



Heart Disease in the Fire Service

IDENTIFYING THE SYMPTOMS • GUIDE FOR PREVENTION

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Acknowledgements

HEART DISEASE IN THE FIRE SERVICE

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Heart Disease in the Fire Service

CHAPTER 1 • INTRODUCTION

The cardiovascular system consists of the heart and vessels (arteries, vein and capillaries) that circulate blood through the body. The heart continuously pumps blood through the vessels of the circulatory system. If the heart stops beating and cardiopulmonary resuscitation is not started within a few minutes, serious brain damage and death will occur.ⁱ Cardiovascular diseases (CVD) are those diseases affecting the cardiovascular system, and thus, affect the function of the heart and/or the blood vessels. CVD is common in the general population and is especially important to fire fighters and emergency medical responders because their jobs may expose them to unique cardiovascular risks. In particular, fire fighting is recognized as a hazardous occupation.ⁱⁱ Although many people may assume that burns and smoke inhalation are the cause of most fire fighter fatalities, CVD is actually the single most frequent cause of duty-related fatalities.ⁱⁱⁱ CVD accounts for almost half of all on-duty fatalities and for every on-duty death from heart disease, there are an estimated 17 non-fatal line of duty cardiovascular events in the U.S. fire service.^{iv}

Commonly, CVD is referred to as heart or cardiac disease. As shown in Figures 1.1 and 1.2, heart disease is a major killer of both men and women in the general populations of the United States and in Canada.

Even though heart or cardiac disease is a major cause of death, it can be prevented and treated. Moreover, increased awareness of risk factors, such as smoking, hypertension and high cholesterol, and improvements in detection, treatment, and risk factor reduction have resulted in a decrease in cardiovascular mortality since 1980.^{vii,viii} Recent cardiovascular mortality trends from the United States and Canada are presented in Figures 1.3 and 1.4.

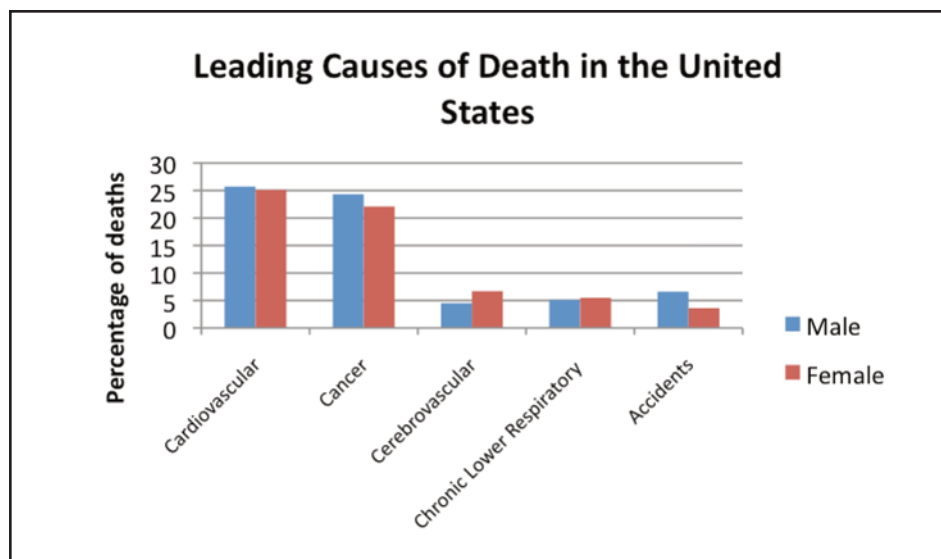


Figure 1.1^v

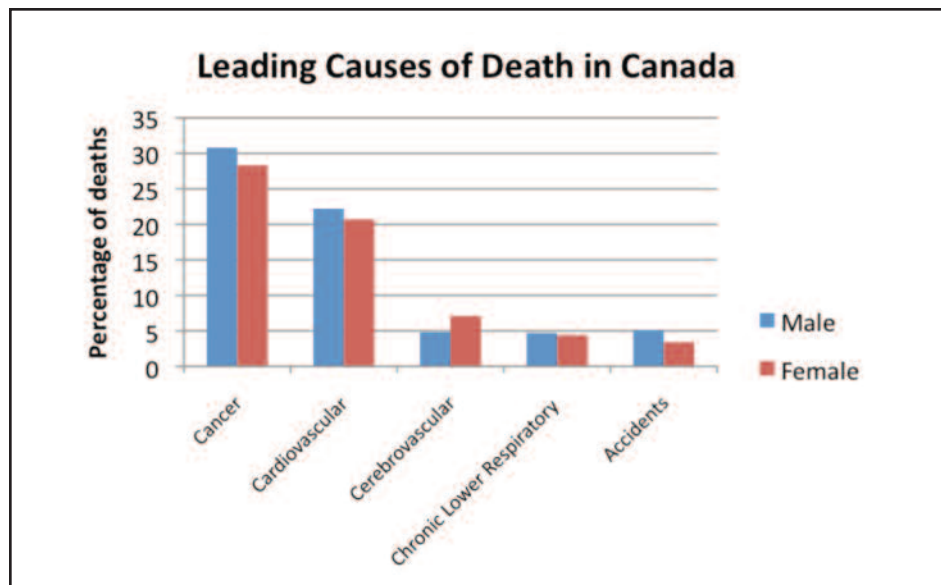


Figure 1.2^{vi}

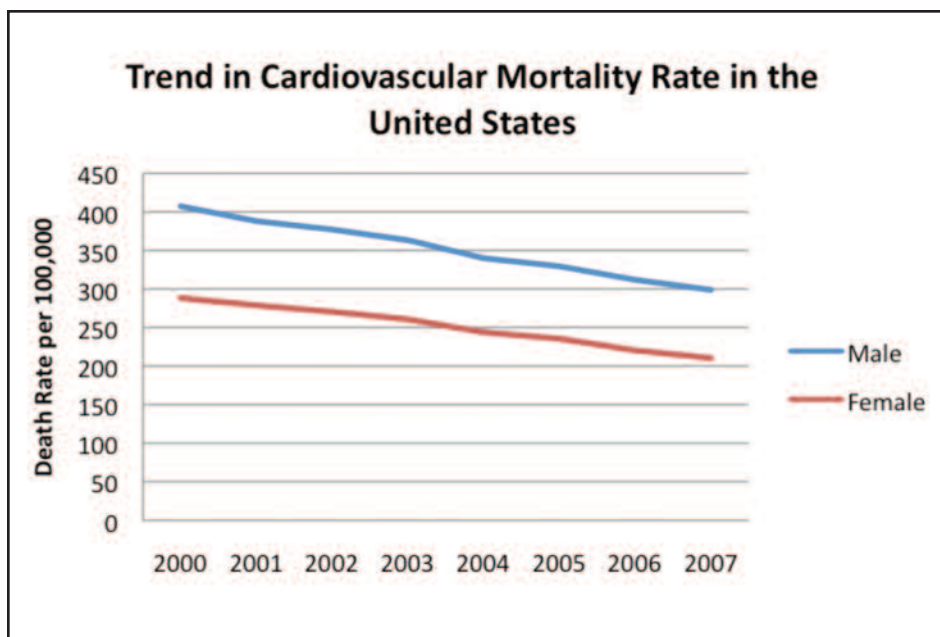


Figure 1.3 ^{ix}

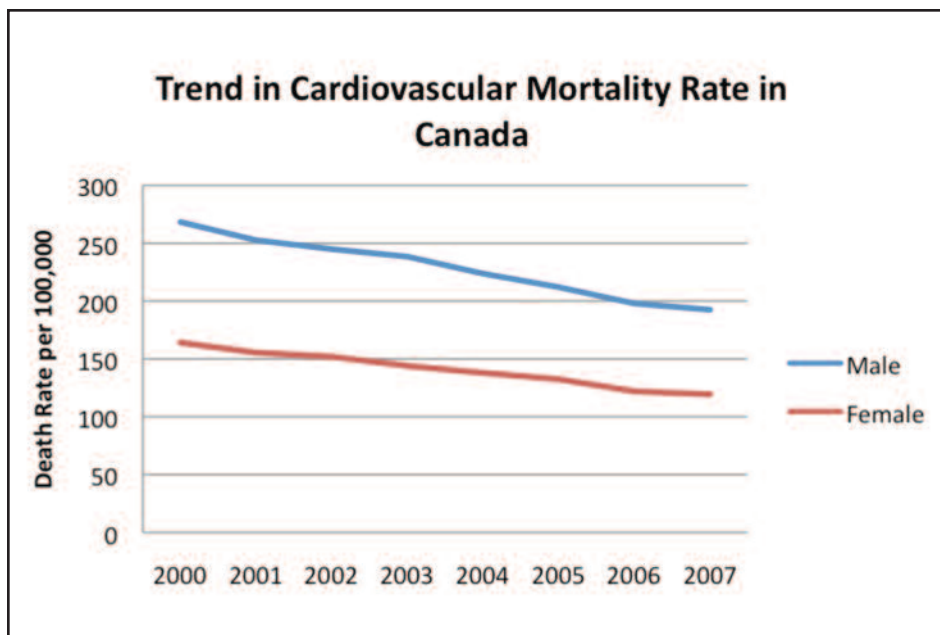


Figure 1.4 ^x

This manual is written for fire fighters and emergency medical responders, a group of individuals who face special risks of cardiac disease or CVD. The manual contains a review and an analysis of several topics, including the evidence that fire fighters and emergency medical responders may be at increased risk for developing heart disease, the normal anatomy and function of the heart, the types of diseases that afflict the heart, the factors that increase fire fighters' risk of developing heart disease, and what fire fighters and emergency medical responders can do to prevent heart disease. Information is also included that addresses the Public Safety Officers Benefits Program in the United States and a review of provincial and state heart legislation.

The International Association of Fire Fighters knows you will find this manual to be informative and useful. ■

ⁱ van Lommel P, van Wees R, Meyers V, Elfferich I. Near-death experience in survivors of cardiac arrest: a prospective study in the Netherlands. *Lancet*. 2001;358:2039-45.

ⁱⁱ Bureau of Labor Statistics, U.S. Department of Labor, Occupational Outlook Handbook, 2010-11 Edition, Fire Fighters, on the Internet at <http://www.bls.gov/oco/ocos329.htm> (visited September 7, 2011).

ⁱⁱⁱ Kales SN, Soteriades ES, Christophi CA, et al. Emergency duties and deaths from heart disease among firefighters in the United States. *N Engl J Med*. 2007;356:1207-1215.

^{iv} Karter MJ, Molis JL. *Firefighter Injuries*. Quincy, MA: National Fire Protection Association; 2005.

^v Heron M. Deaths: Leading Causes for 2007. National Vital Statistics Reports; vol. 59, no. 8. Hyattsville, MD: National Center for Health Statistics. 2011.

^{vi} Statistics Canada. 2010. Leading Causes of Death in Canada, 2007. Catalogue no. 84-215-2010001. Table 2.

^{vii} Ford ES, Ajani UA, Croft JB, Critchley JA, Labarthe DR, Kottke TE, Giles WH, Capewell S. Explaining the decrease in US deaths from coronary disease, 1980–2000. *N Engl J Med*. 2007; 356:

2388–2398.

^{viii} Capewell S, Ford ES, et al. Cardiovascular risk factor trends and potential for reducing coronary heart disease mortality in the United States of America. *Bulletin of the World Health Organization* 2010; 88:120-130. doi: 10.2471/BLT.08.057885.

^{ix} Division of Vital Statistics, Age-Adjusted Death Rates for 113 Selected Causes: United States 1999-2007. Table GMWK293R. National Center for Health Statistics. Hyattsville, MD: National Center for Health Statistics. 2007.

^x Statistics Canada. 2010. Mortality Summary List of Causes. Catalogue no. 84F0209X1E.

Heart Disease in the Fire Service

CHAPTER 2 • HEART DISEASE AND THE OCCUPATION OF FIRE FIGHTING

Fire fighting is recognized as a dangerous occupation. There are over one million North Americans involved in carrying out this vital public service. Although many persons assume that burns and smoke inhalation cause most on-duty deaths, as previously mentioned, heart or cardiovascular disease (CVD) is the single most frequent cause of duty-related fatalities among US fire fighters. CVD accounts for almost half of all fatalities, with 90% caused by coronary heart disease (CHD).^{i,ii} In addition, for every fatal on-duty heart disease (HD) event, there are an estimated 17 non-fatal, line-of-duty CVD events in the US fire service.ⁱⁱⁱ This chapter reviews the evidence regarding associations between fire fighting as an occupation and heart disease by examining four areas: fire fighting and lifetime risk of CVD (cohort mortality studies); CVD as a proportion or fraction of deaths (proportionate mortality); strenuous duties as a trigger for acute CVD events; and temporal variations in CVD events (circadian or daily variations). Strong evidence linking fire fighting to heart disease events comes from the latter three areas with the most robust evidence deriving from studies in the last decade linking specific fire service duties to very high risks of CVD deaths.

A) FIRE FIGHTER MORTALITY STUDIES

The method commonly used to investigate associations between a disease and a specific job is cohort mortality study. A mortality study compares the risk of death from a disease, such as cardiovascular disease, in a group or cohort of people, such as fire fighters, to a reference population.

In a fire fighter CVD mortality study, the number of deaths from CVD in a group of fire fighters is compared to the number of CVD deaths from a reference population. The result will be a ratio of the number of observed deaths in the fire fighters compared to the number of deaths in the reference or comparison

population. The ratio is called a standardized mortality ratio (SMR). If a study demonstrated that fire fighters had increased CVD deaths, the SMR would be greater than 1.0, and a statistical test would indicate a 95% or greater likelihood of the result exceeding 1.0 for reasons other than chance variation. One immediate weakness of this design is that it does not count heart disease per se, but only heart disease deaths. For example, if a fire fighter developed CVD and retired as a result, but later died from another disease, that case would not be counted towards heart disease in the mortality study.

On balance and taken together, cohort mortality studies demonstrated two main findings. First, CVD or heart disease accounts for about 35% of deaths among fire fighters, which is similar to the general population. Second, on balance, the average SMR for coronary heart disease in fire fighters is about 0.9 or 10% lower compared to that of the reference populations.^{iv,v} Haas et al.^{vi} published a review of cohort mortality studies that reported SMRs for fire fighters compared to the general U.S. population. Although most SMRs reported for coronary artery disease were lower than the reference population, one study found an SMR from heart disease of 1.99 for fire fighters with over 30 years of service, which was higher than the reference population. These findings suggest the “healthy work effect”, described below, may be masking actual differences in CVD mortality among fire fighters.

Ideally, the only difference between the groups should be the exposure from fire fighting, with both groups sharing characteristics of race, gender, lifestyle, etc. A typical comparison group for fire fighters is the adult white male population in North America. However, there are significant differences between the general adult white male population and fire fighters that can make conclusions of mortality studies subject to debate. One such difference that is often observed in mortality studies is the “healthy worker effect” (HWE). The HWE is a type of “bias” or error that

results in an observed decrease in mortality in workers when compared with the general population.^{vii} There are many sources of a potential HWE in mortality studies. For example, fire fighters are selected for employment on the basis of certain rigorous criteria. These include written tests, medical examinations and physical abilities testing. Many individuals in the general population with existing medical problems, disabilities, or who otherwise cannot meet the criteria are not necessarily comparable to fire fighters. As a result of this “selection bias”, fire fighters as a group should be healthier than the general population, and would be expected to have a lower number of deaths from CVD than the general population that includes individuals who work less demanding jobs, are not working at all, as well as those with pre-existing medical illnesses.^{viii} Thus, the HWE can mask excess mortality due to harmful exposures from firefighting. It is estimated that the HWE reduces the overall death rate among workers to about 80% of the rate in a reference population.^{ix}

Another weakness of previous studies is they lack any information on individual fire fighters’ work exposures and personal risk factors for CVD. These differences among individual fire fighters can also influence results of mortality studies because exposure to potential cardiovascular risk factors varies within a group of fire fighters. For example, one fire fighter may have a significantly greater exposure to hazards than another over the course of a career. Lacking comprehensive exposure data, researchers use duration of employment as a proxy for exposure, so particular exposures that may cause increased mortality in a proportion of fire fighters would tend to be underestimated in mortality studies. Finally, because most mortality studies rely on information from death certificates, errors and/or inconsistencies in the reported cause of death may result in inaccurate heart disease death counts.

In an effort to interpret conflicting results of mortality studies, researchers

have re-analyzed results from prior studies to ascertain if there is an increased risk of CVD mortality among fire fighters. Choi^x took the results of 23 previously published studies, of which 7 showed positive evidence of increased CVD mortality in fire fighters and 16 that did not, and tried to adjust for the HWE. After conducting a re-assessment, four studies which previously showed no increased association between fire fighting and cardiovascular mortality underestimated the occupational risk of fire fighting and cardiovascular mortality. Choi concluded that overall, there is strong evidence of an increased risk between work as a fire fighter and death from cardiovascular disease.

B) FIRE FIGHTER PROPORTIONATE MORTALITY

Proportionate on-duty CVD mortality refers to the proportion, fraction or percentage of deaths occurring in the line of duty caused by heart and vascular diseases. In this regard, there is unanimous agreement that fire fighters experience the highest proportionate mortality due to heart disease in the line of duty in comparison to other occupations.^{xi, xii} Heart disease-related deaths cause roughly 45% of on-duty deaths per year among fire fighters. For law enforcement, construction, emergency medical services and all occupations combined, the proportion of

on-duty deaths estimated to be due to CVD have been reported as 22%, 12%, 11% and 15%, respectively.^{xiii, xiv} Even though U.S. fire service deaths have decreased since the 1970's, unfortunately, the fraction or proportion due to heart disease has remained consistently high (see Figure 2.1). More recent data show that in 2011, sudden cardiac deaths accounted for about 50% of line of duty fire fighter fatalities.^{xv}

Presumably, the high proportionate mortality observed in the fire service is explained by the unique interaction of fire fighters' risk profiles and the exposures and stressors encountered during specific types of fire fighting duties (see strenuous duties below). Not surprisingly, the risks of on-duty CHD events vary widely across different duties; with the highest risks associated with the most strenuous tasks, while the lowest risks are observed during routine non-emergency or "downtime" situations (see strenuous duties section and Table 2.1).

C) STRENOUS FIRE FIGHTING DUTIES AND TRIGGERING

Numerous studies have shown that various types of strenuous situations (e.g. involving physical and or emotional exertion) can trigger acute cardiovascular events in individuals with underlying disease. In a similar fashion, periodic stressors in the general environment such as surges in air pollution^{xvi} or influenza

activity^{xvii} have been shown to precede spikes in CVD event rates within an exposed population. These heart events are largely confined to "susceptible" persons (the very young, the very old and those who have known heart or lung disease) within the larger group.

In the last decade, a series of three studies examined fire fighting duties in this context by making educated assumptions for the average annual professional time spent by fire fighters in each type of fire service duty. This research provides definitive evidence that certain strenuous fire fighting duties can precipitate or trigger heart disease events in fire fighters with underlying heart problems.^{xviii, xix, xx} These three independent investigations all demonstrate very similar results for the "odds" or probability of heart disease events for specific fire service duties when compared to non-emergency situations (see Table 2.1).

Together, the studies show markedly significant increases in the likelihood of heart disease events during fire suppression, alarm response and return from alarms; and for heart deaths during vigorous physical training exercises. Physical training included all job-related physical fitness activities, physical-abilities testing, and simulated or live fire, rescue, emergency, and search drills. The largest of the three investigations, published by Kales, Soteriades ES, Christophi CA, et al., considered all 449 on-duty deaths attributed to coronary heart disease (CHD) in the U.S. fire service for the period 1994-2004. The authors applied three different statistical analyses using models that made varying assumptions about the length of time fire fighters spent on job duties to account for variations due to volunteer/career status, rural versus urban areas and large and small jurisdictions. No matter which model was used, the risks of CHD death compared to non-emergency situations remained markedly elevated during strenuous duties compared to non-emergency situations. In the most dramatic example, although fire suppression represents only up to 5% of annual professional time among fire fighters, over 30% of on-duty CHD deaths occurred during fire suppression activities. Thus, the study confirmed that the probability of a heart disease event is

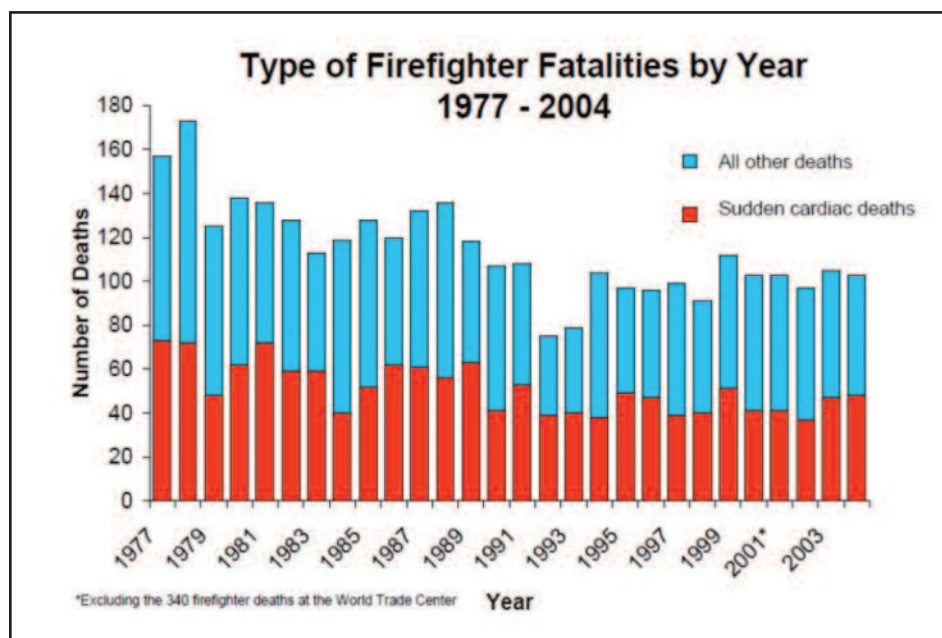


Figure 2.1 ^{xv}

about 10 to over 100 times greater during fire suppression than during non-emergency duties.^{xx}

C) CIRCADIAN (DAILY) PATTERNS OF HEART DISEASE IN THE FIRE SERVICE

Another type of evidence from the same researchers also supports the assertion that emergency duties can trigger or precipitate heart disease deaths. It examines the circadian distribution of fire service CHD deaths or how these deaths are distributed over the course of the 24-hour day.^{xxi} The researchers found that the daily pattern of fire service CHD deaths mirrors the pattern of emergency alarms and dispatches. Therefore, instead of following the typical heart disease pattern seen in the general population, where heart events peak in the morning hours, over two-thirds of line of duty heart deaths in the fire service occur between the hours of noon and midnight (see Figure 2.2 below).

CONCLUSION

Taken together, published studies using epidemiologic evidence to determine if a relationship exists between fire fighting and CVD mortality have not provided clear evidence of an increased risk of CVD death when compared to the general population. The most likely explanation is the “Healthy Worker Effect”. While there may be debate if fire fighters have little or no excess risk of lifetime heart disease mortality, there is robust and compelling evidence that fire fighters experience the highest proportionate on-duty mortality from CVD of any occupation; accounting for almost half of line-of-duty deaths.^{xxiii} Moreover, there is very strong evidence that strenuous fire fighting duties can trigger or precipitate on-duty heart disease events. In particular, heart attacks and sudden cardiac deaths are 10 to over 100 times as likely to occur during fire suppression activities compared to non-emergency situations. Thus, these findings suggest an interaction between fire fighters’ heart disease risk factors and the unique exposures they encounter on-duty in the fire service. ■

Duty Specific Risks of Heart Disease

Type of Duty	Kales, Soteriades ES, Christophi CA et al (Relative Risk of CHD Death) ^{xxiii}	Holder et al (Relative Risk of Heart Event Leading to Retirement) ^{xx}	Kales et al (Relative Risk of CHD Death) ^{xx}
Fire suppression-OR (95% CI)	64.1 (7.4-556)	51 (12-223)	53 (40-72)
Physical training-OR (95% CI)	7.6 (1.8-31.3)	0.68 (0.2-2.7)	5.2 (3.6-7.5)
Alarm response-OR (95% CI)	5.6 (1.1-28.8)	6.4 (2.5-17)	7.4 (5.1-11)
Alarm return-OR (95% CI)	3.4 (0.8-14.7)	0.37 (0.07-1.8)	5.8 (4.1-8.1)
EMS and other non-fire emergencies-OR (95% CI)	1.7 (0.5-5.9)	0.75 (0.3-1.8)	1.3 (0.9-2.0)
Firehouse and other non-fire emergencies-OR (95% CI)	1.0	1.0	1.0

CHD indicates coronary heart disease; EMS, emergency medical service; OR, odds ratio, CI, confidence interval.

Table 2.1

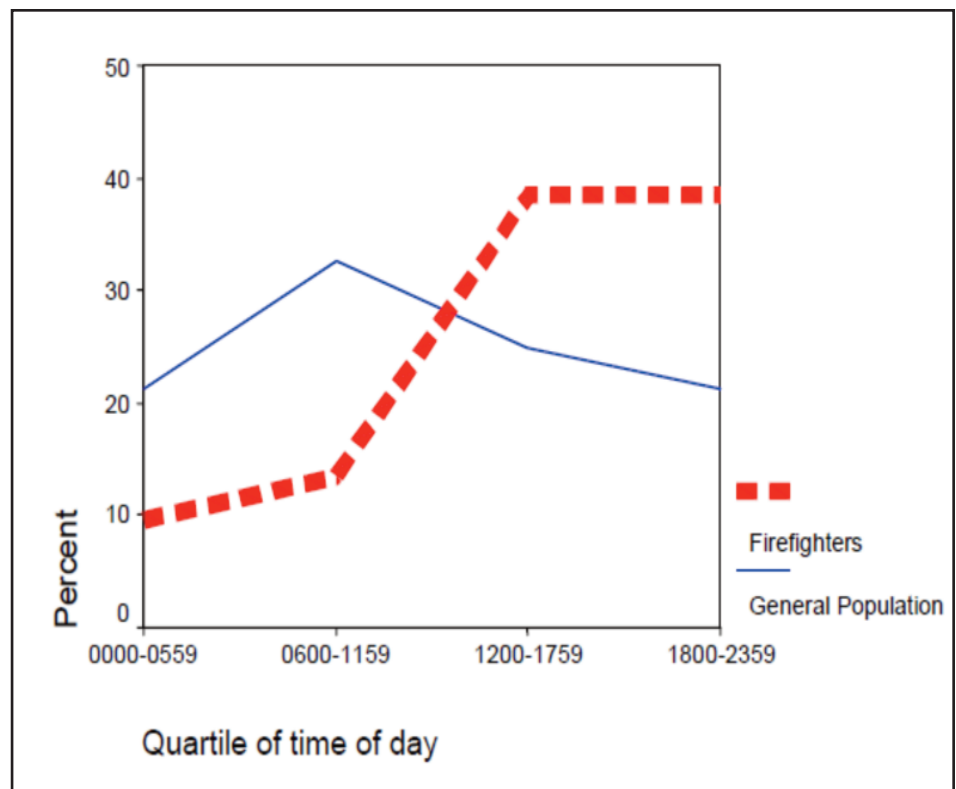


Figure 2.2 ^{xxii}

- i. Fahy RF, LeBlanc PR, Molis JL. Firefighter Fatalities in the United States – 2008. Quincy, MA: National Fire Protection Association; July 2009.
- ii. Kales SN, Soteriades ES, Christophi CA, et al. Emergency duties and deaths from heart disease among firefighters in the United States. *N Engl J Med*. 2007; 356:1207–1215.
- iii. Karter MJ, Molis JL. *Firefighter Injuries*. Quincy, MA: National Fire Protection Association; 2005.
- iv. Rosenstock L, Olsen J. Firefighting and death from cardiovascular causes. *N Engl J Med*. 2007;356:1261–1263.
- v. Soteriades ES, Smith DL, Tsismenakis AJ, Baur, DM, Kales SN. Cardiovascular disease in US firefighters. *Cardiology in Review*. 2011;19:202-215.
- vi. Haas NS, Gochfeld M, Robson MG, et al. Latent health effects in firefighters. *Int J Occup Environ Health*. 2003;9:95–103.
- vii. Choi B. A technique to re-assess epidemiologic evidence in light of the healthy worker effect: the case of firefighting and heart disease. *J Occup Med*. 2000; 42: 1021-1034.
- viii. Soteriades ES, Smith DL, Tsismenakis AJ, Baur, DM, Kales SN. Cardiovascular disease in US firefighters. *Cardiology in Review*. 2011;19:202-215.
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- xvii. Soteriades ES, Smith DL, Tsismenakis AJ, Baur, DM, Kales SN. Cardiovascular disease in US firefighters. *Cardiology in Review*. 2011;19:202-215.
- xviii. Kales SN, Soteriades ES, Christoudias SG, et al. Firefighters and on-duty deaths from coronary heart disease: a case control study. *Environ Health*. 2003;2:14.
- xix. Holder JD, Stallings LA, Peeples L, et al. Firefighter heart presumption retirements in Massachusetts 1997–2004. *J Occup Environ Med*. 2006;48:1047–1053.
- xx. Kales SN, Soteriades ES, Christophi CA, et al. Emergency duties and deaths from heart disease among firefighters in the United States. *N Engl J Med*. 2007; 356:1207–1215.
- xxi. Kales SN, Soteriades ES, Christoudias SG, et al. Firefighters and on-duty deaths from coronary heart disease: a case control study. *Environ Health*. 2003;2:14.
- xxii. Fahy RF, LeBlanc PR, Molis JL. *Firefighter Fatalities in the United States – 2011*. Quincy, MA: National Fire Protection Association; June 2012.
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Heart Disease in the Fire Service

CHAPTER 3 • ANATOMY AND FUNCTION OF THE CARDIOVASCULAR SYSTEM

The cardiovascular or circulatory system consists of the heart and blood vessels responsible for the vital function of transporting blood, oxygen and essential materials throughout the body necessary for survival. The following summary of the anatomy and function of the circulatory system may be helpful in appreciating how diseases of the heart and blood vessels can lead to adverse health outcomes.

THE CIRCULATORY SYSTEM AND NORMAL HEART

The heart's main function is to serve as a pump for blood that transports oxygen and essential materials throughout the body. As Figure 3.1 illustrates, the heart has four chambers: two upper chambers called atria and two lower chambers called ventricles. The right atrium receives blood from the rest of the body and after it fills with blood, it contracts to send blood into the right ventricle. The right ventricle then pumps blood to the lungs where it can pick up oxygen. Blood returning from the lungs enters the left atrium where it is forced into the left ventricle. The left ventricle then pumps out blood to the rest of the body where oxygen can be delivered. The walls of each heart chamber contain myocardium, a type of muscle that is unique to the heart. When myocardium contracts, blood is forced out of a chamber through one-way valves, that when functioning normally, prevent back-flow so the chamber can fill with blood for the next heart beat.

HEART VALVES

Heart valves help ensure that the flow of blood is one-way through each chamber, preventing back-flow that would decrease heart output. The sounds from each heart beat are generated from the closing of these valves. There are four heart valves; the tricuspid, pulmonary, mitral and aortic. The tricuspid valve separates the right atrium and right ventricle; the

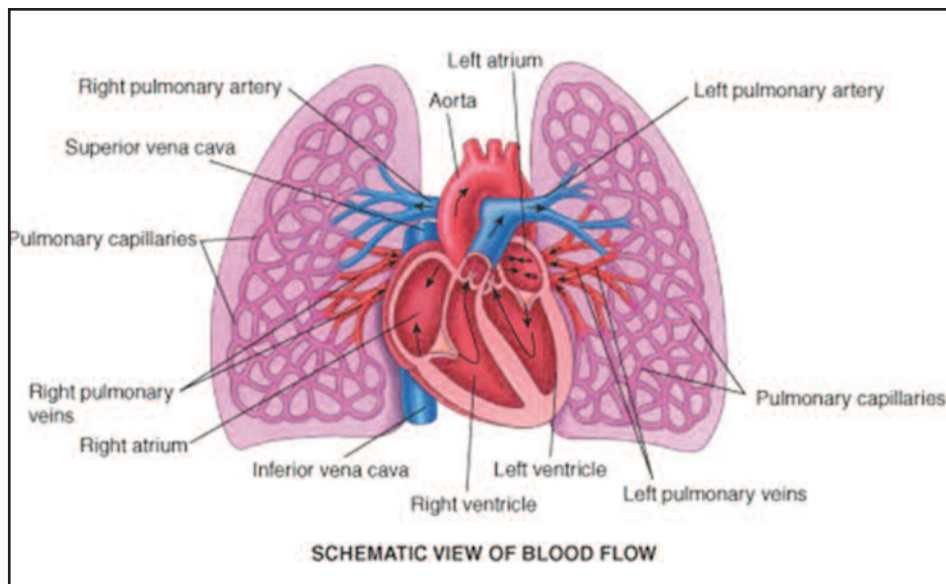


Figure 3.1ⁱ

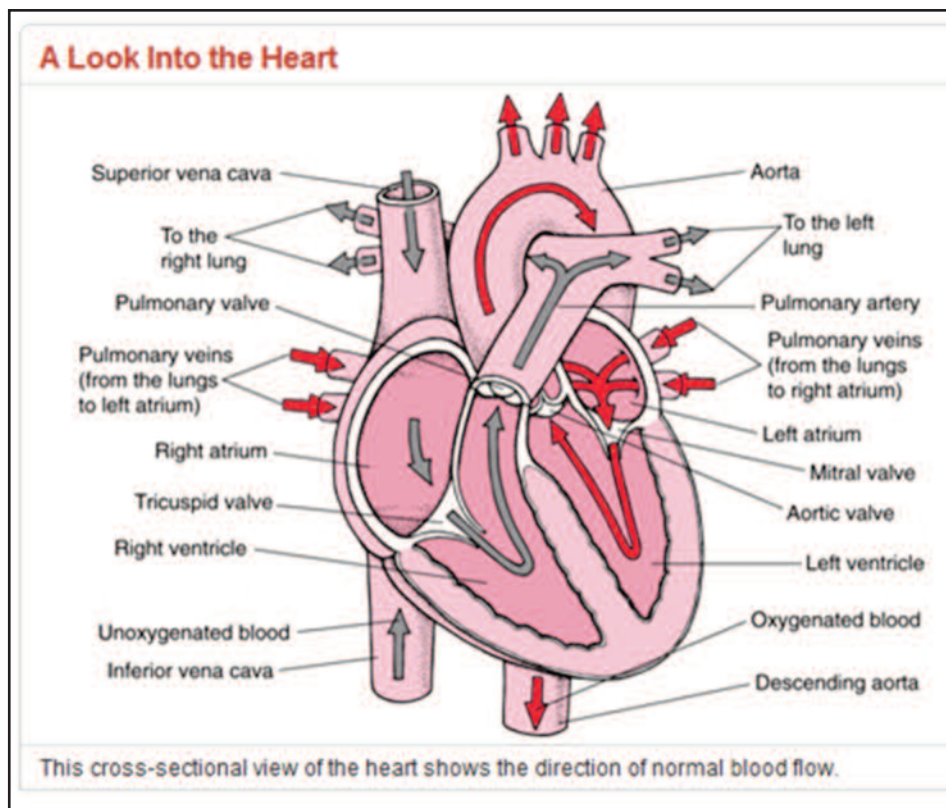


Figure 3.2ⁱⁱ

pulmonary valve separates the right ventricle from the pulmonary artery; mitral valve separates the left atrium and left ventricle; and the aortic valve

separates the left ventricle from the aorta. The locations of the heart valves in relation to the rest of the heart can be seen in Figure 3.2.

CONDUCTION SYSTEM

As previously mentioned, the flow of ions between myocardial cells creates an electrical current that triggers contraction of the heart muscle. To generate an effective contraction of a chamber in the heart, myocardial cells must function in a coordinated manner. Specialized cells in the sinoatrial node (SA node) of the right atrium act as a pacemaker to establish the rate at which the heart beats. These cells generate the flow of ions that start the contraction of the heart. From the SA node, an electrical current spreads through both atria, triggering a contraction and sends blood into both ventricles. The current is also carried to cells in the atrioventricular node (AV node), which then transmit the current into the ventricles via dedicated cells called the AV bundle and Purkinje fibers. After a short delay, through these cells, the flow of ions is carried from the atria into both ventricles to create a synchronized contraction. Figure 3.4 illustrates the locations of the components of the conduction system.

Tracing the Heart's Electrical Pathway

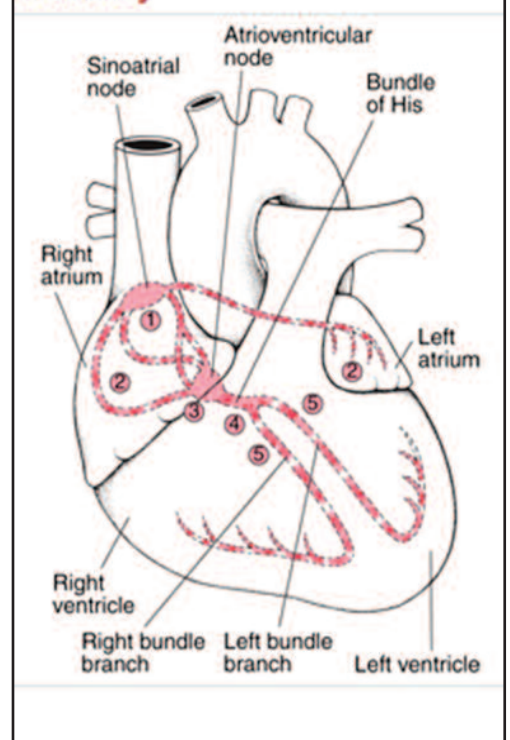


Figure 3.4 ^{iv}

Supplying the Heart With Blood

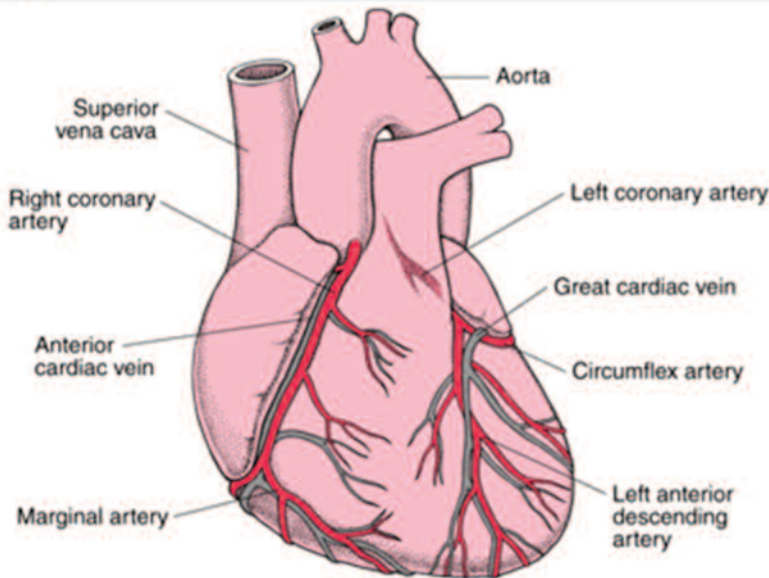


Figure 3.3 ⁱⁱⁱ

BLOOD VESSELS

The body has several types of hollow, tubular vessels that are used to carry blood. Arteries carry blood away from the heart to the tissues and contain muscles that help control the relatively high pressure created when the left ventricle contracts to send blood through the body. Arteries lead to capillaries, which have a very small diameter. Individual red blood cells flow through capillaries in single file, allowing for oxygen exchange between red blood cells and tissue. Capillaries lead to veins that bring blood back towards the right side of the heart. Unlike arteries, veins have thin walls and are under low pressure with blood flow dependent on gravity and pumping action from muscles in the arm and legs that press on the walls of veins. Veins often contain one-way valves to prevent backflow of blood as it is carried back to the heart.

MYOCARDIUM

The heart contains a special type of muscle, called myocardium. Myocardial cells contract and relax to generate the pressure necessary to pump blood. Individual myocardial cells are connected via intercalated discs to form long fibers that form a lattice. The intercalated discs allow individual cells to communicate

with each other. Ions passing through cells create an electric current that releases calcium inside the myocardial cells causing a synchronized contraction of myocardium. Myocardial cells require oxygen to function and receive it through special arteries, called coronary arteries.

CORONARY ARTERIES

The coronary arteries carry oxygen rich blood from the left ventricle to supply the myocardium. There are two major coronary arteries, which supply different areas of the heart. The right coronary artery supplies the myocardium in the right ventricle and part of the left ventricle, and branches of left coronary artery supply myocardium elsewhere in the heart. Figure 3.3 illustrates the major coronary arteries. Commonly, a blockage in a coronary artery interferes with delivery of oxygen to myocardium. If myocardium does not receive enough oxygen, it becomes ischemic (oxygen deprived), and if oxygen is deprived for a long enough period of time, the myocardium will die or “infarct”. Thus, doctors refer to heart attacks as myocardial infarctions or the end manifestation of myocardial ischemia caused by lack of oxygen in an area of heart muscle.

BLOOD PRESSURE (hg)

Blood pressure refers to the pressure within arteries generated by the heart's pumping. Blood pressure is reported in millimeters (mm) of mercury. For example, a pressure of 20 mm means that a column of liquid mercury (Hg) would be elevated 20 mm against gravity. For clinical purposes, two values of blood pressure are measured and recorded together, such as 110/70. The first number, the systolic pressure, is a measurement of the peak pressure in the arteries that occurs after the left ventricle contracts to send blood into the aorta and rest of the body. The second number, the diastolic pressure, is the resting pressure of the arteries.

Blood pressure is determined by multiple variables, such as the volume of blood in the vascular system, force from the left ventricle contraction, and the diameter of arteries, which can be controlled by contraction of muscles in the arterial walls. The body has homeostatic mechanisms to control the effective circulating volume of fluid by altering the rate of blood filtration and excretion of fluid in the kidneys, and secretes hormones that can alter dilation of blood vessels and change the force of heart contractions.

A DYNAMIC SYSTEM

The circulatory system has homeostatic mechanisms in place to respond to conditions requiring increased work to keep the tissues of the body supplied with oxygen. This can include, but is not limited to increased physical exertion, strong emotions, pain and illness. The heart can respond to signals from the nervous system and chemical messengers like epinephrine to change the rate of contraction, force of contraction or amount of blood pumped out of the left ventricle with each contraction. Similarly, the arteries and veins can change diameter that can alter blood pressure. If arteries decrease in diameter, the blood pressure will increase and conversely, if the diameter of arteries is increased, blood pressure will fall. Additionally, medications can interact with this system.

CONCLUSION

The circulatory system is composed of the heart and associated vessels that transport blood, which carries oxygen and essential materials throughout the body. These components form a dynamic system that can respond to multiple demands on the body by altering variables like heart rate, blood pressure, effective circulating volume of blood and myocardial contractility. The brain and other vital organs depend on the proper function of the circulatory system for survival, making circulatory health critically important. ■

^{i, ii, iii, iv} From The Merck Manual Home Health Handbook, edited by Robert Porter. Copyright 2010-2011 by Merck Sharp & Dohme Corp., a subsidiary of Merck & Co., Inc., Whitehouse Station, NJ. Available at: <http://www.merckmanuals.com/home/index.html>. Accessed (3/31/12).

Heart Disease in the Fire Service

CHAPTER 4 • DISEASES OF THE CARDIOVASCULAR SYSTEM

The heart is responsible for a variety of essential functions in order to ensure life. Various anatomic components of the cardiovascular system described in the preceding chapter are subject to disease processes that can disrupt normal physiology and health. This chapter reviews the most common diseases affecting the cardiovascular system.

DISEASES OF THE CORONARY ARTERIES

The coronary arteries supply the myocardium with oxygen and essential nutrients. The most common disease process that can interrupt the flow of blood through the coronary arteries is atherosclerosis. Atherosclerosis is a disease of the arteries caused by deposition of cholesterol plaques on the inner lining of the arteries causing narrowing and altering of blood flow through the artery. It is the underlying cause for most heart attacks and strokes occurring in the United States and Canada. Narrowing of the coronary arteries from atherosclerosis is referred to by different interchangeable terms, such as coronary heart disease (CHD), coronary artery disease, ischemic heart disease, atherosclerotic coronary vascular disease, or atherosclerotic heart disease. CHD is the preferred term and will be used here. CHD accounts for 90% of on-duty heart disease deaths among U.S. fire fighters.ⁱ

The wall of an artery is composed of several layers. Figure 4.1 depicts the normal layers of an artery. The innermost layer is one cell layer thick and is called the endothelium. The endothelium lines the inside of the artery and is in contact with blood cells.

Atherosclerosis starts with damage to endothelial cells, which can occur from fluid shear forces at locations where blood undergoes sudden changes in velocity and direction. After the injury to the cells, platelets and clot forming proteins form a blood clot at the site of the damage. Over time, the body removes the clot and repairs the damage to the endothelium. However, smooth muscle and other body

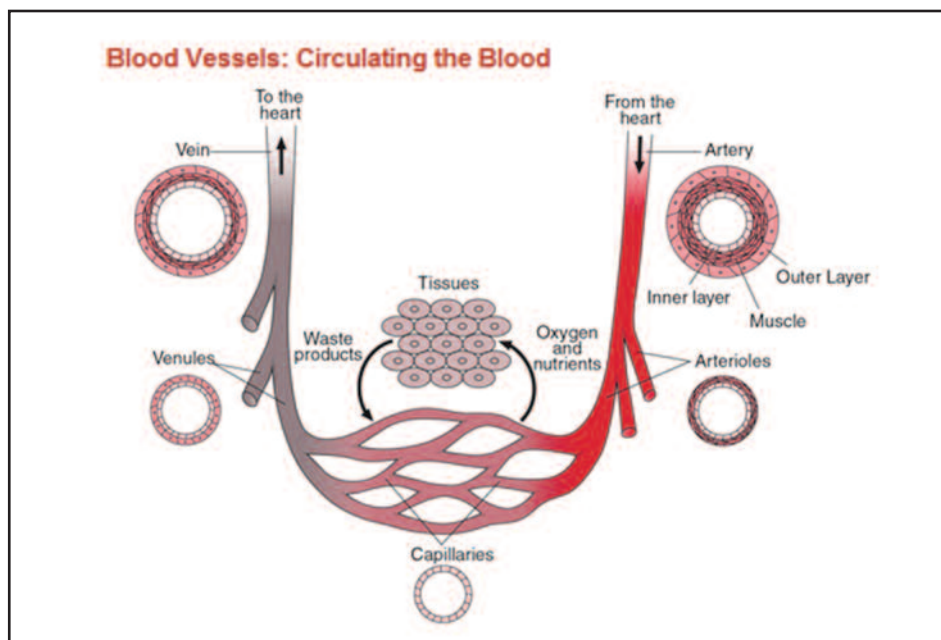


Figure 4.1 ⁱⁱ

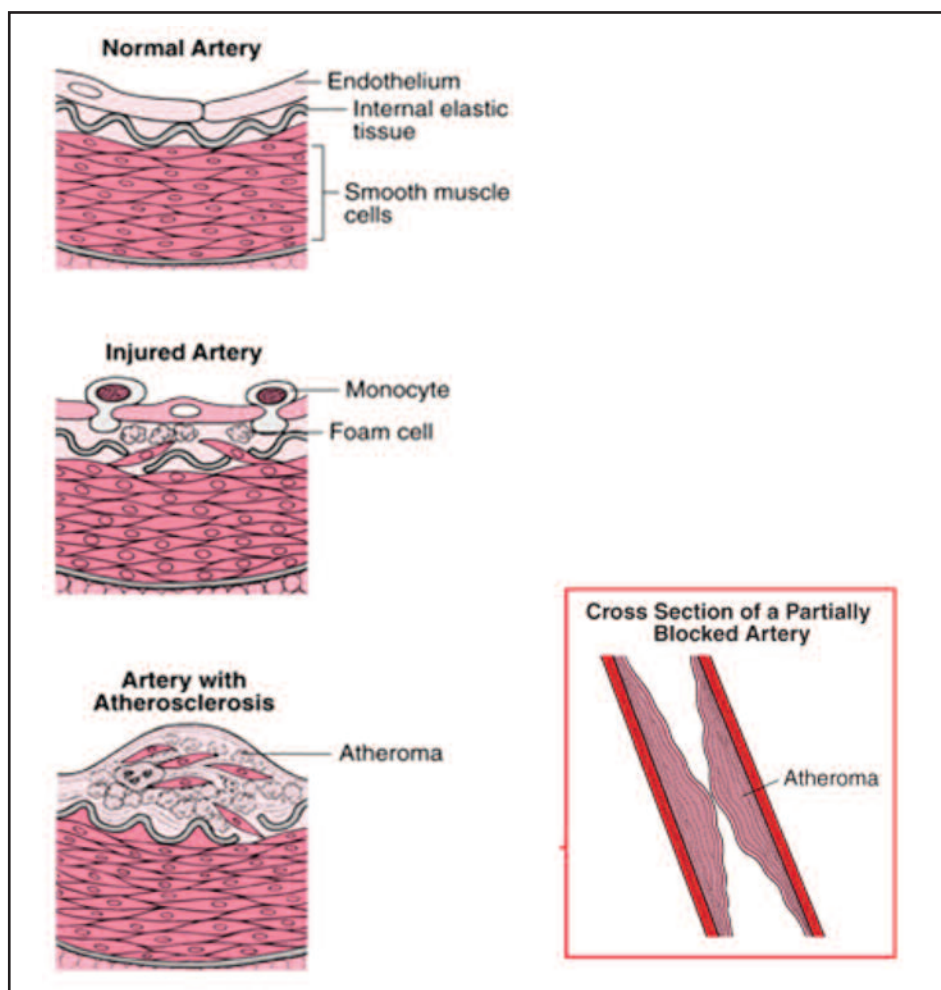


Figure 4.2 ⁱⁱⁱ

cells can enter the area. The area of cellular infiltration leads to deposition of collagen and lipids like cholesterol, which is called an atherosclerotic plaque or atheroma. The atheroma is gradually covered with endothelial cells, but this area of endothelium is prone to repeat injury. Smoking, high blood pressure, excessive dietary fat, and other insults to the cardiovascular system can cause the atheroma to grow, narrowing the artery, which is also known as stenosis. This process is illustrated in Figure 4.2.

The formation of atherosclerosis is gradual, and years can pass before an individual develops symptoms related to narrowing. This process may be accelerated by lifestyle and occupational exposures, but it can also be influenced favorably by lifestyle and other risk reduction methods as illustrated in Figure 4.3. The final end stage outcomes of narrowed or atherosclerotic arteries include angina, which is chest pain or discomfort that occurs when an area of the heart is deprived of oxygen, a heart attack or sudden death, which can be triggered by strenuous firefighting duties in a person with underlying disease. Examples of less common manifestations include fainting, chronic fatigue, shortness of breath, and an abnormal electrocardiogram (EKG).

A common method of identifying coronary arterial narrowing is an exercise or other types of stress tests. In the more common treadmill exercise tests, the subject walks on a treadmill through a series of stages that progress through increasing speed and grade or incline of the treadmill, while having the heart's signals recorded by an EKG. A maximal treadmill test can obtain several different types of important information. The longer the time one is able to continue exercising on a treadmill protocol, the higher that person's aerobic capacity or physical fitness level. Higher fitness levels are associated with a better prognosis (long-term outcomes) and thus, decreased risks for death from both cardiovascular and non-cardiovascular causes. Additionally, if the stress test shows a result consistent with a lack of oxygen in myocardial cells, which is referred to as ischemia, the location and extent of coronary arterial narrowing can be assessed by other tests. The gold standard for this is the cardiac catheterization. A cardiologist performs a

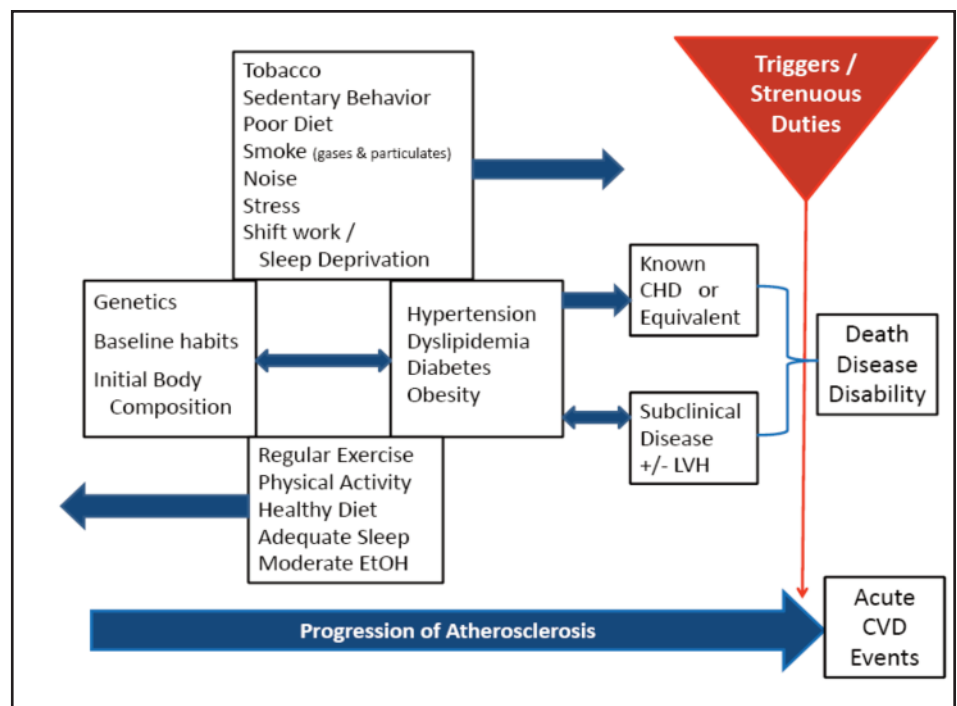


Figure 4.3^{iv}

cardiac catheterization by passing a small tube into the coronary arteries and injecting contrast material that is opaque to X-rays. Under fluoroscopy, the contrast material will reveal any narrowing or blockages of the coronary arteries. If possible, the cardiologist can try to increase the diameter of a narrowed or blocked artery with angioplasty (with or without placing a stent) to restore blood flow. A less invasive alternative to the catheterization is a CT-angiogram, which provides similar views of the heart and coronary arteries by combining computerized tomography (CT) with special vascular contrast material.

ANGINA

Chest pain, or angina, can occur when narrowing of the coronary arteries results in inadequate flow of blood to the myocardial cells. Sensory pain fibers in the heart are stimulated by ischemia, or a lack of oxygen in myocardial cells. Unlike pain fibers in the skin, pain fibers in the heart do not cause localized, sharp pain. Classically, the chest pain that occurs when the heart is not receiving enough blood is described as sub-sternal “pressure” that may radiate into the neck and arms. However, many people may not exhibit the classic symptoms of angina, even though there is severe narrowing of the coronary arteries. These persons may

experience shortness of breath and fatigue without pain.

Angina may be stable, meaning it can be predictably brought on and relieved by a certain level of exertion, and the chest pain that occurs does not necessarily mean that a heart attack is occurring or impending. For example, someone with long-standing narrowing of a coronary artery may feel well at rest because the supply of blood is sufficient. However, with a physiologic stress on the heart, such as from exertion or strong emotion, the heart will attempt to increase the heart rate or force of contraction. In order to accomplish this task, the myocardial cells have to work harder and require an increased supply of blood. If the narrowing of the artery prevents this additional blood flow, the cells will become ischemic and angina will occur. If the individual is able to rest, the myocardial cells do not have to work as hard and the flow of blood again becomes adequate and pain resolves. In the case of stable angina, the pain will resolve within a few minutes of initiating rest.

In unstable angina, the pattern of pain is no longer predictable. Symptoms can start occurring with mild exertion, more frequent exertion, or even complete rest, and typically can worsen precipitously. Unstable angina often indicates the rupture of an atherosclerotic coronary artery plaque and/or presence of a clot

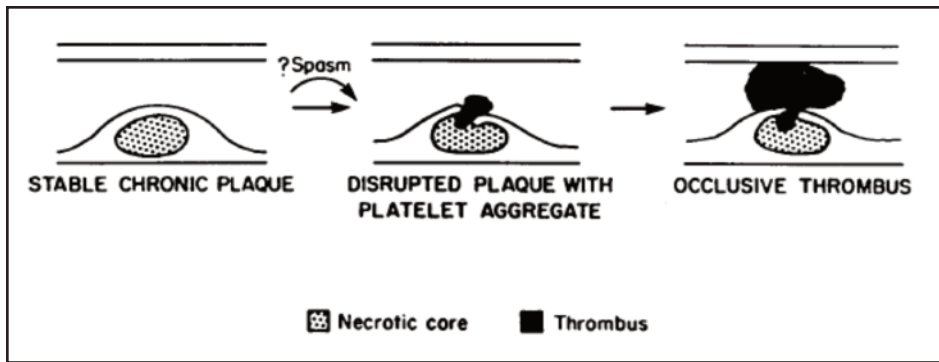


Figure 4.4 ^v

that acutely decreases blood flow. Unstable angina or acute coronary syndrome can lead to an infarction or heart attack and even death (see below) and is a true medical emergency.

HEART ATTACK

A heart attack or myocardial infarction is a common clinical manifestation of CVD. A heart attack most commonly occurs when a coronary artery is severely or completely narrowed by a blood clot. A ruptured atheroma is often implicated. A plaque that ruptures and disrupts the endothelium is very thrombogenic, meaning that clots can form quickly on the exposed surface of a plaque and block an artery. This is illustrated in Figure 4.4.

If a heart attack occurs, the myocardial cells supplied by the artery will become ischemic and chest pain will occur, even if the person is at rest. If the flow of blood is not restored within 10 to 15 minutes, myocardial cells will start to die or infarct. The amount of myocardium that dies depends on the location of the artery involved. With the death of myocardial cells, normal heart function will be disrupted. Common complications of a heart attack are death, heart failure and arrhythmias. After a heart attack, dead myocardium is replaced by scar tissue. The scar tissue does not contract and the usual synchronized contraction of the heart may be diminished to the point where the heart cannot pump enough blood to the rest of the body, a condition termed heart failure. If the area of dead myocardium included the specialized cells responsible for generating or conducting the electrical current necessary for the heart to contract, an abnormal heart rhythm, or arrhythmia, can occur.

SUDDEN DEATH

In the case of sudden cardiac death, a person will suddenly collapse and quickly die from cessation of blood flow in the circulatory system. One mechanism is sudden clot formation in an area of the coronary arteries that blocks much of the heart's blood supply therefore causing the heart to stop beating. Another mechanism is an abnormal heart rhythm originating from the ventricles (ventricular tachycardia, or fibrillation) that does not allow the heart to generate effective contractions so that blood cannot reach the brain and other vital organs. In either circumstance, the lack of blood flow to the brain causes unconsciousness within seconds and death within minutes.

OTHER DISEASES OF THE CORONARY ARTERIES

There are other less common disorders that can cause blockages of the coronary arteries. However, these conditions are relatively less common and not associated with exposures typically encountered with firefighting. These include congenital abnormalities, coronary vasospasm, vasculitis, large dosing of ionizing radiation, and blunt trauma to the chest.

DISEASES OF THE HEART MUSCLE (CARDIOMYOPATHY)

Diseases of the myocardial cells are termed cardiomyopathies. The cardiomyopathies can be organized into categories; congestive, hypertrophic and restrictive. Figure 4.5 shows how myocardium in the ventricles of the heart can appear for each of the cardiomyopathies compared to a normal heart.

DILATED (OR CONGESTIVE) CARDIOMYOPATHY

Conditions that damage, but not kill, myocardial cells can impair effective heart contractions. If enough of the myocardium is affected, the heart will become dilated and the chambers overfilled with blood as the heart is not as efficient in pumping blood. Persons with dilated cardiomyopathy can present with clinical signs of heart failure. The most common causes of dilated cardiomyopathy are heart damage due to previous heart attacks, various viral infections, alcohol abuse, valvular heart disease and chronic uncontrolled hypertension (high blood pressure).

HYPERTROPHIC CARDIOMYOPATHY

This condition has not been associated with any occupational exposures. It is triggered by an abnormal growth of myocardium that is caused by a genetic abnormality. The abnormal growth of muscle can create an eccentric hypertrophy involving the septum of the heart. This growth of heart muscle can lead to an outflow obstruction of blood in the heart, causing heart failure and fatal arrhythmias. This obstruction may be associated with a heart murmur.

RESTRICTIVE CARDIOMYOPATHY

This type of cardiomyopathy has not been linked to any occupational exposures. It is caused by an inability of the myocardium to adequately relax, impairing filling of heart chambers that normally occurs between heart beats, compromising cardiac output. The walls of the myocardium become stiff, often from infiltrative diseases such as sarcoidosis, or cancers such as amyloidosis.

LEFT VENTRICULAR HYPERTROPHY

Left ventricular hypertrophy (LVH) refers to a concentrated growth of myocardium in the left ventricle in response to having to chronically work harder to pump blood. It may resemble hypertrophic cardiomyopathy described above. It most commonly occurs in individuals who have chronic, untreated

Types of Cardiomyopathy

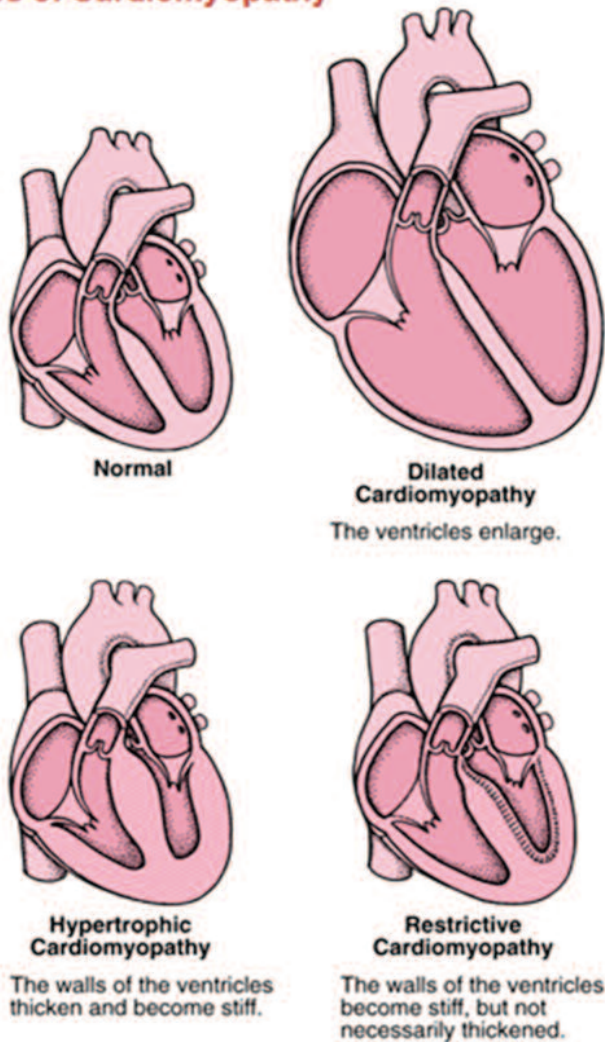


Figure 4.5^{vi}

hypertension. Because the hypertrophied cells have to work harder, they require an increased blood supply and may be more susceptible to adverse outcomes of CVD, including heart attacks and sudden death. A review of fire fighter autopsies demonstrated that close to 60% of on-duty deaths caused by heart disease had evidence of LVH.^{vii}

DISEASES OF THE HEART VALVES

Firefighting has not been linked with any increased risk of developing valvular heart disease. Heart valves may become damaged by infection, congenital abnormalities or degenerative damage with time. The most common problems are valvular stenosis and insufficiency. Stenosis means a valve cannot open completely and insufficiency means that

the valve cannot close completely. In both cases, the heart must work harder to pump blood. In the case of stenosis, the heart must generate an increased force of contraction to push blood through the smaller opening. In insufficiency, the efficiency of the pump is impaired as less blood is pumped out with each beat, so the heart must work harder to force out the same amount of blood as it did before the valve began to leak. Both valvular stenosis and insufficiency can lead to heart failure.

MITRAL VALVE PROLAPSE

Mitral valve prolapse has not been associated with firefighting or occupational exposures. It is caused by an abnormal mitral valve that does not close normally and as a result pushes back, or

prolapses, into the left atrium during contraction of the left ventricle. This condition may cause a heart murmur, chest pain that is unrelated to narrowing or occlusion of the coronary arteries, and abnormal heart beats. However, most individuals with this condition do not experience any symptoms, do not require treatment and can lead a normal life.

INFECTIOUS ENDOCARDITIS

This condition has not been associated with fire fighting. It is caused by infection of the heart valve. Persons with some type of underlying valvular abnormality are at higher risk. It is also associated with illicit intravenous drug use. More recently, it has also been found to occur in association with intravascular devices and procedures.^{viii} It can lead to destruction of the valve and infective particles can be seeded to the rest of the body via the blood. Some of these infected particles can create blockages that can obstruct blood vessels elsewhere in the body. For example, a blockage, or embolism to an artery in the brain could cause a stroke.

DISEASES OF THE CONDUCTION SYSTEM

As mentioned in the previous chapter of this manual, the heart contains specialized cells that are responsible for generating and conducting electrical current throughout the heart to maintain synchronized contraction of the heart chambers to pump blood effectively. The more serious disorders of the conduction system are reviewed below.

ARRHYTHMIAS

An arrhythmia is an abnormal transfer of electrical current through the heart's conduction system. Multiple causes of arrhythmias exist, often an abnormal area of heart tissue acts as a focus for the aberrant conduction, such as ischemic cells or scar tissue. Very severe heart failure is also a risk factor for arrhythmias. Arrhythmias can involve faulty conduction of current in all chambers or only the ventricles or atria. An arrhythmia can lead to very slow heart rates (bradycardia) or fast heart rates (tachycardia). Tachycardia may cause the heart to beat at rates in excess of 150 beats per minute. The heart may not be able to

keep pace in terms of refilling with blood and pumping the blood effectively at such high rates, leading to low blood pressure and tissue ischemia that require emergent medical treatment. If an arrhythmia causes very rapid conduction of electrical current to the myocardial cells, the heart may not be able to sustain an organized contraction at all, and is called fibrillation. While tachycardias and fibrillation can affect the atria or the ventricles, ventricular tachycardia and fibrillation are life-threatening.

In the case of atrial fibrillation, the atria are unable to effectively pump blood into the ventricles. However, the ventricles are able to fill to about 70% without any contribution from atrial contraction. If the AV node does not conduct the very rapid rate of the atria to the ventricles and the heart is not working very hard, an individual may be able to tolerate atrial fibrillation without experiencing ischemia. However, atrial fibrillation is linked to an increased risk of stroke from clots formed in blood within the atria that are not effectively contracting. Treatment of atrial fibrillation generally includes measures to control the ventricular rate, medications when indicated to decrease the risk of clotting and measures when possible to convert the heart back into a normal rhythm and maintain such a rhythm.

In the case of ventricular tachycardia and fibrillation, the ventricles are unable to effectively contract to pump blood, leading to rapid loss of consciousness and death. The treatment is to apply an

external electric shock to the heart to reset the normal rate rhythm, which is termed cardioversion. Individuals meeting specific clinical criteria, such as severe heart failure or underlying abnormal heart rhythms may be eligible for implantation of an automated internal cardiac defibrillator (AICD). The AICD is programmed to sense onset of a potentially fatal arrhythmia and deliver an electric shock to the myocardium. The AICD has been associated with a decrease in mortality for those who meet the clinical eligibility criteria.

HEART BLOCK

Heart block occurs when the conduction of electrical current through the heart is delayed or completely blocked. A complete interruption is called a complete heart block or a third degree heart block and frequently involves damaged cells in the AV node. Third degree heart block can be life-threatening. If the electrical current from the atria cannot be conducted through the AV node into the Purkinje fibers, the ventricles may not be able to contract at a sufficient rate to maintain adequate blood pressure to sustain life. In cases such as a third degree heart block, a cardiologist can implant a pacemaker to deliver electric shocks directly into the myocardium to cause a contraction at normal heart rates.

CONCLUSION

CHD is the most common heart problem that fire fighters will experience. The process of plaque deposition and growth is gradual and often can be prevented and treated effectively. Fire fighters should be aware of the major risk factors for CHD and the lifestyle and medical measures that can help them decrease their risk of developing CHD (see Chapter 5). ■

ⁱ Kales SN, Soteriades ES, Christophi CA, et al. Emergency duties and deaths from heart disease among firefighters in the United States. *N Engl J Med*. 2007;356:1207–1215.

ⁱⁱ From The Merck Manual Home Health Handbook, edited by Robert Porter. Copyright 2010-2011 by Merck Sharp & Dohme Corp., a subsidiary of Merck & Co., Inc., Whitehouse Station, NJ. Available at: <http://www.merckmanuals.com/home/index.html>. Accessed (3/31/12).

ⁱⁱⁱ From The Merck Manual Home Health Handbook, edited by Robert Porter. Copyright

2010-2011 by Merck Sharp & Dohme Corp., a subsidiary of Merck & Co., Inc., Whitehouse Station, NJ. Available at: <http://www.merckmanuals.com/home/index.html>. Accessed (3/31/12).

^{iv} Soteriades ES, Smith DL, Tsismenakis AJ, Baur, DM, Kales SN. Cardiovascular disease in US firefighters. *Cardiology in Review*. 2011;19:202-215.

^v Schoen, F.J.: Interventional and Surgical Cardiovascular Pathology, Clinical Correlations and Basic Principles. Philadelphia, W.B. Saunders Co., 1989, Figure 7, p. 59.

^{vi} From The Merck Manual Home Health

Handbook, edited by Robert Porter. Copyright 2010-2011 by Merck Sharp & Dohme Corp., a subsidiary of Merck & Co., Inc., Whitehouse Station, NJ. Available at: <http://www.merckmanuals.com/home/index.html>. Accessed (3/31/12).

^{vii} Geibe JR, Holder J, Peebles L, et al. Predictors of on-duty coronary events in male firefighters in the United States. *Am J Cardiol*. 2008;101:585–589.

^{viii} Brusch JL, et al. (11/29/11). Infective Endocarditis. Retrieved from <http://emedicine.medscape.com/article/216650-overview>

Heart Disease in the Fire Service

CHAPTER 5 • RISK FACTORS FOR HEART DISEASE

Sudden cardiac death is the leading cause of on-duty deaths among fire fighters.ⁱ The vast majority of these cases are due to coronary heart disease (CHD).ⁱⁱ Research has identified multiple risk factors in the general population for developing CHD that are universally accepted. Additionally, fire fighters face special occupational exposures and hazards that may contribute to the risk of CHD, and some of these exposures have been shown to increase the odds of triggering acute cardiovascular events that can lead to premature retirement and death. Many of the standard CHD risk factors for the general population were derived from large scale, prospective cohort studies, such as the Framingham Heart Study and Nurses' Health Study. Some CHD risk factors, like diet and physical activity, can be improved or worsened by changes in behavior, lifestyle and the work environment. Therefore, they are known as modifiable risk factors. Other risk factors, like age and gender, cannot be changed and are called non-modifiable risk factors. This chapter reviews major CHD risk factors, categorizing them into standard risk factors- modifiable and non-modifiable- and special occupational risk factors faced by fire fighters.

STANDARD CHD RISKS IN FIRE FIGHTERS

Studies of fire fighters who experience on-duty CHD events and premature retirements related to heart disease have identified several risk factors that are associated with an increased probability or "odds ratio" of having an on-duty CHD event. These are identical to many of the key risk factors previously identified during research of the general population. Fire fighters who develop on-duty CHD events have an excess of these risk factors compared to fire fighters who do not develop on-duty CHD events. Table 5.1 summarizes research findings. For example, current smokers have over eight times greater odds of experiencing on-duty CHD fatalities compared to those not currently smoking, as well as having over two times

	On-Duty CHD Fatalities OR (95% CI)	Non-CHD Cardiovascular Retirements	CHD Retirements OR (95% CI)
OR (95% CI)			
Current smoking	8.6 (4.2-17)	2.5 (1.2-5.1)	3.9 (2.5-6.2)
Hypertension	12 (5.8-25)	11 (6.1-20)	5.4 (3.7-7.9)
Obesity (BMI ≥30 kg/m ²)	3.1 (1.5-6.6)	3.6 (2.0-6.4)	1.4 (0.96-1.93)
Total Cholesterol ≥ 200 mg/dL	4.4 (1.5-13)	1.1 (0.51-2.24)	2.4 (1.6-3.6)
Diabetes mellitus	10.2 (3.7-28)	7.7 (2.9-20)	13 (6.1-28)
Prior diagnosis of CHD	35 (9.5-128)	NA	30 (9.1-96)
Age ≥45 years old	18 (8.5-40)	26 (13-51)	63 (35-111)
CHD, Coronary Heart Disease; OR, Odds Ratio; CI, Confidence Intervals; BMI, Body Mass Index			

Table 5.1 ⁱⁱⁱ

greater odds of a non-CHD cardiovascular retirement and almost four times greater odds of CHD retirements. Likewise, fire fighters with hypertension have twelve times greater odds of experiencing on-duty CHD fatalities compared to those with normal blood pressure.

MODIFIABLE RISKS

Tobacco Use

Cigarette smoking resulted in an estimated 443,000 premature deaths each year from 2000 to 2004 due to smoking-related illnesses, with approximately 49,000 of these deaths attributable to second hand smoke.^{iv} Tobacco has been associated with harmful changes in blood pressure, carbon monoxide and lipid levels. Cigarette smokers are 2 to 4 times more likely to develop CHD compared to non-smokers.^{iv} On average, male smokers die 13.2 years earlier than male nonsmokers, and female smokers die 14.5 years earlier than female non-smokers.^{iv}

Exposure to second hand tobacco smoke has been associated with increased CHD risk. Non-smokers who are exposed to second hand smoke at home or work increase their risk of developing CHD by 25% to 30%.^v Brief exposures to smoke (direct or second hand) can cause platelets to become stickier, damage to the lining of blood vessels, and decrease coronary flow reserves, potentially increasing the risk of a heart attack.^v

While some U.S. states have enacted legislation that prohibits hiring fire fighters who smoke, tobacco use continues among some fire fighters in communities without smoking restrictions. Recent research estimates the prevalence of smoking in the fire service from 10 to 18%.^{vi} However, among fire fighters who have died from on-duty CVD events, the prevalence ranges from 40-50%.^{vi}

While smoking among fire fighters has declined, it has unfortunately been accompanied by an apparent increase in the use of smokeless tobacco. A recent large survey found that almost 1 in 5 or 17-18% of fire fighters in the central U.S. use smokeless tobacco.^{vii} Fire fighters should know that although smokeless tobacco may be less harmful than smoking tobacco, nonetheless, its use has been associated with an increased risk of death from heart attack and stroke and increased risk of cancers of the mouth and throat.^{viii,ix}

High Blood Pressure

High blood pressure, or hypertension, is defined by having any one of the following conditions:

- systolic blood pressure ≥ 140 mm Hg.
- diastolic blood pressure ≥ 90 mm Hg.
- taking antihypertensive medicine.
- having been told at least twice by a physician or other health professional that one has high blood pressure.

In the United States, one in three adults has high blood pressure.^x There are also ethnic variations in the prevalence and severity of hypertension, with the prevalence of hypertension among African-Americans being one of the highest in the world. Generally, compared to whites, blacks develop high blood pressure earlier in life and their average blood pressures are higher. As a result, compared to whites, blacks have a 1.5 times greater rate of death caused by heart disease.^{xi} Chronic, uncontrolled hypertension may lead to left ventricular hypertrophy (see Chapter 4), as the heart must work harder to pump blood against an increased pressure. Long-term effects of hypertension include increased risk of heart disease, stroke and kidney disease. Data from the Framingham Heart Study indicate that hypertension is associated with shorter life expectancy, with total life expectancy 5.1 years longer for men without hypertension and 4.9 years longer for women without hypertension at 50 years of age.^{xii} Figure 5.1 shows that the heart disease rate per 1,000 people increases as the systolic and diastolic blood pressure levels increase; with men having higher rates of heart disease than women.

There is evidence that adverse events attributed to hypertension may be concentrated in those individuals with undiagnosed or inappropriately treated hypertension. In fire fighters who had autopsies after an on-duty death from CHD, 56% had left ventricular hypertrophy and/or enlarged hearts, which is also known as cardiomegaly.^{xiv} In a prospective study of fire fighters with hypertension, almost 75% lacked appropriate treatment of their blood pressures.^{xv} Investigators in another study observed almost three times the rate of adverse employment outcomes (including on-duty death, on-duty injury, and premature retirement) with hypertension, largely due to fire fighters with high blood pressure who were not taking medication to control their hypertension.^{xvi} Approximately 20% to 30% of fire fighters have hypertension.^{xvii}

Although many health effects of chronic hypertension have been described, newer research indicates that blood pressure in the prehypertension range is also harmful. Prehypertension is defined as untreated systolic blood pressure of 120-139 mm Hg or untreated diastolic blood pressure of

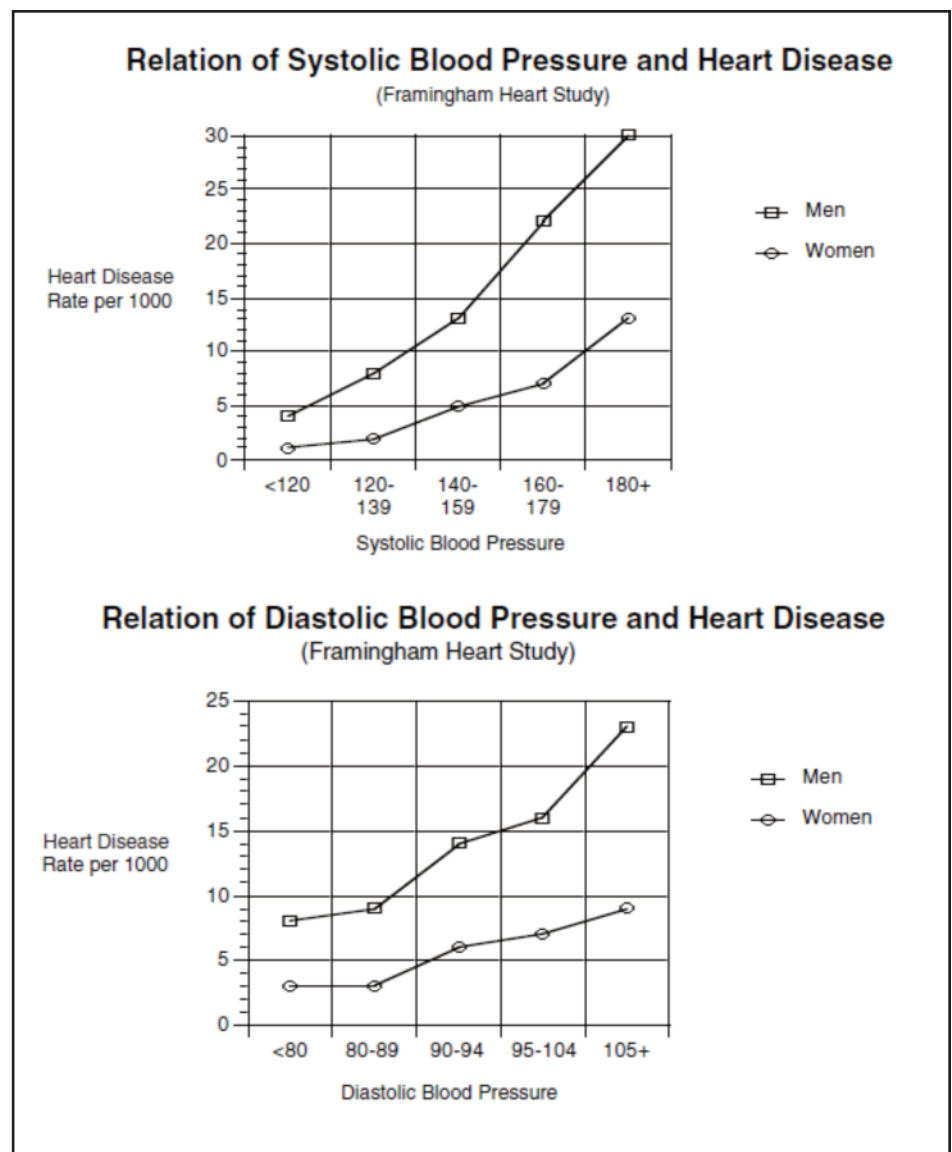


Figure 5.1^{xiii}

80-89 mm Hg.^{xviii} The presence of prehypertension may also be a marker for other CHD risks. In a survey study of the general population, people with prehypertension were more likely than those with normal blood pressure levels to have above-normal cholesterol levels, diabetes mellitus^{xix}, and be overweight or obese. Compared to normal blood pressure, prehypertension in the Framingham Heart Study was associated with a 1.5 to 2-fold risk for major cardiovascular disease events^{xix}. Most CHD events in the general population and among emergency responders occur in people with prehypertensive to mildly elevated blood pressures with average systolic pressure of 140 to 146 mm Hg and diastolic pressures ranging between 88 to 92 mm Hg.^{xx} Approximately 50% of fire fighters have blood pressures in the prehypertensive range.^{xx}

Obesity

Obesity, defined as a Body Mass Index (BMI) >30 kg/m² or total body fat > 25%, is a well-established risk for cardiovascular disease. Some assume that BMI falsely over-estimates the number of obese individuals. While this can be true among athletes and others who have a muscular build, it may not be true for some fire fighters. In a recent investigation of career and volunteer fire fighters it was shown that obesity was even more prevalent when measured with body fat as compared to BMI.^{xxi} The study also found those that had high BMIs also had high cholesterol levels, higher blood pressure and a lower exercise tolerance.

Regardless of how it is measured, recent scientific research suggests that the distribution of body fat is an important predictor of negative health outcomes.

Individuals with more intra-abdominal/visceral fat, which is fat around abdominal organs, are at an increased risk of hypertension, dyslipidemia, coronary artery disease, and premature death. Excessive abdominal fat, as revealed by waist circumference measures, creates increased inflammation in the body. This occurs because fat cells release pro-inflammatory cytokines, cell signaling molecules that activate the immune system, which ‘turns on’ an inflammatory cascade at genetic and cellular levels, ultimately affecting the entire body. This is important because current scientific research links chronically increased inflammation to several chronic disease states such as cardiovascular disease, prediabetes/diabetes, cancer, and dementia. Expert consensus indicates that a waist circumference measurement, measured at the level of the iliac crests (the curved ridge at the top of the hip bone) that is greater than 102 cm (40 inches) in men, and 88 cm (35 inches) in women imparts a significant increase in the risk of chronic disease, including cardiovascular disease.

Elevated BMI is a predictor for diabetes mellitus, stroke, sleep-disordered breathing, as well as other health conditions, including some cancers, liver disease, gallbladder disease, musculoskeletal diseases and reproductive abnormalities. In analysis of data from almost 900,000 adults, overall mortality was lowest at BMI range of 22.5 kg/m² to 25 kg/m², and each 5 kg/m² higher BMI was associated with approximately 30% higher all-cause mortality.^{xxii} Data from

the Framingham Heart Study estimate that the decrease in life expectancy due to being overweight, defined as a BMI between 25 kg/m² to 30 kg/m², ranges from a loss of 3.1 years for 40-year old male non-smokers to 6.7 years for male smokers, and 3.3 years for 40-year old female non-smokers to 7.2 years for female smokers.^{xxiii}

In fire fighters, obesity is a risk factor for job-related disability, on-duty coronary heart disease events, and CHD retirements.^{xxiv} Similar to the general population, the average BMI among fire fighters and emergency responders is increasing. Data collected in the 1980s and early 1990s showed the average veteran fire fighter had a BMI that ranged from 25.4 kg/m² to 26.7 kg/m², but by 1996-1997 the mean BMI was 29 kg/m² and by 2001 it had increased to 29.7 kg/m².

Cholesterol and Triglycerides

Cholesterol and triglycerides are types of molecules referred to as lipids. Cholesterol is required for essential bodily function, such as cell wall and hormone synthesis. Cholesterol is transported throughout the body bound to carrier proteins, including low density lipoprotein (LDL) and high density lipoprotein (HDL). LDL is responsible for delivery of cholesterol to body tissue and is commonly referred to as “bad cholesterol.” HDL transports cholesterol away from body tissues and is often called “good cholesterol.” Triglycerides comprise the fat stored in our bodies. Elevated concentrations of total cholesterol, LDL cholesterol, triglycerides and decreased levels of HDL have been

associated with increased risk of CHD. Figure 5.2 illustrates the association of heart disease mortality with increasing levels of total cholesterol.

Fire fighters may not always have the opportunity to eat meals at a regular time due to the demands of being available to respond to emergencies. Like other shift workers, fire fighters are more likely to eat meals with higher proportion of fats that adversely affect blood lipid levels.^{xxvi} Among fire fighters, the prevalence of low HDL (<40 mg/dL) ranges from 26% to 31%, and high fasting triglyceride concentrations (>150 mg/dL) have been found in over 20%.^{xxvii, xxviii} These values are comparable to surveys of the general population, which demonstrate that among adult males the prevalence of low HDL is 28.6% and that approximately 1 in 3 U.S. adults had a triglyceride level ≥ 150 mg/dL during 1999-2004.^{xxix} Similar to the general population, adverse health effects from abnormal blood lipid levels, or dyslipidemia, are observed in fire fighters, although precise assessment of dyslipidemia as an independent risk factor for on-duty CHD events have been limited by studies lacking premorbid lipid values in fire fighters who suffer events. However, in unadjusted analyses, high total cholesterol (≥ 200 mg/dL) is associated with a 2.4-fold increased risk of coronary heart disease retirement and 4.4-fold increased risk of on-duty coronary heart disease death.^{xxx, xxxi}

Diabetes Mellitus

Diabetes mellitus is a disease of blood sugar or glucose metabolism due to deficiencies (Type I) or resistance to (Type II) insulin, a hormone. Individuals with diabetes have elevated glucose concentrations and often have concurrent hypertension and lipid disorders. Diabetes conveys an increased risk for both coronary heart disease and fatal heart attacks. The prevalence of Type II diabetes in the fire service has been observed to range from 1% to 4%.^{xxxii, xxxiii, xxxiv} Among fire fighters, diabetes accounts for about 21% of on-duty CHD events and 26% of CHD-related retirements.^{xxxv, xxxvi} Type II diabetes alone is not a significant predictor of on-duty CHD and CHD retirements.^{xxxv, xxxvi} This is likely because diabetes modifies the risk of CHD through its effects on hypertension, cholesterol levels, and atherosclerosis.

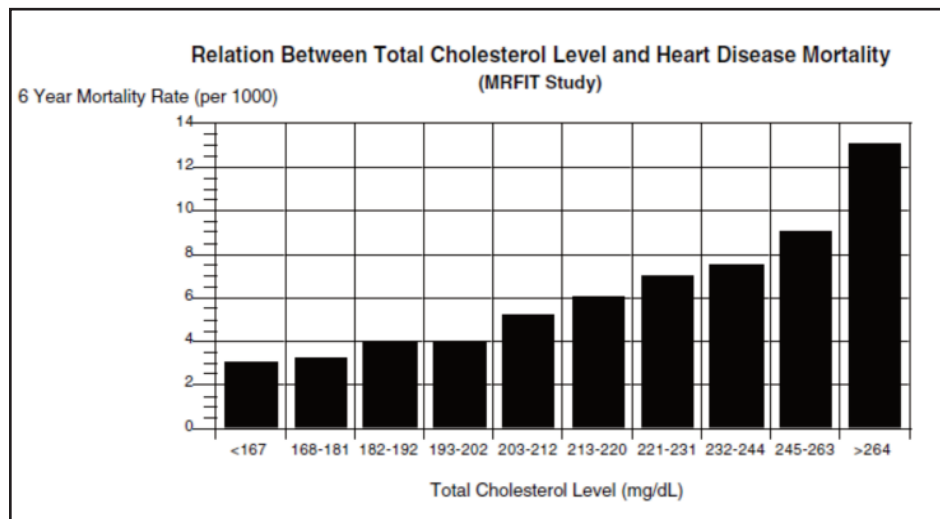


Figure 5.2^{xxv}

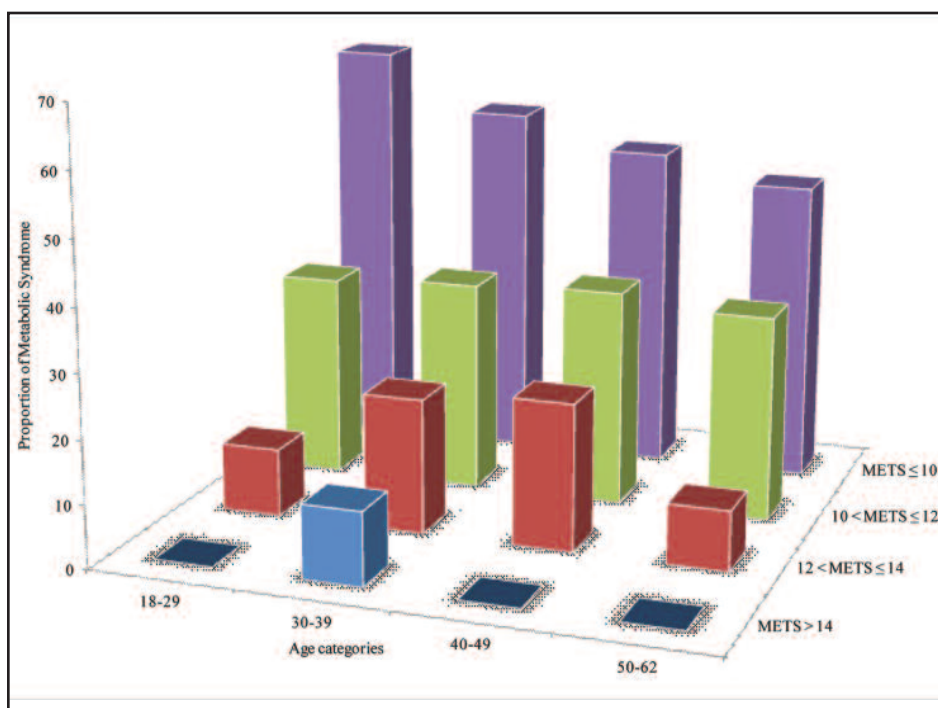


Figure 5.3^{xlv}

Established CHD and CHD Equivalents

Established CHD is disease that is already present, and conditions defined as CHD equivalents, such as peripheral artery disease, carotid stenosis, stroke or transient ischemic attacks, are considered together for risk assessment purposes. CHD or a CHD equivalent is associated with a very high risk of subsequent further on-duty CHD events, on-duty CHD fatality and CHD retirements. The prevalence of established CHD is as low as 1% in career fire fighters, but as high as 9% in volunteers.^{xxxvii, xxxviii} For comparison, the prevalence of established CHD in US adult males is 8.3%.^{xxxix} In studies of fire fighters, previously diagnosed CHD accounted for 31% of fatal on-duty CHD events and 18% of nonfatal on-duty CHD events.^{xl} This translates to a greater than 30-fold risk of on-duty CHD events for those fire fighters with a pre-existing CHD diagnosis.

Metabolic Syndrome

Metabolic syndrome refers to a cluster of risk factors for cardiovascular disease and Type II diabetes mellitus. It is an independent predictor for cardiovascular events and has also been associated with atrial fibrillation and heart failure. The most recent criteria defines metabolic syndrome when ≥ 3 of the following risk factors are present^{xli}:

- fasting plasma glucose ≥ 100 mg/dL or

undergoing treatment for elevated glucose.

- HDL cholesterol < 40 mg/dL in men or < 50 mg/dL in women or undergoing drug treatment for reduced HDL.
- fasting triglycerides ≥ 150 mg/dL or undergoing drug treatments for elevated triglycerides.
- abdominal obesity (elevated waist circumference, population- and country specific) for U.S. men waist circumference ≥ 94 cm.
- blood pressure > 130 mm Hg systolic or > 85 mm Hg diastolic or undergoing drug treatment for hypertension or antihypertensive drug treatment in a patient with a history of hypertension.

The prevalence of metabolic syndrome varies by the definition used in earlier studies. The age-adjusted prevalence was 35.1% for men and 32.6% for women according to NHANES 2003 to 2006 data, and among men, the age-specific prevalence was 20.3% for those 20 to 39 years of age, 40.8% for men 40 to 59 years of age and 51.5% for men ≥ 60 years of age.^{xlii} In an analysis of multiple studies, metabolic syndrome was associated with a 1.54-fold increase in relative risk for cardiovascular events after adjustment for the individual components of the

syndrome.^{xliii} The observed cardiovascular risk associated with the metabolic syndrome increases with the number of components and varies with the possible combination of components. The greatest risk was observed with the combination of central obesity, high blood pressure and hyperglycemia.^{xliv}

A recent study of U.S. career fire fighters from the Midwest found an alarmingly high prevalence (28.3%) of metabolic syndrome among these emergency responders expected to be younger, more active and healthier than the general U.S. adult population.^{xlv} As expected the prevalence of metabolic syndrome increased with the age of these fire fighters: 15% in the youngest (18-29 years) to 35% oldest (50-62 years). In this study, fitness level was measured by an individual performing an exercise test and a metabolic equivalent of task (MET) was calculated. A MET is defined as the rate of oxygen consumption during a task compared to a resting rate and can be considered as an index of the intensity of an activity. A MET value of 1 correlates to quiet sitting, 11.8 METS correlates to running at 8 miles per hour or at a pace of 7.5 minutes a mile^{xlvi}.

As seen in Figure 5.3, fire fighters with the same fitness levels, as defined by number of METS calculated from the exercise test, had roughly the same prevalence of metabolic syndrome, even among different age groups. However, as fitness levels decrease, the prevalence of metabolic syndrome increases dramatically among fire fighters of the same age group. After controlling for physical fitness, as measured by the exercise test, age was no longer a significant predictor of the metabolic syndrome.

Physical Activity/ Physical Fitness

Many epidemiologic studies in the general population have proven that increasing physical activity and physical fitness significantly lowers the risk of CHD.^{xlvii, xlviii} The mechanisms of decreased risk are multifactorial and include improved body composition and reduced levels of cardiovascular risk factors and inflammation. Physical activity is defined as self-reported physical exertion such as exercise; whereas physical fitness is defined by objective measurements such as treadmill exercise tolerance tests. Because measured fitness

is a more accurate measure than self-reported activity, increases in cardiorespiratory fitness are associated with greater decreases in CHD risk.^{xlviii} For example, in a large meta-analysis each one MET increase in fitness conveyed 13% and 15% decrements in all-cause mortality and CHD, respectively.^{xlvii}

Many fire departments do not require regular exercise regimens or the maintenance of discrete physical fitness parameters after hire.^{xlx} Fire fighters experience prolonged sedentary periods punctuated by having to perform very strenuous tasks, and may not have the opportunity to engage in regular physical activity of adequate intensity and duration. This is especially important as it relates to on-duty CHD events, as studies have demonstrated that heavy physical exertion can trigger the onset of a heart attack, particularly in those who do not engage in regular exercise of adequate duration and intensity. On the positive side, recent studies in fire fighters have demonstrated that increasing levels of physical activity and especially physical fitness are associated with improved cardiovascular risk profiles and a lower risk of metabolic syndrome (see above).^{l, li}

Poor Dietary Habits

In randomized controlled trials, dietary habits affect multiple cardiovascular risk factors, such as blood pressure, LDL and HDL cholesterol, triglycerides, glucose levels and obesity.^v While multiple prospective cohort trials indicate little effect of total fat consumption on cardiovascular disease risk, each 2% of calories from *trans* fat was associated with a 23% higher risk of CHD.^{lii, liii} Regarding carbohydrate consumption, pooled analysis from 11 cohort studies observed that for each 5% energy of carbohydrate consumption in place of saturated fat was associated with a 7% increase in risk of CHD.^{liv} Similarly, results from the Nurses' Health Study noted that regular consumption of sugar-sweetened beverages was independently associated with a higher incidence of CHD.^{lv} In the U.S. general population, it is estimated that on an annual basis, high dietary salt intake is responsible for 102,000 deaths, low dietary omega-3 fatty acids for 84,000 deaths, high dietary *trans* fat for 82,000 deaths and low consumption of fruits and vegetables for 55,000 deaths.^{lvi}

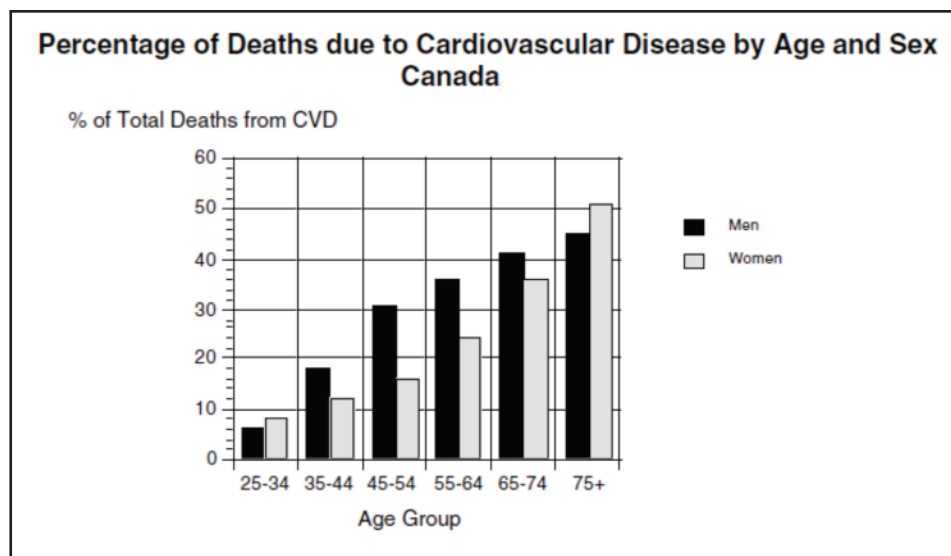


Figure 5.4^{lix}

Fire fighters and emergency responders are shift workers who are required to respond to unpredictable emergencies, resulting in unreliable meal times. “Firehouse culture” has a reputation for recipes high in fat and dense in simple, refined carbohydrates, such as white rice or pasta made from white flour.^{lvii} Despite general awareness of some of the health benefits from healthy food choices, dietary habits do not always change. For example, in one study of fire fighters with an 84% prevalence of overweight or obesity, while 90% of study participants were aware that food choices can prevent the development of heart disease, 37% reported that they enjoyed what they ate and did not want to change.^{lviii}

NON-MODIFIABLE RISKS

Age/Gender

Age is an independent predictor for adverse CHD outcomes. Heart disease occurs as people age, with younger women at decreased risk of mortality from CHD. With increased age, the difference in CHD mortality between men and women decreases. The observed difference has been explained by the effects of female hormones, called estrogens, which offer a protective benefit to premenopausal women; however, women have a lower survival rate after a heart attack at all ages compared to men. Figure 5.4 depicts age specific CHD mortality for men compared to women.

As expected, similar relationships have been observed in fire fighters, with the risk of on-duty CHD deaths increasing

dramatically after the age of 40, which is depicted in Figure 5.5.

Family History

Premature paternal history of a heart attack approximately doubles the risk of a heart attack in men and increases the risk in women by about 70%.^{lxi, lxii} Similarly, history of heart disease in a sibling increases the odds of heart disease in men and women by approximately 50%.^{lxiii} The increased risk of heart disease associated with family history is presumably related in part to common genetics. However, the full genetic basis for CHD has not yet been determined, and the genetic markers identified to date have not been shown to add significantly to existing CHD risk prediction tools.^{lxiv}

OCCUPATIONAL CHD RISKS IN FIRE FIGHTERS

Fire fighters face hazardous exposures and exceptional working conditions that may increase their risk of CHD. These can be divided into acute and chronic stressors, as depicted in Table 5.2.

Smoke Exposure

Inhalation of smoke containing gases and particulates is a hazard to fire fighters. While use of self-contained breathing apparatus (SCBA) during fire attack and suppression may decrease exposure, fire fighters may not wear SCBA or other respirators during the “overhaul” period after a fire, even though harmful inhalants have been documented to be present.^{lxv, lxvi} Fire

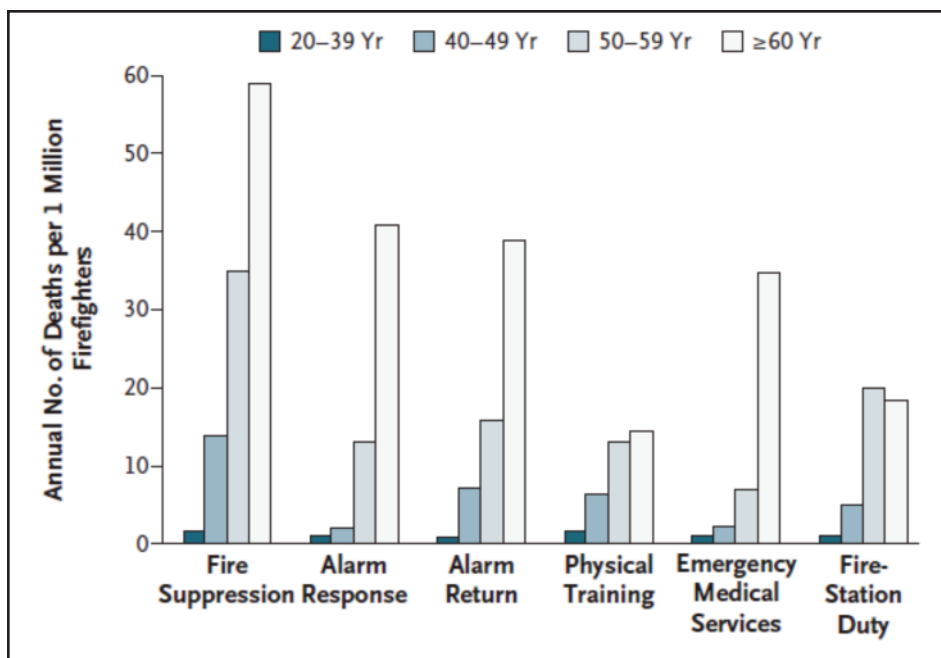


Figure 5.5^{lx}

fighters should be encouraged to wear appropriate personal protective equipment during all activities with smoke exposure.^{lxxvii}

Smoke containing chemical asphyxiants, such as carbon monoxide, cyanide and hydrogen sulfide, interferes with effective oxygenation and can lead to myocardial ischemia in people with CHD. Many effects of exposure to carbon monoxide have been described. Carbon monoxide is formed by the incomplete combustion of carbon, and binds to hemoglobin, the protein in red blood cells that carry oxygen to the body. At sufficient concentrations, carbon monoxide can cause reduced exercise capacity and lead to myocardial ischemia, even in an otherwise healthy heart.^{lxxviii} In animal studies, chronic exposure to carbon monoxide has been associated with accelerated atherosclerosis.^{lxxix} Other chemicals that may be found in products of combustion include particulates, which have been associated with autonomic dysfunction, including arrhythmias, increased heart rate and decreased heart rate variability.^{lxx, lxxi, lxxii} Additional substances with suspected or known direct and indirect cardiac effects that may be present in combustion products include polycyclic aromatic hydrocarbons, arsenic, carbon disulfide, lead and cadmium.^{lxxiii} While plausible mechanisms for increased CHD risk from smoke exist, additional research will

further quantify the cardiovascular consequences of chronic smoke exposure among fire fighters.

Noise

Exposure to noise has been linked with increased blood pressure. Alarms, vehicle engines and mechanized rescue equipment typically generate noise exposures between 63 to 85 decibels (dBA).^{lxxiv} However, documented exposures have been as high as 116 dBA.^{lxxv} It is estimated that systolic blood pressure acutely rises by 0.51 mm Hg for each 5 decibel increase in acute occupational noise exposure.^{lxxvi} While there is general agreement that blood pressure response to intermittent noise

will persist during the exposure, there is not currently sufficient evidence to determine if this effect is long-standing.^{lxxvii}

Psychological Stress

Fire fighters experience increased and various psychological stressors at work. Work related factors that appear to contribute to increased stress include high occupational demands and low decisional latitude, presumably leading to changes in the nervous system and hormonal homeostasis with subsequent elevated blood pressure, elevated heart rate, dyslipidemia and poor sleep.^{lxxviii} Susceptible fire fighters who are exposed to extreme stressors may develop post-traumatic stress disorder, which is also associated with adverse effects on blood pressure, heart rate and the metabolic syndrome.^{lxxix, lxxx, lxxxi}

Shift Work

Fire fighters work long shifts and may be required to staff rotating shifts. The presence of overtime and second jobs may also contribute to chronic sleep deprivation. Evidence from other occupations supports the association between shift work and increased risk of cardiovascular disease.^{lxxxii} The mechanisms are likely multifactorial, involving altered diet, sleep disruption, physical inactivity, psychological stress and altered circadian rhythms.^{lxxxiii, lxxxiv} Sleep deprivation has been associated with adverse metabolic changes, hypertension and cardiovascular disease.^{lxxxv, lxxxvi, lxxxvii, lxxxviii}

Potential Occupational Cardiovascular Hazards

Chronic

Long sedentary periods
Smoke exposure
Noise
Shift work/partial sleep deprivation
Fire house dietary patterns
Occupational stress
Post-traumatic stress disorders
High job demand and low decisional control

Acute

Irregular physical exertion
Smoke exposure
Noise
Excess heat/dehydration
Duty-specific hazards
Firefighting activities
Physical training
Alarm response

Table 5.2^{lxxvii}

ACUTE CARDIOVASCULAR STRAIN OF FIREFIGHTING

Firefighting acts as a stressor on the cardiovascular system in several ways. An individual's physiologic response largely depends on underlying health status and cardiorespiratory fitness, as depicted in Figure 5.7.

Sympathetic Activation

Firefighting induces activation of the sympathetic nervous system with associated release of catecholamines like epinephrine (adrenaline). This “fight or flight” response can cause rapid increase in heart rates. In studies that recorded heart rates of fire fighters responding to alarms, investigators noted heart rates rose quickly in response to the station alarm, and reached maximal or near-maximal rates during simulated or actual fire emergencies.^{lxxxix, xc, xci, xcii, xciii, xciv} For example, even though the physical activity required to enter a truck after hearing an alarm should not increase the heart rate to more than 100 beats per minute, heart rates, especially among younger fire fighters, increased to as high as 130-150 beats per minute after an alarm sounded.^{xciv}

Physical Workload

Firefighting requires strenuous exertion, such as carrying tools and wearing personal protective equipment, advancing hose lines, breaching walls, ceilings and roofs, climbing and performing rescues.

Physical workload is measured using metabolic equivalents, or METs. A MET is defined as the rate of oxygen consumption during a task compared to a resting rate and can be considered as an index of the intensity of an activity. A MET value of 1 correlates to quiet sitting, 11.8 METS correlates to running at 8 miles per hour or at a pace of 7.5 minutes a mile.^{xcv} Commonly, the number of METS is measured by an individual undergoing an exercise treadmill test.

In a study of fire fighters performing simulated firefighting duties, the time required to complete the tasks was inversely correlated with the number of METS achieved on fitness testing.^{xcvi} In other words, fire fighters who had higher levels of aerobic fitness as measured by their ability to reach a higher MET value, safely completed the tasks more quickly. Researchers who measured fitness levels

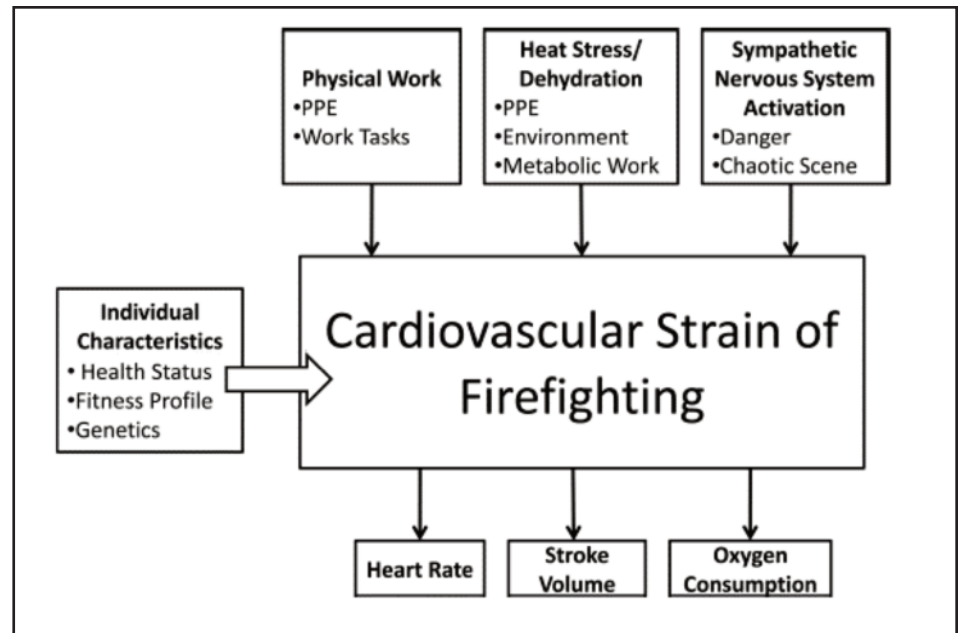


Figure 5.7^{lxxxix}

in a sample of fire fighters participating in a standard firefighting physical activities test noted that 100% of those who were unable to reach 9.7 METS failed the test.^{xcvii} Numerous scientific studies have demonstrated that the aerobic capacity required to perform firefighting tasks during simulated fire conditions is at least 12 METS (42 ml oxygen/kg/min). At levels below 12 METS, a fire fighter shall be counseled to improve his or her fitness and a prescribed aerobic program may be a consideration. At levels at or below 8 METS, a prescribed aerobic fitness program shall be required and the authorities having jurisdiction (AHJ) shall be advised to consider restriction from essential fire fighting job tasks. Ongoing studies are attempting to quantify fitness levels on the basis of relative risk of future health outcomes.^{xcviii}

Heat

Fire fighters experience thermal strain from the heat of fires as well as the heat generated by metabolic activities while performing tasks, which acts as a cardiovascular stressor. Additionally, insulated personal protective equipment limits heat dissipation.^{xcviii} Data gathered from fire training estimate that core body temperatures increase at a rate of about 0.05°C/min or 1.0°C after 20 minutes of acute fire fighting.^{xcix, c, ci} Susceptible individuals who experienced the same rate of temperature increase for longer periods could suffer heat-related injuries and illness. There are multiple recognized

factors that increase the risk of heat illness, including obesity, low levels of physical fitness, lack of acclimatization, dehydration and a prior episode of heat illness.^{xcviii, cii} Certain medical conditions, including diabetes, heart disease, diarrhea, sunburn and viral illnesses; and medications that interfere with thermoregulation, such as stimulants, anticholinergics and some cardiovascular drugs are associated with an increased risk of heat illness.^{cii, ciii}

Dehydration

Dehydration decreases plasma volume, resulting in an increase in the concentration of red blood cells, also known as hemoconcentration, and impaired thermoregulation which may lead to decreases in cardiac output. Fire fighters may secrete up to 1.2 to 1.9 L/hour of sweat during strenuous firefighting while wearing personal protective equipment.^{civ, cv, cvi} In a study of fire fighters who completed a series of three, 7-minute training drills with live fires, stroke volume, or the volume of blood that is pumped from one ventricle of the heart with each beat, decreased to almost 20% below baseline levels, even though there was a 10-minute break to rest and drink fluids.^{civ} Dehydration linked hemoconcentration may be responsible for the increase in circulating platelets observed during fire fighting and may lead to an environment that favors the formation of blood clots.^{cvii, cviii}

CONCLUSION

There are many known CHD risk factors; some are modifiable, while others, such as age and gender are not. Both fire fighters and the general population share many of the same risk factors.

Additionally, fire fighters also face special occupational circumstances that raise the risk of CHD and the risk for triggering on-duty CHD events. Fire fighters can improve their health by changing personal and professional modifiable CHD risk factors. Specifically, it is

important for fire fighters to have good diets, increase their physical fitness through adequate exercise and physical activity and maintain good sleep hygiene by obtaining an average of 7-8 hours of sleep per night. ■

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Heart Disease in the Fire Service

CHAPTER 6 • PREVENTING HEART DISEASE

Cardiovascular disease is the leading cause of on-duty death among fire fighters. Research studies have identified multiple cardiovascular risk factors that fire fighters face. Chapter 5 discussed potential occupational cardiovascular hazards in fire fighters (See Table 6.1) and non-occupational risk factors. There is a preponderance of scientific evidence demonstrating that efforts to decrease modifiable factors can decrease the risk of heart disease. This chapter will discuss how lifestyle changes can help prevent or decrease the development of cardiovascular disease.

PHYSICAL ACTIVITY

Fire fighters must have a high level of physical fitness to perform their job duties. While any exercise is preferable to inactivity, regular aerobic activity and muscle strengthening exercises are necessary for primary and secondary prevention of heart disease. Benefits of regular exercise include positive changes in body weight, blood pressure, cholesterol, glucose, mood and cardiovascular fitness.

There are several methods to define intensity of exercise. The American College of Sports Medicine (ACSM) defines exercise intensity by percentage of maximum heart rate (MHR), rate of perceived exertion, and METS.ⁱ Moderate activity has been defined as 64% to 76% MHR, vigorous activity as 77% to 95% MHR. The MHR can be calculated by subtracting your age from 220. For example, a 40 year old has a MHR of 180, and for moderate activity the target heart rate is 115 to 137 heart beats a minute. METS refers to metabolic equivalents and is determined by measuring the amount of oxygen consumed (see Chapter 5). The ACSM rates exercise intensity using METS. For men (for women, mean values are one to two METS lower than for men), shown in Table 6.1.

AGE (years)	# METS (moderate)	# METS (vigorous)
20-39	4.8 - 7.1	7.2 - 10.1
40-64	4.0 - 5.9	6.0 - 8.4
65-70	3.2 - 4.7	4.8 - 6.7

Table 6.1 ⁱ

Some examples of physical activities in METS areⁱⁱ:

- Running, 4 mph (13 min/mile) 6 METS
- Walking, carrying 25 to 49 lb load, upstairs 8 METS
- Bicycling, 14-15.9 mph 10 METS
- Walking, carrying > 74 lb load, upstairs 12 METS
- Running, 9 mph (6.5 min/mile) 12.8 METS

For the general adult population, the USDA recommendations for physical activity are:ⁱⁱⁱ

- Muscle-strengthening activities that involve all major muscle groups on 2 or more days a week.
- At least 150 minutes (2 hours and 30 minutes) a week of moderate-intensity, or 75 minutes (1 hour and 15 minutes) a week of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate- and vigorous-intensity aerobic activity. Aerobic activity should be performed in episodes of at least 10 minutes, and preferably, it should be spread throughout the week.
- For additional and more extensive health benefits, adults should increase their aerobic physical activity to 300 minutes (5 hours) a week of moderate-intensity, or 150 minutes a week of vigorous-intensity aerobic physical activity, or an equivalent combination of moderate- and vigorous-intensity activity.

To reach your goal fitness level, any exercise regimen will vary depending on individual factors. It is recommended that before starting an exercise program, you should consult a physician if:

- You are over 40 years old and are not regularly physically active
- You have a chronic illness or require daily medications
- You develop concerning symptoms with exertion that include but are not limited to chest pain, difficulty breathing, or dizziness.

WELLNESS AT WORK

Fitness and wellness programs, if properly designed and administered, offer an opportunity for prevention of cardiovascular disease. A comprehensive program should emphasize healthy diets, regular physical activity and good sleep hygiene, as well as provide continuing education and Employee Assistance Programs (EAP) options.^{iv}

The Fire Service Joint Labor Management Wellness-Fitness Initiative (WFI) is a historic partnership between the IAFF and the International Association of Fire Chiefs (IAFC) as a way to improve the wellness of fire department uniformed personnel. Ten public career fire departments from the United States and Canada participated. Each of these departments committed themselves to this Wellness-Fitness Initiative by requiring mandatory participation of all of their uniformed personnel in this program.

The intention of the WFI is that its implementation should be a positive individualized program that is non-punitive. All component results are measured against the individual's previous examinations and assessments and not against any standard or norm. However, medical practice standards may be used when results indicate that lifesaving intervention is required.

Confidentiality of medical information is the most critical aspect of the WFI. The unauthorized release of personal details which may be recorded as part of a medical evaluation causes legal, ethical, and personal problems for the employee, employer and examining physician. All information obtained from medical and physical evaluations should be considered confidential, and the employer will only have access to information regarding fitness for duty, necessary work restrictions, and if needed, appropriate accommodations. Also, all medical information must be maintained in separate files from all other personnel information.

The WFI is a comprehensive program that addresses the needs of the total individual in a program to build and maintain fit fire fighters and EMS personnel. Fitness—physical, mental, and emotional—requires an effective wellness program available to recruits, incumbents, and retirees. Components of the WFI include medical evaluation, fitness, injury/fitness/medical rehabilitation, behavioral health, and data collection.

The WFI is designed to improve the quality of life for all fire fighters while simultaneously seeking to prove the value of investing wellness resources over time. The Cost Justification Chapter of the WFI Third Edition outlines the significant cost savings in lost work time, workers compensation, and disability when implementing a comprehensive wellness-fitness program.

HIGH BLOOD PRESSURE

High blood pressure or hypertension is a recognized risk factor for heart disease. Untreated, elevated blood pressure can also damage the brain, kidneys and eyes. While family history and genetics may contribute to the incidence of high blood pressure, the impact of lifestyle choices cannot be underemphasized. Adoption of healthy lifestyles is critical for the prevention of hypertension, essential for

the management of those with high blood pressure, and has been shown to decrease cardiovascular risk.^v

Major lifestyle changes that have been shown to lower blood pressure include weight loss in those who are overweight or obese; adoption of the Dietary Approaches to Stop Hypertension (DASH) eating plan; regular physical activity; moderation of alcohol and sodium consumption.^{vi} Healthy behaviors also enhance the efficacy of antihypertensive medications used to treat those with high blood pressures. For example, adoption of the DASH eating plan has effects similar to a single drug therapy, while combination of several lifestyle modifications can achieve even better results.^{vii} Adjunctive to behavior change, pharmacologic treatments have been shown to reduce the complications of hypertension. Clinical trials have demonstrated that goal blood pressure levels can be achieved in most patients who are hypertensive, with many proven medications to choose from.

STEPS YOU CAN TAKE TODAY

- Aerobic and muscle strengthening exercises that includes moderate physical exertion for at least 30 minutes on most days of the week.
- Maintain a healthy weight.
- Eat a healthy diet that limits sodium to <1.5 grams a day.
- Don't smoke.
- Limit daily alcohol use to < 2 drinks for men and < 1 drink for women.
- Check your blood pressure periodically as hypertension may not have any symptoms.
- Treat high blood pressure if you have hypertension.

PSYCHOLOGICAL STRESS

Fire fighters face many psychological stressors while performing duties that include responding to fires, performing rescues, terrorism, etc. Excessive stress may lead to increased heart rate, elevated blood pressure and sleep disturbances.^{viii} Personal and occupational stressors can also contribute to unhealthy behaviors

such as smoking, excessive eating, or increased alcohol consumption. Susceptible fire fighters exposed to extreme stressors may develop post-traumatic stress disorder (PTSD).

Although working conditions have a primary role in causing job stress, individual and other situational factors can strengthen or weaken this influence.^{ix} For example, a sick family member or need to work a second job may intensify the effects of work stressors. However, individual factors can also help to reduce the effects of occupational stressors, such as a balance between work and family or personal life, a support network of friends and coworkers, and a relaxed and positive outlook.^{ix}

There are many signs and symptoms of difficulty coping with stress. Learning to recognize when you or a coworker is having difficulty coping with stress is important so corrective action can be taken. Knowing how and when to ask for assistance can avert negative consequences of stressors. Many departments have employee assistance programs (EAPs) that provide confidential, short term counseling.

Because there are many causes of work stressors, there are many strategies to reduce or prevent them. While it may not be possible to immediately address the source of the stress, there are preventive steps that can be taken. The American Psychological Association suggests the following tips^x:

Identify the cause. You may find that your stress arises from something that's easy to correct. A psychologist can help you define and analyze these stressors, and develop action plans for dealing with them.

Monitor your moods. If you feel stressed during the day, write down what caused it along your thoughts and moods. Again, you may find the cause to be less serious than you first thought.

Make time for yourself at least two or three times a week. Even ten minutes a day of "personal time" can help refresh your mental outlook and slow down your body's stress response systems. Turn off the phone, spend time alone in your room, exercise, or meditate to your favorite music.

Walk away when you're angry. Before you react, take time to mentally regroup by counting to 10. Then look at the situation again. Walking or other physical activities will also help you work off steam.

Analyze your schedule. Assess your priorities and delegate whatever tasks you can (e.g., order out dinner after a busy day, share household responsibilities). Eliminate tasks that are “shoulds” but not “musts.”

Set reasonable standards for yourself and others. Don’t expect perfection.

OBESITY

Overweight and obesity are terms for ranges of weight that are greater than what is generally considered healthy for a given height.^{xi} Being overweight or obese is associated with increased risk of future adverse health effects. There is a national obesity epidemic, with over two out of every three adults in the U.S. currently overweight or obese.^{xii} Analysis of data trends from the Framingham Heart Study revealed that among normal weight adults between 30 and 59 years of age, the four year rates of becoming overweight varied from 26% to 30% in men and 14% to 19% in women.^{xiii}

Among adults, overweight and obesity ranges are commonly determined using weight and height to calculate a body mass index (BMI). BMI is used because for most people, it correlates with the amount of body fat. An adult with a BMI between 25 kg/m² and 29.9 kg/m² is considered overweight, while an adult with a BMI of ≥ 30 kg/m² is considered obese. As an example, an adult who is 5’9” tall and weighs 169 lbs. to 202 lbs. has a BMI that is overweight, while an adult who is 5’9” tall and weighs 203 lbs. or more has a BMI that is obese. Even though BMI correlates with the amount of body fat, BMI does not directly measure body fat. Other methods of estimating body fat and body fat distribution include measurements of skinfold thickness, waist circumference, calculation of waist-to-hip circumference ratios, and other techniques such as ultrasound, bioelectrical impedance, computed tomography, magnetic resonance imaging and dual-emission X-ray absorptiometry (DEXA or DXA).

An ideal body weight with normal range BMI can be obtained through a combination of diet and exercise so metabolic requirements are matched with caloric intake. Healthy eating and physical activity are always the primary means to reach a healthy weight. The “Dietary

Guidelines for Americans” published jointly by the U.S. Department of Health and Human Services (HHS) and the U.S. Department of Agriculture (USDA) offers guidance on developing a healthy eating plan and tips for caloric intake (see next section on diet). Additionally, we have increasing knowledge that getting the proper amount of sleep is also important to maintaining a healthy weight, and that short sleep and shift work can adversely affect metabolism and weight (see sleep section page 29).

DIET

A healthy diet is an important component of preventing heart disease. In randomized controlled trials, dietary habits have been shown to affect many cardiovascular risk factors, such as cholesterol levels, blood pressure, glucose levels and obesity. For example, individual nutritional determinants associated with adiposity or weight gain include larger portion sizes, higher intake of sugar-sweetened beverages, and greater consumption of fast food and commercially prepared meals.^{xiv} Consultation with a dietician can also help personnel with designing sample menus and healthy eating tips.

The Fit to Survive (FTS) program, part of the IAFF/IAFC Fire Service Joint Labor Management Wellness-Fitness Initiative, was created to promote continuous education of fire fighters regarding healthy dietary patterns and nutrition. The working environment of uniformed personnel presents unique challenges to the maintenance of healthy eating habits. The FTS website offers expert advice and practical information on staying fit and healthy. The FTS menu planner provides recipes for simple, healthy meals that can be easily prepared on the job. The menu planner also helps fire fighters plan ahead for each day, week, and month, and provides complete nutrition information for each recipe. Each day’s meals add up to approximately 2,200 calories. The FTS program also provides information on how to make the healthiest choices when eating on the run to help avoid fast foods that are high in carbohydrates, fats, and sodium.

The “Dietary Guidelines for Americans, 2010” was published jointly by the U.S. Department of Health and Human Services (HHS) and the U.S. Department of Agriculture (USDA). It contains

evidence-based nutritional guidance to promote health, reduce the risk of chronic diseases, and reduce the prevalence of overweight and obesity through improved nutrition and physical activity.^{xv} Key recommendations about food and nutrients are summarized in the following paragraphs. Consult your physician for any questions or concerns that you may have about beginning a new diet.

SODIUM

Sodium, which is found in salt, is an essential nutrient, usually needed in only small quantities. Generally, higher sodium consumption is associated with higher blood pressure. Evidence from research documents that as sodium intake decreases, so does blood pressure.^{xvi} Most people consume more sodium than they need. Sodium is added to food for

STEPS YOU CAN TAKE TODAY

- Read the Nutrition Facts label for information on the sodium content of foods and purchase foods that are low in sodium.
- Consume more fresh foods and fewer processed foods that are high in sodium.
- Eat more home-prepared foods, and use little or no salt or salt-containing seasonings when cooking or eating foods.
- When eating at restaurants, ask that salt not be added to your food or order lower sodium options, if available.

multiple reasons, such as baking, flavoring and curing meat. Most sodium comes from salt added to processed foods. Individuals should reduce their sodium intake to less than 2.3 grams a day; however, African Americans, individuals with hypertension, diabetes, or chronic kidney disease and individuals ages 51 and older should limit sodium intake to 1.5 grams a day.

FATS AND CHOLESTEROL

Fats are found in plant and animal foods. Fats supply calories and aid in the absorption of vitamins. Dietary

guidelines recommend that fats should account for 20% to 35% of daily caloric intake. Fats often contain a mixture of fatty acids, which are categorized as saturated, trans, monounsaturated, or polyunsaturated. The types of fatty acids consumed are more important in impacting the risk of cardiovascular disease than is the total amount of fat in the diet. The “better” fats are unsaturated fats. Foods from plants, except coconut oil, palm kernel oil, and palm oil, tend to have more monounsaturated and/or polyunsaturated fatty acids. Foods from animals, except seafood, tend to have more saturated fatty acids. Most fats that have a high percentage of saturated or trans fatty acids are solid at room temperature and are referred to as “solid fats.” Solid fats are found in most animal foods but also can be made from vegetable oils through the process of hydrogenation. Fats that have more unsaturated fatty acids are usually liquid at room temperature and are referred to as “oils.”

Most saturated fats that we eat come from animals, such as beef, lamb, pork, poultry with skin, and dairy products made from whole or reduced-fat (2%) milk. These foods also contain cholesterol. Baked and fried foods can also have elevated levels of saturated fats. Some plant foods, such as palm oil, palm kernel oil, and coconut oil also contain saturated fats, but do not contain cholesterol. Trans fats are found in many foods. While some trans fats are derived from animal sources, most come from partially hydrogenated fat that can be found in commercially baked products and fried foods. There is strong evidence that higher intake of most dietary saturated and trans fatty acids are associated with higher levels of blood total cholesterol and low-density lipoprotein (LDL) cholesterol, both are risk factors for heart disease.^{xvi} The American Heart Association recommends individuals should restrict their intake of saturated fats to less than 7 % of total daily calories and limit intake of trans fats to as low as possible. This means you should try to avoid eating foods that contain partially hydrogenated vegetable oils, and if you are eating foods from animals, try meals containing poultry, lean meats, and fish.

Unsaturated fats or “good fats” can either be monounsaturated or

polyunsaturated. Monounsaturated fats have been used for millennia in olive oil, one of the fundamental components of the Mediterranean diet. Foods rich “good” fats include olive, canola, sunflower, soy, and corn oils; nuts, seeds, and fish. The American Heart Association recommends eating unsalted nuts, legumes and seeds at least 4 servings a week. However, while unsaturated fats are “better” than saturated and trans fats, excessive consumption can lead to unwanted calories.

Omega-3 fatty acid is a polyunsaturated fat, which can be found in oily fish, such as mackerel and sardines. Consumption of omega-3 fatty acids have been shown to have a favorable cardiovascular profile. The American Heart Association recommends that people eat a variety of fish, preferably oily fish (salmon, tuna, mackerel, herring and trout), at least twice a week. In addition to eating meals with a variety of fish, individuals with coronary artery disease or elevated serum triglyceride levels should also consult their personal physicians regarding the advisability of taking daily omega-3 fatty acid supplements.

Cholesterol is a compound defined as a waxy steroid of fat and is used in the body in cell membranes and hormones. Dietary sources of cholesterol are found in animal foods. Dietary cholesterol has been shown to raise blood LDL cholesterol levels in some individuals, and moderate evidence demonstrates a relationship between higher intake of cholesterol and higher risk of cardiovascular disease. However, this effect is reduced when saturated fatty acid intake is low, and the potential

STEPS YOU CAN TAKE TODAY

- Consume < 7% of daily calories from saturated fatty acids.
- Keep trans fatty acid consumption as low as possible.
- Consume less than 300 mg per day of dietary cholesterol.

negative effects of dietary cholesterol are relatively small compared to those of saturated and trans fatty acids.^{xvi} Total cholesterol consumption should be < 300 mg a day to help maintain normal blood cholesterol levels, but in individuals at

higher risk of cardiovascular disease, total consumption should be < 200 mg a day. As an example, a medium egg has about 185 mg of cholesterol and a large one has about 215 mg.

ADDED SUGARS

Carbohydrates are categorized as simple, including sugars, or complex, including starches and fibers. Some sugars occur naturally in food, such as fruits and milk, while others are added to food for various reasons, including sweetening the flavor of foods and for preservation purposes. Often added sugars supply calories but little essential nutrients or fiber. Daily consumption of carbohydrates should range between 45% to 65% of total calories.

The American Heart Association recommends that no more than half of your daily discretionary calorie allowance come from added sugars. Daily discretionary calories come from eating foods after daily nutrient needs are already met, but do not contribute to weight gain. For most American women, this is less than 100 calories per day (about 6 teaspoons of added sugar) and less than 150 per day for men (about 9 teaspoons of added sugar).

REFINED GRAINS

Foods that come from plants such as wheat, rice, corn or oats are grains. There are two main types of grain products: whole grains and refined grains. Whole grains contain the entire grain, including the bran, germ and endosperm. Examples include whole-wheat flour, oatmeal and brown rice. Whole grains are a good source of vitamins, minerals and fiber. Dietary fiber from whole grains helps reduce cholesterol. It can be difficult to try and identify foods with whole grains without looking at the ingredient label. For many whole-grains, the words “whole” will appear before the grain’s name in the ingredient list, such as “whole grain.” The whole grain should be the first ingredient listed. The American Heart Association Whole Grain heart-check mark on food labels identifies products with whole grains.

Refined grains have been milled, which removes the bran and germ. Some examples of refined grains are wheat flour and white rice. During the refining process

of whole grains, vitamins, minerals and fiber are lost. Many refined grains have vitamin and minerals added during the later stages of refining, which return some, but not all of the beneficial ingredients.

The number of recommended servings of grains depends on your calorie needs. The recommended amount of grains that someone should consume every day is measured as “ounce-equivalents” but is commonly referred to as “ounces” (or servings) of grains. For example, a person who needs to eat 2,000 calories each day should eat 6 to 8 servings of grains, at least

half should come from whole-grains. The recommended amount of refined grains is no more than 3 ounce-equivalents a day, and whole grains should be added to the diet to account for at least half of all grains eaten.^{xvi} The recommended amount of fiber is 25 grams daily. A single serving of grains would be equal to 1 slice of bread, 1 cup of cereal or ½ cup of pasta.

GENERAL TIPS FOR EATING HEALTHY

As discussed above, eating healthy means having a diet containing a variety of fruits, vegetables, nuts and grain products, as well as judicious amounts of fats. Learning how to read and understand food labels can help you make healthier choices. In addition to Table 6.2 that summarizes suggested serving sizes of foods for 1,600 and 2,000 calories a day diets, the following are some general tips for healthier eating habits:

- **Fruits and Vegetables:** Eat a variety with a goal of 4 ½ servings a day. Limit consumption of potatoes, as they contain starch, which has the same deleterious effect on blood sugar as refined grains and sweets.
- **Grains:** Choose whole grains, such as whole wheat bread, and brown rice. Eating too much of refined grains, such as white bread and white rice, can raise the risk of heart disease.
- **Proteins:** Choose fish, poultry, beans, or nuts, which contain healthful nutrients. Limit red meat and avoid processed meats. Keep saturated fats to <7 % of total calories a day.
- **Oils:** Use olive, canola, and other plant oils. Avoid trans fats.
- **Nuts:** Eat at least 4 servings of nuts, legumes and seeds a week

STEPS YOU CAN TAKE TODAY

- Eat foods containing fiber, with a recommended 25 grams of fiber daily.
- Eat 6 to 8 servings of grains daily, with no more than 3 servings from refined grains.

Food Type	1,600 Calories	2,000 Calories	Examples of One Serving
Grains At least half of your servings should be whole-grain.	6 servings per day	6-8 servings per day	<ul style="list-style-type: none"> • 1 slice bread • 1 oz dry cereal (check nutrition label for cup measurements of different products) • 1/2 cup cooked rice, pasta, or cereal (about the size of a baseball)
Vegetables Eat a variety of colors and types	3-4 servings per day	4-5 servings per day	<ul style="list-style-type: none"> • 1 cup raw leafy vegetables (about the size of a small fist) • 1/2 cup cut-up raw or cooked vegetables • 1/2 cup vegetable juice
Fruits Eat a variety of colors and types	4 servings per day	4-5 servings per day	<ul style="list-style-type: none"> • 1 medium fruit (about the size of a baseball) • 1/4 cup dried fruit • 1/2 cup fresh, frozen, or canned fruit • 1/2 cup fruit juice
Fat-free or low-fat dairy Products	2-3 servings per day	2-3 servings per day	<ul style="list-style-type: none"> • 1 cup fat-free or low-fat milk • 1 cup fat-free or low-fat yogurt • 1 and 1/2 oz fat-free or low-fat cheese (about the size of 6 stacked dice)
Lean meats, poultry, and seafood	3-6 oz (cooked) per day	Less than 6 oz per day	<ul style="list-style-type: none"> • 3 oz cooked meat (about the size of a computer mouse) • 3 oz grilled fish (about the size of a checkbook)
Fats and oils Use liquid vegetable oils and soft margarine most often	2 servings per day	2-3 servings per day	Examples of One Serving <ul style="list-style-type: none"> • 1 tsp soft margarine • 1 Tbsp mayonnaise • 1 tsp vegetable oil • 1 Tbsp regular or 2 Tbsp low-fat salad dressing (fat-free dressing does not count as a serving)
Nuts, seeds, and legumes	3-4 servings per week	4-5 servings per week	<ul style="list-style-type: none"> • 1/3 cup or 1 and 1/2 oz nuts • 2 Tbsp peanut butter • 2 Tbsp or 1/2 oz seeds • 1/2 cup dry beans or peas
Sweets and added sugars	0 servings per week	5 or fewer servings per week	<ul style="list-style-type: none"> • 1 Tbsp sugar • 1 Tbsp jelly or jam • 1/2 cup sorbet and ices • 1 cup lemonade

Table 6.2 ^{xvii}

- **Fluids:** Drink water, tea, or coffee (with little or no sugar). Limit milk and dairy to 1-2 servings per day and juice to 1 small glass a day. Avoid drinks with added sugar.

ADDITIONAL NUTRITIONAL INFORMATION

There are several well researched sources of information for those seeking to eat healthier. The American Heart Association publishes and maintains online information about nutrition, physical activity, smoking cessation and weight management. The U.S. government publishes “The Dietary Guidelines for Americans” that can be found online or ordered from the USDA. The USDA also provides resources to help individuals develop personalized nutrition plans, track food and physical activities, and get tips to support healthy eating choices. Nutrition experts at the Harvard School of Public Health in conjunction with Harvard Health Publications have produced the Healthy Eating Plate, a visual guide to help eat healthy (see Figure 6.1). The Healthy Eating Plate also addresses deficiencies in the USDA guidelines.

SLEEP HYGIENE

Sleep hygiene is a variety of different practices that are necessary to have normal, quality night time sleep and full daytime alertness.^{xix} Sleep hygiene is important for everyone and can prevent the onset of sleep disorders. Sleep disturbances and daytime sleepiness are signs of poor sleep hygiene. The most important factor is maintaining a regular sleep and wake pattern. Most adults require 7-8 hours of sleep each night.

Workers will benefit from sleeping in a dark, quiet room, at a cool and comfortable temperature. Having a regular routine of preparing for sleep also helps. Night and shift workers may also consider dark curtains and trying to minimize possible disturbances from unwanted noise. Permanent night workers should also seek to maintain a regular sleep schedule, even on days off. Reverting to a daytime schedule when off-duty can make it more difficult to sleep during the day after resuming night shifts.^{xx} Individuals who rotate shifts can adjust their sleep schedules so they can

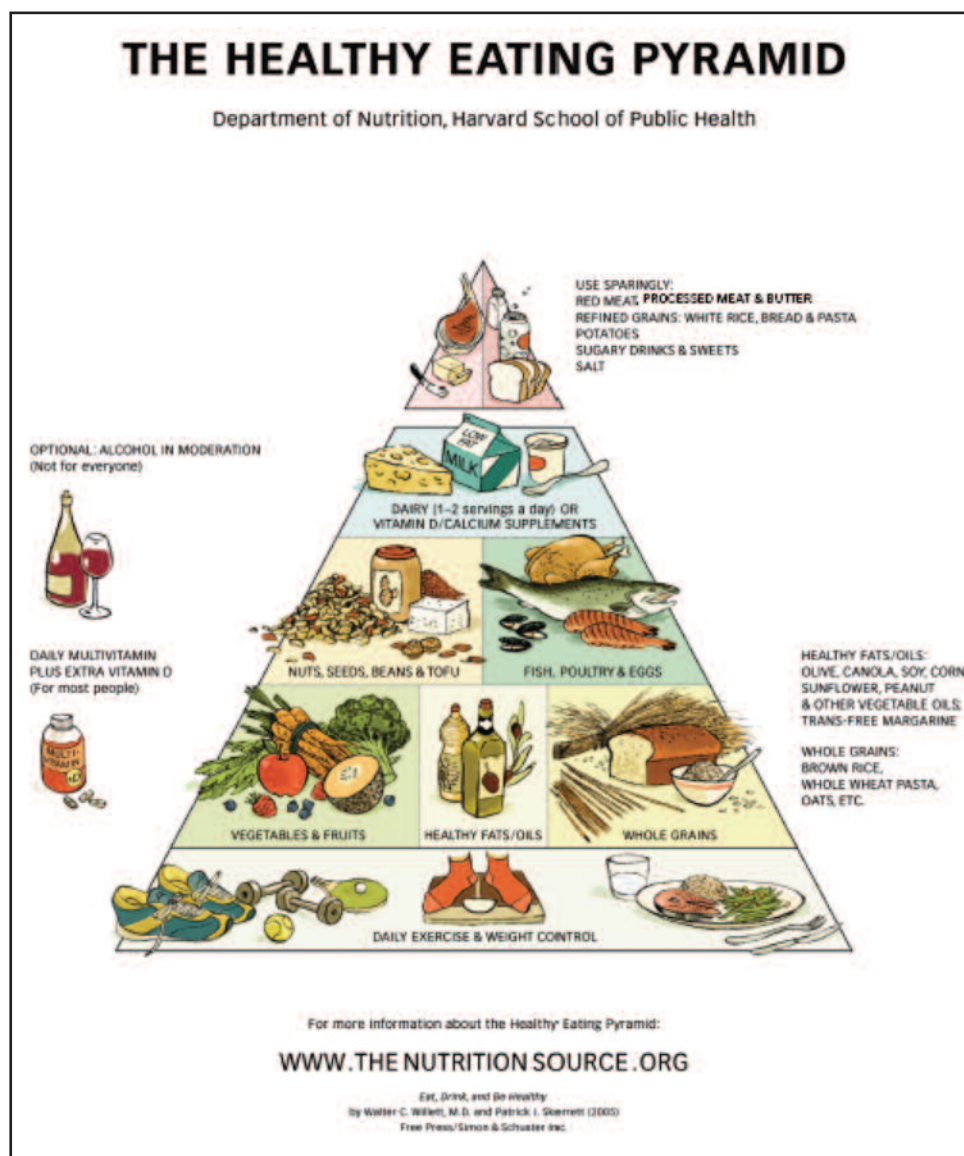


Figure 6.1^{xviii}

adapt to upcoming shift changes. For example, on the last few days of an evening shift, workers should delay their bedtimes and rising times by 1 to 2 hours, so by the time they start a night shift schedule, they have already began the process of adapting to the new schedule.^{xix}

Those who staff on-call shifts face additional problems as they may not be able to anticipate their schedules, and may benefit from napping if they are unable to maintain their sleep. Naps may help offset some of the effects of sleep deprivation and temporarily improve alertness, but they are not a substitute for adequate nightly sleep. Brief naps (less than 30 minutes) during a work shift are preferred, as longer naps that allow deeper sleep may briefly hinder performance due to sleep inertia, which is the body's tendency to want to remain at rest between 15 minutes to an hour after

waking. Caffeine may be taken before a brief nap because it takes some time to achieve its stimulant effects and will further increase alertness upon awakening from the nap. This may be especially important for those who have to react immediately upon awakening.^{xix}

In terms of adjuncts to a regular sleep cycle, occasional use of caffeine has been shown to reduce sleepiness and enhance alertness, but it should not be consumed within 4 hours of nighttime sleep. Sleeping pills are often taken by shift workers, but long-term regular use is not recommended because they do not address the underlying cause of sleepiness, which is inadequate sleep. Furthermore, these drugs are not recommended for use in public safety workers. Additionally, the effectiveness of sleeping pills, such as benzodiazepines and newer prescription sleep medications

can wane with time and dependency issues can develop. In particular, people with a history of addiction, or alcohol and drug abuse, are at an increased risk of dependence from sleep aids.^{xxi} Over the counter sleep aids are not recommended for inducing sleep as many products cause prolonged drowsiness up to several hours after awakening.^{xix} Use of alcohol to promote sleep is also not recommended. While it can help initiate sleep, it causes later sleep disruption as the alcohol is metabolized and arousal occurs.

Work site conditions can also promote alertness in shift workers. It is recommended that workplaces be cool, with bright lighting. Healthy food choices should be available. Workers should avoid “junk food” including fried foods, but should not try to go to sleep hungry or immediately after eating a large meal.^{xix}

Tips for Good Sleep Hygiene: ^{xix, xx, xxi}

- Try to go to bed at the same time every day
- Establish relaxing pre-sleep rituals such as a warm bath
- Make sure your bedroom is a quiet, dark, and relaxing environment
- Make sure your bed is comfortable and use it only for sleeping
- Try to keep a regular schedule, with regular times for eating, performing chores, etc.
- Exercise regularly, but not too close to bedtime
- Avoid large meals before bedtime.

TOBACCO

Smoking is the number-one cause of premature death and a significant contributor to heart disease, lung disease and cancer. It causes 438,000 deaths in the United States each year and 8.6 million Americans live with serious smoking-related illness. It is also the leading cause of fires, including fires that

have claimed the lives of IAFF members. Smokeless tobacco products, such as oral tobacco or “chew” and inhaled tobacco or “snuff”, are not safe alternatives to cigarettes. Recent evidence has implicated smokeless tobacco products in the development of cancer as well as reproductive health issues, including decreased sperm counts in men and premature births during pregnancy.^{xxii} The good news is some health benefits of quitting are immediate. Tobacco cessation, even among those who have smoked for many years, can greatly reduce the risk of dying from heart disease. People who quit smoking can cut the risk of dying from heart disease in half. When a smoker quits, the risk of heart disease death begins to fall quickly and approaches the risk of nonsmokers after several years. Quitting also decreases the risk of other circulatory diseases, such as abdominal aortic aneurysms and strokes.^{xxiii}

Given the many harmful effects associated with tobacco, the IAFF and the IAFC have adopted three main goals in our Wellness-Fitness Initiative Tobacco Cessation Policy:

- All new fire department candidates shall be tobacco free upon appointment and throughout their length of service to the department.
- Current fire department uniformed personnel shall not use tobacco products inside the work-site, within or on fire department apparatus, or inside training facilities.
- A fire department sanctioned tobacco cessation program shall be made available to incumbent tobacco users. Tobacco cessation programs must be non-punitive and must include short and long term goals.

The IAFF continues our efforts to become the first tobacco-free union in North America. This initiative encourages IAFF members and their families to take on healthier lifestyles by becoming smoke and tobacco free.

STEPS YOU CAN TAKE TODAY

- Visit www.iaff.org/smokefree to learn more about becoming smoke-free including:
 - Information on the health risks of smoking and the benefits of quitting.
 - Tips on how friends and family can help a smoker quit.
 - Information on how to encourage health insurance plans to make sure they cover smoking cessation.
- Consider combining cessation medications and counseling. The combination of medication and counseling is more effective for smoking cessation than either medication or counseling alone.

CONCLUSION

As a profession, fire fighters experience a higher proportional mortality from heart disease. Prevention is effective in decreasing the risk for developing heart disease. Modifiable risk factors like tobacco cessation, maintaining healthy blood pressure, ideal body weight, healthy diet and regular physical activity can prevent or decrease the severity of cardiovascular disease. The published federal guidelines regarding recommended preventive measures have an evidenced-based foundation. If they are adopted on a widespread basis, there will be a significant improvement in the morbidity and mortality due to heart disease. You can lower your risk for heart disease by following these recommendations.

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http://www.heart.org/HEARTORG/GettingHealthy/NutritionCenter/HealthyDietGoals/Suggested-Servings-from-Each-Food-Group_UCM_318186_Article.jsp.
- xviii Copyright © 2008 Harvard University. For more information about The Healthy Eating Pyramid, please see The Nutrition Source, Department of Nutrition, Harvard School of Public Health, <http://www.thenutritionsource.org>, and Eat, Drink, and Be Healthy, by Walter Willet, M.D. and Patrick J. Skerrett (2005), Free Press/Simon & Schuster Inc.
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Heart Disease in the Fire Service

CHAPTER 7 • HEART DISEASE AND FIRE FIGHTER BENEFITS

The International Association of Fire Fighters has been addressing the issues of fire fighters and cardiovascular disease for decades. The IAFF has protected our members by pursuing enactment of legislation that provides protection and compensation for those fire fighters whose health has deteriorated through the performance of their firefighting occupation. These laws have ranged from federal legislation, to provide compensation for the families of those fire fighters who die or are severely disabled in the line-of-duty, to state and provincial legislation extending retirement and/or worker compensation benefits to those who become disabled from occupationally contracted diseases.

FIRE FIGHTING ENVIRONMENT

Fire fighters, like most workers, have little idea about the identity of many of the materials they are potentially exposed to or the hazards of such exposures. Nevertheless, fire fighters continue to respond to the scene and work immediately to save lives and reduce property damage without regard to the potential hazards that may exist. A fire emergency has no controls or occupational safety and health standards to reduce the effect of toxic chemicals. It is an uncontrollable environment that is fought by fire fighters using heavy, bulky and often times inadequate personal protective equipment and clothing. The effect is not only physically demanding, but involves exposure to air contaminants, some of which are known to cause diseases of the cardiovascular system.

The fire fighting profession illustrates the selective impact of past safety and health initiatives. Despite the advances made in safety and health areas, fire fighters are still being killed, injured and diseased at an alarming rate. Professional fire fighters have inordinate numbers of line-of-duty deaths, deaths due to occupational diseases, forced retirements, and line-of-duty injuries.

IAFF POSITION ON HEART DISEASE

It is the position of the IAFF that cardiovascular disease is exacerbated by fire fighting duties, and that fire fighting increases the incidence of cardiovascular disease in fire fighters. Fire fighters and emergency medical personnel face the possibility of death or injury every time they respond to an alarm. While risk may be part of the profession, fire fighter and emergency medical personnel deaths, injuries, and occupational diseases should not be part of the job.

STATE AND PROVINCIAL HEART DISEASE PRESUMPTIVE LAWS

Presumptive disability laws state that specific diseases or conditions are presumed to come from an individual's occupation. In recognition of the causal relationship between fire fighting and heart disease, 37 states and seven provinces (shown below in Table 7.1) have adopted presumptive laws to provide disability benefits to fire fighters diagnosed with cardiovascular disease and related conditions. These laws presume that cardiovascular disease is occupationally related to fire fighting. Consequently, their provisions shift the burden of proof from the employee to the employer to demonstrate that the disease or condition was not in fact associated with the occupation but with another cause. A fire fighter diagnosed with heart disease covered by a presumptive disability law would be entitled to:

- Payment of medical expenses
- Disability retirement benefits
- Workers' compensation benefits
- Lost wages or benefits for spouse and/or family

The benefits provided by presumptive disability laws vary between states and provinces. Additionally, many workers' compensation boards in Canada and the U.S. have established a history of identifying heart disease in fire fighters as employment-related. While all these laws recognize heart disease as occupationally related to fire fighting, some have exclusions and prerequisites for obtaining benefits. Many states and provinces require a minimum number of years of service before a condition or illness is presumed to be associated with fire fighting. Some laws also include rebuttal clauses that allow employers to challenge the job relatedness of a condition or illness. In this case the employer must demonstrate that the condition or illness did not arise from the occupation of fire fighting but from some other cause. It is also important to remember that despite the presence of presumptive legislation, there is still no guarantee that the claim will be approved.

The IAFF maintains full copies of all state and provincial laws or regulations and the number of worker compensation awards from the United States and Canada that address heart disease. The IAFF also provides assistance and information to obtain or maintain heart disease legislation and regulations.

PROVINCES WITH PRESUMPTIVE HEART LAWS

Alberta*	Ontario
Manitoba	Saskatchewan
New Brunswick*	Yukon*
Northwest Territories	

STATES WITH PRESUMPTIVE HEART LAWS

Alabama	Minnesota
Alaska	Missouri
California	Nebraska
Connecticut	Nevada
Florida	Ohio
Georgia	Oklahoma
Hawaii	Oregon
Idaho	South Carolina
Illinois	South Dakota
Louisiana	Tennessee
Maine	Texas*
Maryland	Utah
Massachusetts	Vermont
Michigan	

* covers myocardial infarction/heart attack only

The following section summarizes the different laws and benefit programs established in the U.S. for families of fire fighters who are killed or permanently disabled from injuries sustained while in the line of duty. The IAFF Division of Occupational Health, Safety and Medicine will provide our affiliates and the fire fighter's family with assistance in filing for these benefits.

PUBLIC SAFETY OFFICER BENEFITS ACT

The Public Safety Officers Benefits (PSOB) Act (Public Law 94-430) became law on September 29, 1976. The legislation provided for a \$50,000 death benefit for fire fighters (paid and volunteer) and law enforcement officers who died in the line of duty (emergency or non-emergency) from a traumatic injury. The Act does not cover deaths resulting from occupational illness or pulmonary disease unless a traumatic injury is a substantial factor to the death.

The PSOB Act has since been amended to increase the benefit amount each year to reflect any increase in the consumer price index. On October 26, 2001, as part of the Patriot Act of 2001, the benefit was increased to \$250,000 and made retroactive to January 1, 2001.

The Act did exclude federal fire fighters; however on October 12, 1984 the Act was amended to correct this exclusion. Likewise, on October 15, 1986 public sector EMS personnel were also amended into the coverage of the Act. On June 25, 2002, the Act was amended by the enactment of the Mychal Judge Police and Fire Chaplains Safety Officers Benefit Act, which allows coverage of fire chaplains under the Act and authorizes all beneficiaries of fallen fire fighters, not just parents, spouses or children to receive federal compensation.

PSOB DISABILITY AMENDMENT

On November 29, 1990, Congress amended the PSOB Act to include permanent and total disability. The amendment was tightly drawn, sharply limited in scope, and intended to cover only those public safety officers permanently unable to perform any gainful employment.

The PSOB disability amendment recognizes that state, local and agency benefit programs are primarily responsible for the hundreds, perhaps thousands, of public safety officer disability pensions awarded each year. The PSOB Act is clear that benefits awarded are supplementary in nature and by law are not to offset any worker compensation payment or disability pension benefit. Even when an officer is disabled by a severe, catastrophic injury received in the line of duty, PSOB benefits do not come into play unless the injuries are so disabling as to permanently prevent any gainful employment. This standard recognizes that in all but rare cases a disabled public safety officer will have the capacity to supplement a state or local disability pension with employment earnings of varying degrees.

On August 10, 2006 new regulations for the PSOB were issued that incorporated all prior amendments to the original regulations and added the regulations for the Hometown Heroes Act.

HOMETOWN HEROES SURVIVORS BENEFITS ACT

The Hometown Heroes Survivors Benefits Act of 2003 (HHA) amended the PSOB Act to cover deaths from heart attack and stroke that occur in the line-of-duty. The HHA establishes the presumption that public safety officers who suffer a fatal heart attack or stroke up to 24 hours, after engaging in a line of duty activity or formal training exercise that required non-routine stressful or strenuous physical activity, died as a direct and proximate result of a personal injury sustained in the line of duty.

The HHA defines "non-routine stressful or strenuous physical activity" as:

- Activity that is not performed as a matter of routine.
- Entails an unusually high level of physical exertion.
- Engaging in line of duty activities that pose or appear to pose significant threats or involves reasonability foreseeable risks of threats.
- Participating in training exercises that realistically stimulate significant threats or hazards.
- Provokes or causes an unusually high level of alarm, fear, or anxiety.

The HHA specifically excludes fatalities related to activities of a clerical, administrative, or non-manual nature. The HHA provision only covers deaths occurring on or after December 15, 2003 and is not retroactive; therefore it does not apply to deaths occurring before the aforementioned date.

POLICE, FIRE AND EMERGENCY OFFICERS EDUCATIONAL ASSISTANCE ACT

The Police, Fire and Emergency Officers Educational Assistance (PSOEA) Act was signed into law in October 1998. The law was created to provide financial assistance for higher education to the dependents of federal, state, and local public safety officers who are killed or permanently and totally disabled as a result of traumatic injury sustained in the line of

duty and eligible for the PSOB death or disability benefit. This is the only federally funded program that provides educational benefits for the spouse and children of fire fighters killed in the line of duty. The PSOE program is administered by the U.S. Department of Justice's Office of Special Programs.

This assistance is only available after the PSOB death or disability claim process has been completed and benefits have been awarded. Further, the PSOE applicant must have received at least a portion of the PSOB benefits and be defined as the officer's spouse or child under the PSOB Act and regulations. In January 2000, the law further extended the retroactive eligibility date for financial assistance. Accordingly, the law applies to the spouses or children of public safety officers whose deaths or permanent and total disabilities are covered by the PSOB Program on or after January 1, 1978. Public safety officers' children will no longer be eligible after their 27th birthday, absent a finding by the Attorney General of extraordinary circumstances. The PSOE Program will provide an educational assistance allowance, which may be used solely to defray educational expenses, including tuition, room and board, books, supplies, and education-related fees or costs.

Finally, the IAFF has been attempting to secure public safety officer benefits for Canadian fire fighters. The IAFF supports the creation of a federally funded PSOB in Canada which at this time has not been accepted at the federal level by any ministry. However, the establishment of such a fund is well within the purview of the federal government, and the IAFF continues to work towards implementation.

SUMMARY OF LEGISLATION

The following summarizes legislation and precedent court cases that affected the law:

- ***Beverly Morrow, et al. v. The United States.*** U.S. Court of Claims case in which a fire fighter's widow sought benefits following the death of her husband of a heart attack six weeks after an initial attack associated with a smoke inhalation incident. Benefits were denied as death was attributed to heart disease.

- ***Hubert Smykowski, et al. v. The United States.*** U.S. Court of Claims case in which a police officer died after a struggle with a suspect. Court upheld the Administrators ruling that the stress and strain of a struggle was not a traumatic injury as defined by the PSOB Act.
- ***Carrie Rose, etc. v. Arkansas State Police.*** The U.S. Supreme Court ruled that any law that authorizes a state to offset state worker compensation benefits against benefits paid by the Federal PSOB program is in conflict with the supplementary nature of the PSOB Act and is therefore invalid under the supremacy clause of the U.S. Constitution.
- Public Safety Officers' Benefits Act of 1976, Part J. Original act detailing the provision of death benefits. Introduced to the 94th Congress, September 29, 1976.
- Federal Register, May 6, 1977, Part II. The rules adopted by the Law
- Enforcement Assistance Administration for implementation of the PSOB Act are written.
- Federal Register, Vol. 43, No. 180 - September 15, 1978. Results of meeting detailing the contribution of carbon monoxide and heart disease in the deaths of public safety officers.
- Federal Register, Vol. 45, No. 51 - March 13, 1980. Amendments to the hearing and appeal provisions of the regulations.
- Federal Register, Vol. 50, No. 128, July 3, 1985. An amendment to the PSOB Act which transfers the administration of the Act from the LEAA to the Bureau of Justice Assistance. In addition, federal public safety officers are now covered under the act and "gross negligence" and "intoxication" standards are defined within this amendment.
- Federal Register, Vol. 53, No. 50, March 15, 1988. Amendment to the PSOB Act which includes provision of death benefit coverage to members of public rescue squads or ambulance crews. Also

an explanation of EMS coverage in correspondence from the U.S. Department of Justice.

- Federal Register, Vol. 57, No. 113, June 11, 1992. Amendment to the PSOB Act to include coverage for disability benefits. Such disability is defined as permanent and total as a direct result of a catastrophic personal injury sustained in the line of duty which will prevent an individual from performing any gainful work.
- Public Law 107-37 - September 18, 2001, [115 STAT. 219]. Amendment to the PSOB Act to provide for the expedited payment of PSOB benefits for a public safety officer who was killed or suffered a catastrophic injury producing permanent and total disability as a direct and proximate result of a personal injury sustained in the line of duty in connection with the terrorist attacks of September 11, 2001.
- Public Law 107-56 - October 26, 2001, [115 STAT. 369]. Amendment to the PSOB Act to provide for the expedited payment of PSOB benefits for a public safety officer who was killed or suffered a catastrophic injury producing permanent and total disability as a direct and proximate result of a personal injury sustained in the line of duty in connection with prevention, investigation, rescue, or recovery efforts related to any terrorist attack. Increases the PSOB program benefit payment to \$250,000 retroactive to January 1, 2001.
- Public Law 107-196 - June 24, 2002, [116 STAT. 719]. Amendment to the PSOB Act to include coverage of fire chaplains and allows all beneficiaries of fallen fire fighters, not just parents, spouses or children to receive the federal compensation.
- Public Law No: 108-182 December 15, 2003 [117 STAT. 2649]. Amendment to the PSOB Act to ensure that a public safety officer who suffers a fatal heart attack or stroke while on duty shall be presumed to have died in the line of duty for purposes of public safety officer survivor benefits. The legislation was entitled the Hometown Heroes Act.

- Public Law 109–162 January 5, 2006 [119 STAT. 2960, 3120]. Amendment to the PSOB Act contained in the DOJ Reauthorization Act and contains several clarifying and conforming changes. New definitions included the term “member of a rescue squad or ambulance crew” that is now defined as “an officially recognized or designated public employee member of a rescue squad or ambulance crew.” It also amended the PSOB Act to ensure that the pre-existing statutory limitation on payments to non-civilians referred to the individual who was injured or killed, and not to any potential beneficiaries. Finally, this legislation amended certain provisions of the PSOB Act regarding designation of beneficiaries when the officer dies without a spouse or eligible children and removed the need for a one-year waiting period to ensure payment to the beneficiary of the officer’s “most recently executed life insurance policy.”
- Federal Register, Vol. 71, No. 154, August 10, 2006. The new regulations for administration of all PSOB benefits that incorporated all prior amendments to the original regulations and added the provisions of the Hometown Heroes Act. This document addresses the PSOB Act and regulations in five parts. The first part of this document describes the structure and background of the PSOB Program and aspects of the history of its administration. The second part covers the recent changes to the PSOB Act contained in Public Law 109–162. The third part addresses the comments received by BJA that relate to the proposed provisions implementing the Hometown Heroes Act, and explains the changes being made in the final rule. The fourth part is a specific discussion of the terms “line of duty” and “authorized commuting.” The last part addresses the remainder of the comments in a section-by-section analysis, indicating where changes to provisions were made, or where BJA determined no changes were necessary. ■

