERS

SCD is the leading cause of on-duty structural firefighter deaths and a significant cause of mortality in Western countries (4,7,26). SCD in this context is defined as a death occurring within 24 hr of strenuous or stressful on-duty activity (8,26). Common risk factors include obesity, smoking, hypertension, and type 2 diabetes, with obesity showing a powerful association (4). Between 24 – 34% of United States firefighters are classified as obese using body mass index (BMI) standards; however, BMI may overestimate risk in individuals with high muscle mass (29). Nonetheless, the high prevalence of excessive body fat underscores a potentially serious health concern. Firefighters face unique occupational stressors that compound traditional cardiovascular risks. During fire suppression, heart rates can reach close to maximum levels, placing a significant strain on the cardiovascular system (40).

THERMAL AND PHYSIOLOGICAL STRESS

Firefighting exposes workers to extreme heat generated by both fires and the heavy, insulated protective gear required for safety. Firefighting activities have been shown to decrease in stroke volume in the heart and exhibit other signs of cardiac fatigue (14,17,41). The International Society of Sports Nutrition (ISSN) recommends daily water intakes of 2.7 L for women and 3.7 L for men, with electrolyte solutions during operations to replace sweat losses (16). Failure to maintain hydration can reduce cardiac output and oxygen delivery, potentially precipitating infarction and SCD.

Sleep deprivation further compounds cardiovascular strain (2). Firefighters often suffer from sleep deprivation (20,28,36,46). Chronic sleep loss increases inflammatory cytokines and disrupts cardiovascular recovery. Combined with sustained physical stress and heat exposure, this creates a potent environment for cardiac dysfunction.

Firefighters are also routinely exposed to environmental toxins through smoke, fuel spills, and chemical incidents. Even their protective gear contains per- and polyfluoroalkyl substances (PFAS) linked to chronic disease (10,18,37). Repeated exposure to such toxins has been associated with long-term cardiovascular and metabolic damage.

PHYSICAL, ENVIRONMENTAL, AND BEHAVIORAL STRESSORS

Firefighting demands prolonged physical exertion in hostile environmental or ambient conditions. Near-maximal effort in extreme heat challenges the body's ability to maintain perfusion and temperature balance. Protective gear traps heat and sweat, which reduces evaporative cooling and causes dehydration (24,50). As a result, blood viscosity and cardiac afterload are increased. According to Poiseuille's law, elevated viscosity raises resistance, forcing the heart to work harder to maintain circulation (6,47). This strain, coupled with reduced pulmonary gas exchange, diminishes oxygen delivery and increases the risk of ischemia or infarction—especially in those with preexisting cardiovascular disease (11).

ENVIRONMENTAL EXPOSURE

Firefighters are frequently exposed to polluted air containing fine particulate matter, which has been directly linked to cardiovascular morbidity (1). While single exposures may not cause chronic illness, cumulative exposure dramatically increases disease risk. The World Trade Center disaster exemplified this danger: responders exposed to toxic dust containing cement, metals, and asbestos later developed respiratory and cardiovascular diseases at elevated rates (1,30).

PSYCHOSOCIAL STRESS AND SLEEP DEPRIVATION

Firefighting also imposes heavy psychological burdens. Regular exposure to traumatic events contributes to high rates of depression and post-traumatic stress disorder (PTSD). The US Fire Administration reports suicide rates of 18 per 100,000 among firefighters—higher than the general population—underscoring chronic occupational stress (15). Studies link workplace stress to cardiovascular mortality, arterial stiffness, and impaired sleep quality (9,12,51).

Chronic stress elevates cortisol, a hormone that, in excess, contributes to hypertension, insulin resistance, and adiposity—all risk factors for heart disease (9,19). Increased systemic inflammation, another stress response, promotes atherosclerosis by damaging the vascular endothelium and facilitating plaque deposition (19,29,40). Over time, this process can narrow arteries, increase afterload, and precipitate cardiac events (9,19,29,40).

Sleep deprivation worsens these outcomes. Approximately 73% of firefighters report inadequate sleep during shifts (3). Insufficient rest elevates oxidative stress and inflammatory markers, increasing the risk for cardiovascular disease, obesity, and even cancer (19,34,42,44,48,49). These physiological and psychological stressors interact, amplifying one another and compounding cardiovascular risk.

LIFESTYLE FACTORS AND OCCUPATIONAL CULTURE

Many cardiovascular risks in the fire service stem from modifiable lifestyle behaviors. Despite being classified as tactical athletes, firefighters often mirror the broader population's health habits—frequently consuming calorie-dense, nutrient-poor foods and leading sedentary lives (24,39).

NUTRITION

Firehouse meals are often communal and centered on convenience, favoring processed foods, red meats, and high-sodium dishes typical of the Standard American Diet (25,39). This dietary pattern contributes to obesity, hypertension, and dyslipidemia. Time constraints, shift work, and unpredictable call schedules contribute to a reliance on such foods.

Transitioning toward a Mediterranean-style diet—rich in fruits, vegetables, whole grains, lean proteins, and healthy fats—has been shown to reduce cardiovascular risk and improve lipid profiles (23,31). Education and cultural changes are essential, as food traditions within the fire service are deeply ingrained. Nutrition initiatives and peer-mentoring programs can promote healthier choices without disrupting camaraderie.

PHYSICAL ACTIVITY

Although firefighting requires intermittent intense exertion, many firefighters are sedentary outside of work. Soteriades et al. found that over half of firefighters reported little or no physical activity beyond their job duties (29). This falls short of the World Health Organization's recommendation of 150 – 300 min of moderate-intensity activity per week (5). Sedentary behavior contributes to obesity, hypertension, and reduced aerobic capacity—all of which elevate cardiovascular risk.

Structured fitness programs within departments can improve health outcomes. Aerobic and resistance training enhance cardiorespiratory fitness, lower blood pressure, and improve insulin sensitivity. Exercise also reduces anxiety and depression, providing dual benefits for both physical and mental health.

TOBACCO USE

Tobacco use remains another preventable risk factor. A 2015 national survey found that 21% of firefighters used tobacco—higher than the general US population (21). While cigarette smoking has declined, smokeless tobacco use has increased (35). Both forms are linked to hypertension, atherosclerosis, and cancer. Enhanced cessation programs addressing smokeless tobacco specifically, combined with workplace support and incentives, could significantly reduce this risk.

PREVENTION AND INTERVENTION STRATEGIES

Cardiovascular disease risk factors among firefighters can be categorized into two groups: preventable and non-preventable. Non-preventable risks include genetic predispositions, unavoidable occupational exposures, and inherent elements of sleep disruption associated with shift work. Preventable risks, including diet, exercise habits, and tobacco use, offer the most significant opportunity for improvement.

FITNESS AND EXERCISE

Consistent physical activity is among the most effective ways to mitigate cardiovascular risk (13,38). Regular exercise improves aerobic capacity, reduces fat mass, and enhances resilience to physical stressors encountered on the job (27). Departments should prioritize structured fitness programs, annual assessments, and access to exercise facilities—resources that also demand municipal policies, funding, and experts in tactical strength and conditioning (32). Research consistently shows that physically fit firefighters experience fewer cardiac events and recover more effectively from high-intensity exertion.

NUTRITION AND HYDRATION

Improving nutritional education is equally vital. Implementing wellness programs that teach meal planning, hydration strategies, and the benefits of a Mediterranean-style diet can lead to long-term cultural shifts (23,31). During operations, maintaining hydration with water and electrolyte solutions helps sustain cardiovascular performance and prevent heat-related cardiac strain.

STRESS MANAGEMENT AND SLEEP

Given the psychological toll of firefighting, mental health resources are critical (45). Peer-support teams, counseling services, and mindfulness-based programs can reduce stress and cortisol levels. Departments can also modify shift structures to improve sleep opportunities, such as implementing 48/96 schedules or nap-friendly policies during extended shifts. However, more research is needed in these areas to ensure efficacy.

TOBACCO CESSATION

Comprehensive cessation programs should address both smoking and smokeless tobacco use. Incentive-based approaches, such as reduced insurance premiums or wellness bonuses, may encourage participation (22,33). Departments that integrate cessation support into broader wellness initiatives report higher success rates and improved overall morale (22,33).

CONCLUSION

Firefighting is a noble, yet perilous profession. Beyond the immediate dangers of flames and collapsing structures, firefighters face a silent and pervasive threat—cardiovascular disease. The combination of extreme physical exertion, heat stress, sleep deprivation, poor diet, and occupational exposure creates a perfect storm for cardiac events. However, many of these risks are modifiable. Through structured exercise, improved nutrition, adequate hydration, and tobacco cessation, firefighters can significantly reduce their risk of developing cardiovascular disease. Organizational support, education, and cultural change within departments are key to sustainable success. Resources like the International Association of Fire Fighters (IAFF) and International Association of Fire Chiefs (IAFC) Wellness-Fitness Initiative and the ISSN's Position Statement on Tactical Athlete Nutrition, Supplementation, and Hydration are good starting points for those looking to implement change within the fire service (16).

Firefighters dedicate their lives to protecting others; by adopting evidence-based wellness strategies, they can better protect their own. Through targeted prevention and intervention, firefighters can transform this high-risk profession into one that not only saves lives but sustains them.

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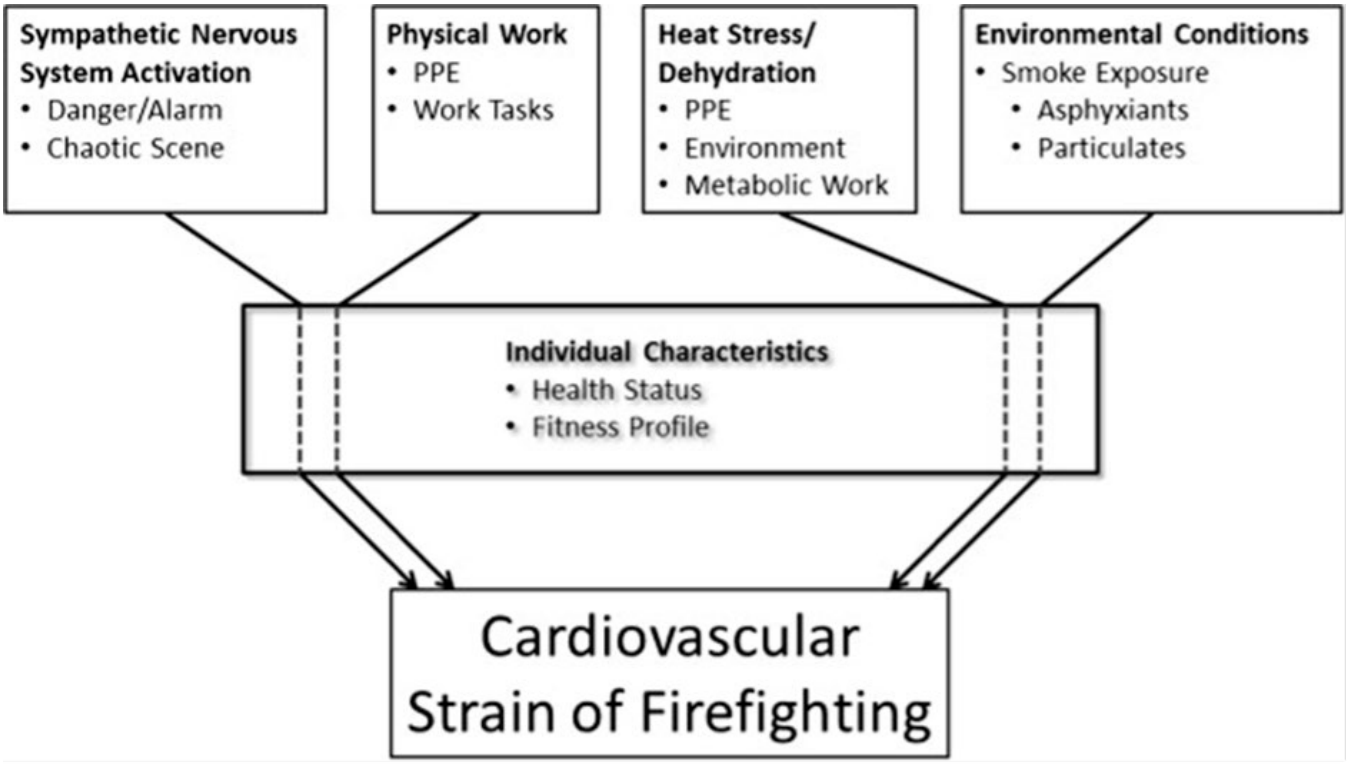

FIGURE 1. FACTORS AFFECTING THE CARDIOVASCULAR STRAIN ASSOCIATED WITH FIREFIGHTING

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