Addressing the Epidemic of Obesity in the United States Fire Service

A Report Prepared for the National Volunteer Fire Council

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Supporting Those Who Serve

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Introduction

When we think about the typical individual who excels in a job, stereotypes automatically come to mind based on the requirements of that occupation. Imagining a trusted physician evokes the image of someone who is intelligent, compassionate, and caring. Stereotypes of United State Marines include bravery, commitment, and a high level of fitness. What comes to your mind when you think of a firefighter?

Traditionally, firefighters were fodder for impressive photos in calendars and were known as icons of fitness and strength. Classic images of firefighters include a reassuring combination of technical skill, physical fitness, and bravery. From a young age, we think of our firefighters as being able to carry us from a burning building, run up flights of stairs, and break down doors to rescue a loved one. Our nation depends on the fire service to respond to nearly every major domestic emergency that occurs at a moment's notice. Few would disagree that firefighters should maintain a high level of physical fitness, including aerobic and anaerobic fitness, flexibility, and muscular endurance, strength, and power. Without high levels of health and fitness, firefighters may not be able to perform the strenuous physical requirements of their job and they risk injury and even death for themselves, their comrades, and those they serve.

Are the classic images of firefighters as healthy, fit, and strong still accurate? Although firefighters' bravery and commitment to public service has never been in doubt, a chilling epidemic has been slowly developing in the fire service which threatens their ability to effectively respond to the emergencies and disasters that will inevitably occur in our country. As in our nation at large, the number of individuals who are overweight, obese, and unfit has risen to alarming levels in fire departments, both volunteer and career, across our nation. In fact, the best evidence suggests that rates of the overweight and obese are higher in the fire service than in the general public.

This report will urge everyone from national fire service leadership, to department chiefs, to individual firefighters to think creatively and join in efforts to reverse the negative trends of unhealthy body weight and poor physical fitness. It is time to begin a national conversation regarding obesity in the fire service. This report provides basic data which can be used to educate yourself and your colleagues about the epidemic and provides suggestions you can use to address fitness in your department.

The content of this report is for informational purposes only. It is not a substitute for advice from your physician. You should seek prompt medical care for any specific health issues; only your healthcare provider should diagnose a medical condition and prescribe treatment. You may also wish to consult with your health care professional or nutritionist before starting a new diet or fitness regimen.

About the Authors

Although the National Volunteer Fire Council (NVFC) and a large number of firefighters have provided valuable feedback on the information in this publication, the opinions expressed and any errors belong to the authors and do not necessarily represent the official position of the NVFC. The authors are well-versed in the subject matter and have conducted nutrition and fitness research for over two decades, including the largest studies of obesity, physical activity, and nutrition in the fire service conducted to date. They have been involved in a large number of safety and health initiatives in the fire service and have worked in over 100 firehouses nationwide. As certified fitness instructors, they have personally conducted body composition and fitness assessments on well over 1,000 firefighters from Hawaii to the East Coast and spend much of the year working directly with firefighters.

The authors care deeply about the fire service and are honored to write this document. If you have any questions or would like to provide useful information or ideas regarding addressing obesity and fitness in the fire service, please feel free to email the authors at the addresses below:

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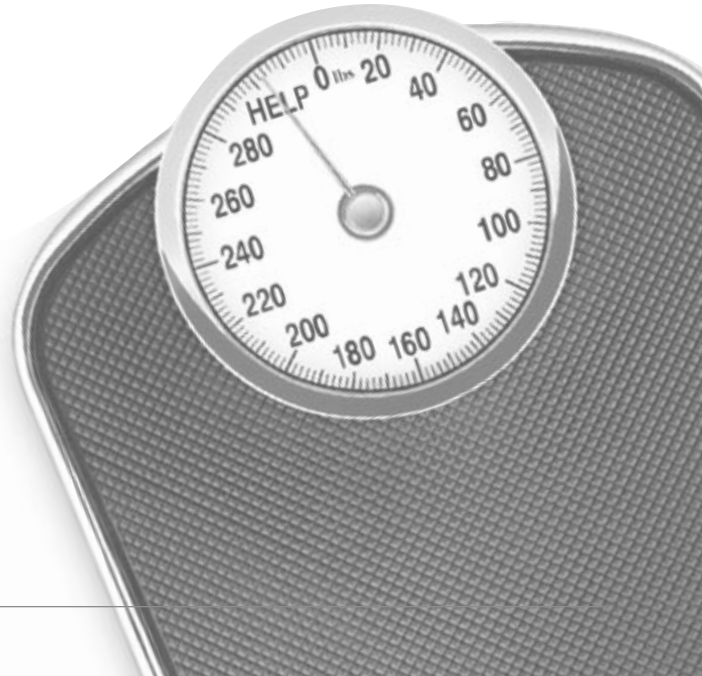

Executive Summary

Chapter 1
Obesity and Its Impact

> More than two-thirds of Americans are overweight or obese.

> The rates of obesity have increased dramatically since the 1980s when only 13 percent of adults were considered obese.

> Overweight and obese individuals are at increased risk for metabolic syndrome, cardiovascular disease, hypertension, diabetes, cancer, and sleep disorders.

> The direct and indirect costs of obesity are staggering and include greater absenteeism at work, lower worker productivity, and greater disability than those who maintain a healthy weight.

Chapter 2
Obesity in the Fire Service

> Rates of overweight and obese individuals in the fire service are higher than those found in the general public, ranging from 73 percent to 88 percent of firefighters.

> The high rates of obesity in the fire service do not appear to be due to inaccuracy in measurement.

> Research demonstrates that a large percentage of firefighters do not meet minimal standards of physical fitness.

> Occupational factors may place firefighters at high risk for weight gain, including shift work, sleep disruption, unhealthy eating patterns in the firehouse, and the absence of fitness standards for firefighters.

> Overweight and obese firefighters have been shown to suffer from a large number of problems compared to their colleagues, including hypertension, higher risks for cardiovascular disease, low fitness, reduced muscular strength, and more frequent cardiac events.

> Overweight and obese firefighters are less fit to perform their jobs and cost fire departments significantly more than firefighters with a healthy weight.

> Several initiatives have attempted to address the high levels of overweight, obese, and unfit firefighters, including NFPA 1583: Standard on Health-Related Fitness Programs for Fire Department Members, NFPA 1582: Standard on Comprehensive Occupational Medical Programs for Fire Departments, the NVFC's Heart-Healthy Firefighter Program, the NVFC and U.S. Fire Administration's *Health and Wellness Guide for the Volunteer Fire and Emergency Services*, and the International Association of Fire Fighters/International Association of Fire Chiefs Wellness/Fitness Initiative.

Chapter 3
Why Is There An Epidemic of Obesity in the Fire Service?

> The nutrition environment in many firehouses appears to reinforce poor eating habits and unhealthy nutrition.

> Attempts to improve nutrition in the firehouse often are met with resistance.

> Firefighters often consume diets high in processed carbohydrates and sugar, which promote obesity and cardiovascular disease.

> Diets that keep insulin levels stable and focus on foods with a low glycemic index promote a healthy body composition and improved performance.

> Firefighters overestimate the ability of physical activity to counteract the impact of large food portions or unhealthy dietary choices.

Chapter 4
Innovative Trends in Obesity and Fitness Research

> Firefighters should eat natural, whole foods and avoid processed foods, fast foods, and sugar.

> The Slow Food Movement encourages a return to traditional cooking methods and a focus on high-quality eating.

> Ancestral Eating teaches the benefits of returning to the diets on which humans evolved and warns of the problems of foods which have only recently entered our food supply.

> High Intensity Training is an effective, time-efficient form of exercise which is ideally suited for firefighters.

> Functional Exercise focuses on natural movements that mimic activities involved in firefighting.

> CrossFit® represents an exciting approach to fitness for firefighters which stresses both high-intensity training and functional movements.

Chapter 5
Recommendations for the Fire Service for Combating Obesity and Increasing Fitness

> Recommendations are provided for how firefighters can significantly improve their nutrition.

> Fire departments should consider conducting annual fitness assessments.

> Minimal fitness recommendations for all firefighters should be a priority.

> An effective fitness program can be implemented by fire departments at minimal cost and using existing facilities.

Chapter 1

Obesity and Its Impact

Metabolic Syndrome I Cardiovascular Disease I Hypertension I Diabetes I Sleep Apnea I Cholesterol

Obesity and Overweight in the United States

Obesity has become one of the leading health concerns among the medical and public health communities in the United States and is now considered to be of epidemic proportions. Rates of obesity in the U.S. are tracked through the National Health and Nutrition Examination Survey (NHANES).[1] Data from the most recent NHANES found that 33.8 percent of Americans are obese and an additional 34.2 percent are overweight. It has been estimated that every year an estimated 112,000 preventable deaths occur due to obesity.[2] The dramatic increases in obesity and its related medical disorders is a relatively recent occurrence compared to past decades. Before the 1980s, only about 13 percent of adults were considered obese. While rates in the past decade have been relatively stable, they remain extremely high.

Definitions of Overweight & Obesity

Several definitions of overweight and obesity exist depending on the type of measure used. ***Body Mass Index*** (BMI) is one of the most consistently used measures by doctors, research, and the public health service.[3] BMI is calculated by using height and weight and, for most people, is highly correlated with measured body fat. Standard cutoffs for BMI have been set by the World Health Organization as underweight (<18.5), healthy weight (18.5 – 24.9), overweight (25.0 – 29.9), obesity class I (30.0 – 34.9), obesity class II (35.0 – 39.9), and obesity class III (>40.0).[4]

Calculating Your Body Mass Index (BMI)

$$\text{BMI} = \frac{\text{weight (kg)}}{\text{height (m2)}} \quad \textbf{OR} \quad \text{BMI} = 703 \times \frac{\text{weight (lbs)}}{\text{height (in}^2\text{)}}$$

Waist circumference (WC) is also commonly used to estimate overweight and obesity. Fat accumulation around the waist is particularly detrimental to overall health and is highly related to disease and death. The WC cutoff is >35 inches for women and >40 inches for men. Clinical guidelines suggest that waist circumference may be particularly helpful in determining increased risk for dyslipidemia, hypertension, CVD, and type 2 diabetes among people who are categorized as overweight using BMI. This is because elevated waist circumference is an independent marker of disease risk even among individuals thought to be at low or modest risk for disease or death using BMI.

Body fat is another measure to determine overweight and obesity and is considered the most accurate way of estimating risk for disease and death. Several tools are available for measuring body fat including calipers, bioelectrical impedance, and dual energy X-ray absorptiometry (DXA). With calipers, measurements are taken on three to eight prescribed spots on the body and entered into an equation to estimate average body fat. Bioelectrical impedance uses a minute electrical signal that travels through the body and estimates body fat based on age, gender, height, weight, and the speed of the signal. DXA is a full body X-ray that is able to most accurately measure the proportions of your body that are fat, muscle mass, water, and bone. It is now considered to be the "gold standard" method against which all other tools are measured.

The cut-offs defining obesity are based on the relationship between body composition and disease or death. For example, those in the overweight or obese categories are at higher risk for diseases like stroke, type 2 diabetes, hypertension, coronary artery disease, osteoarthritis, sleep apnea or respiratory problems, dyslipidemia, and some cancers. *(See Table 1 on page 8)*.

Why Obesity is a Problem

Although many people would like to be at a healthy weight primarily for cultural or appearance reasons, the medical community is concerned about obesity because it raises the risk of suffering from a number of significant health problems. The following is a review of several medical problems associated with an unhealthy body composition.

Metabolic syndrome is related to increased risk of cardiovascular disease, stroke, and diabetes. It is diagnosed when a person has three or more of a designated list of risk factors: (a) a waist circumference over 40 inches for men and 35 inches for women; (b) serum triglycerides of 150 mg/dL or higher; (c) high density lipoproteins (HDL) levels below 40 mg/dL in men or 50 mg/dL in women; (d) blood pressure over 130/85 mm Hg; and (e) fasting glucose of more than 100 mg/dL.[5]

In the U.S., approximately 34 percent of adults over the age of 20 meet the criteria of metabolic syndrome, with higher rates in older groups than younger groups.[6] Important for those who are overweight or obese, the prevalence of the risk factors which define metabolic syndrome increase as BMI increases. Among groups who are underweight or normal weight, only 7 percent of men are classified as having metabolic syndrome,

Table 1 – Categorization of Risk: BMI, Waist Circumference, Body Fat

BMI	Waist Circumference (Women)	Waist Circumference (Men)	Body Fat (Women)	Body Fat (Men)
<18.5 Underweight	< 35 Acceptable	< 40 Acceptable	10 - 13% Essential Fat	2 - 5% Essential Fat
18.5 – 24.9 Healthy Weight	≥ 35 Increased Risk	> 40 Increased Risk	14 - 20% Athlete	6 - 13% Athlete
25 – 29.9 Overweight			21 - 24% Fitness	14 - 17% Fitness
30 – 34.9 Obesity, Class I			25 - 31% Average	18 - 24% Average
35 – 39.9 Obesity, Class II			≥ 32% Obese	≥ 25% Obese
≥ 40 Obesity, Class III				

while overweight males were six times more likely and obese males were 32 times more likely to receive this diagnosis. Similarly, only 9 percent of females in the underweight category met the criteria for metabolic syndrome, while women in the overweight category were 5.5 times and obese women 17 times more likely than normal weight peers to meet criteria. As you can see, being overweight or obese dramatically increases your chance of developing metabolic syndrome.

What is metabolic syndrome?

Metabolic Syndrome is diagnosed when someone has 3 or more of the following:

> Waist circumference over 40 inches for men and 35 inches for women

> Serum triglycerides of 150 mg/dL or higher

> High density lipoproteins (HDL) levels below 40 mg/dL in men or 50 mg/dL in women

> Blood pressure over 130/85 mm Hg

> Fasting glucose of more than 100 mg/dL

Cardiovascular disease (CVD) is considered to be any disease of the heart and includes coronary heart disease, stroke, and high blood pressure. One in three adults has some form of CVD, according to the American Heart Association. CVD is the leading cause of death in the U.S., accounting for more mortality than the three diseases following it on the list (cancer, chronic lower respiratory disease, and injury).[7] Obesity has been found to be highly related to or cause a number of risk factors for heart disease including high blood pressure, high triglycerides and diabetes.[8] Obesity is also an independent risk factor for CVD.[9]

Hypertension is defined as having an average systolic blood pressure greater or equal to 140 mmHg or an average diastolic blood pressure greater or equal to 90 mmHg. It is believed that hypertension is related to obesity because obese individuals retain more sodium and have more fatty tissue, which in turn increases vascular resistance, which means the body has to work harder to get blood to flow. A large international study that looked at hypertension and obesity in a sample of over 10,000 people found that a 10 kg (or 22 lb.) increase in weight led to a 3.0 mmHg increase in systolic blood pressure and a 2.3 mmHg higher diastolic blood pressure.[10]

Diabetes, particularly type 2 diabetes, is known to be highly related to obesity and lifestyle factors such as diet, and results when a body isn't able to properly manage blood sugar which leads to high glucose levels. Insulin is a hormone that regulates how cells manage glucose. When you eat carbohydrates, your body breaks down the starches and sugars into glucose, which becomes the fuel your cells use to operate. Insulin is the vehicle that carries the sugars into the cells. When there is not enough insulin in your body or your cells become

resistant to the insulin, the level of glucose in your blood stream increases. When these levels stay high over a long period of time, damage can occur to the heart, nerves, eyes, and kidneys.

According to the Centers for Disease Control and Prevention, there are 25.8 million people in the U.S. with diabetes and an additional 79 million with pre-diabetes.[11] People who have diabetes are two to four times more likely to have a stroke then people who don't. For every BMI unit increase over 22kg/m^2 there is a 25 percent increased risk of diabetes.[12]

Cancer risks have also been found to be related to obesity. In particular, according to the National Heart, Lung and Blood Institute, there is convincing evidence that obesity is related to colon, breast, endometrial, and gallbladder cancer. For instance, when studies compare women with a BMI below 22 kg/m^2 with women who have a BMI over 29 kg/m^2, the rate of distal colon cancer is double.[13]

Sleep apnea is the sleep disorder most commonly associated with obesity. Sleep apnea occurs when a person has periods where their breathing pauses while they are sleeping. They frequently begin gasping in their sleep as they try to catch their breath. Sleep apnea often leads to daytime sleepiness and fatigue as the person doesn't get enough rest during the night. Risk for sleep apnea increases as weight increases, and is particularly common in men with a neck circumference over 17 inches and women with a neck circumference over 16 inches.[14] Sleep apnea is diagnosed through sleep studies where breathing is monitored while a person sleeps.

Cholesterol is a waxy lipid substance that serves a number of functions in the body including: insulating neurons, repairing cells, building cell walls, producing bile, starting the synthesis of hormones (e.g. testosterone, estrogen, DHEA, cortisol), and metabolization of fat-soluble vitamins. Cholesterol is critical to the health of the human body and is not the evil substance which we have sometimes been led to believe. Despite conventional wisdom, recent studies suggest that dietary cholesterol is not directly related to the amount of cholesterol in your arteries, and the amount of cholesterol in your diet is largely unrelated to your risk for obesity or heart disease. *(See the notes section for more information)*.

Cholesterol, along with triglycerides and other fats, is transported through your body by lipoproteins, which are spherical fat molecules with water soluble proteins wrapped around them. There are several types of lipoprotein, including high density (HDL), low density (LDL), and Very Low Density (VLDL) lipoproteins. Studies have demonstrated that heart disease risk is related to certain types of lipoproteins as opposed to total cholesterol levels. Higher levels of LDL particles increase risk, whereas higher HDL cholesterol levels appear to decrease risk.

Diets which help prevent obesity, those high in healthy meats, vegetables, fruits, nuts, and seeds, combat the process which leads to atherosclerosis (hardening of the arteries). A healthy diet promotes the production of HDL, which gathers small, dense LDL and oxidized cholesterol that become stuck in artery walls and sends them back to the liver for recycling. Low carbohydrate diets and exercise, two factors which have shown to be associated with healthy body composition, also raise levels of HDL. Diets which raise triglycerides appear to suppress HDL production. Thus, among the most important components of a blood test for "cholesterol levels" (remember, it isn't total cholesterol that is important) are HDL (which you want to be higher) and Triglycerides (which you want to be lower) levels. Overall LDL levels are less informative, unless your physician has access to a lab which can separate out small, dense LDL. Other LDL components appear to be harmless, which is why a large percentage of people who have heart attacks also have relatively low LDL levels. *(See Notes section for more information about cholesterol)*.

Economic Costs of Obesity in the United States

As the prevalence of obesity has continued to increase over the last several decades in the United States and worldwide, so have the costs to the people who suffer from weight problems, their families, and to employers. The economic costs related to obesity have been estimated based on the direct healthcare costs associated with treating diseases linked to obesity, such hypertension and diabetes, and the indirect costs, such as lost productivity.

The direct health care costs of obesity include expenses (both out-of-pocket and insurance covered) related to treatment or services provided by a healthcare practitioner for office-based, outpatient, inpatient hospital, or emergency room care and pharmaceuticals or procedures.[15] However, because obesity as a condition is usually not treated directly, the direct costs of obesity are estimated based on the cost of treating conditions related to obesity such as diabetes, heart disease, hypertension, osteoarthritis, sleep apnea, etc.[16,17]

Studies that estimated the direct costs of obesity all agree on one thing – the costs are staggering. For example, Wolf and Colditz conducted the first study in this area and estimated the direct costs of obesity to be $45.8 billion in 1990 dollars among all Americans.[18] More recent studies such as Finkelstein et al.[19] estimated that the direct costs attributable to obesity among full-time workers to be $30.3 billion dollars (in 2006 dollars) and that individuals with extreme obesity (BMI>35) accounted for 57 percent of those costs. However, Finkelstein and colleagues also examined the direct costs of obesity in the U.S. overall and found that medical cost could be as high as $147 billion dollars per year.[20] Dor and colleagues reviewed a large number of studies that have been conducted in the United States over the last 20+ years and concluded that the direct costs attributable to obesity have substantially increased over time due to the growing number of people who are overweight.[21]

As noted earlier, indirect costs are those that are not direct medical expenditures, but represent measures of lost productivity in the workforce. They include "presenteeism" (where a worker is at work but unable to perform at their top capacity due to obesity-related health problems), absenteeism (missed work days or sick leave), disability and worker's compensation claims, and premature death. A number of studies have examined the relationship between obesity and presenteeism or absenteeism. For example, Tucker and Friedman found that obese workers were 70 percent more likely to experience "high-level" absenteeism (seven or more absences due to illness in the past six months) than lean employees. Pronk and associates found that obesity was associated with more lost work days and greater difficulty getting along with co-workers, while greater levels of physical activity and cardiorespiratory fitness were associated with higher work quality, job performance, and greater work quantity in workers from a variety of occupations.[22, 23]

Finkelstein et al. evaluated the costs associated with presenteeism and absenteeism in a sample of over 32,000 full-time workers. Average incremental annual costs per worker for absenteeism and presenteeism associated with obesity were estimated to be $1,960 and $5,193 for obese male workers and $1,736 and $5,393 for obese female workers, respectively. This means that for all workers, obesity is estimated to cost employers $12.8 billion and $30 billion for productivity losses associated with absenteeism and presenteeism, respectively.[24]

Notes

For information about what scientists now think about cholesterol and its role in heart disease, see:

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For an easy-to-understand review of the Rabbani article see "Super-sticky, 'ultra-bad' cholesterol revealed in people at high risk for heart disease" in Science Daily; URL: www.sciencedaily.com/releases/2011/05/110526204953.htm

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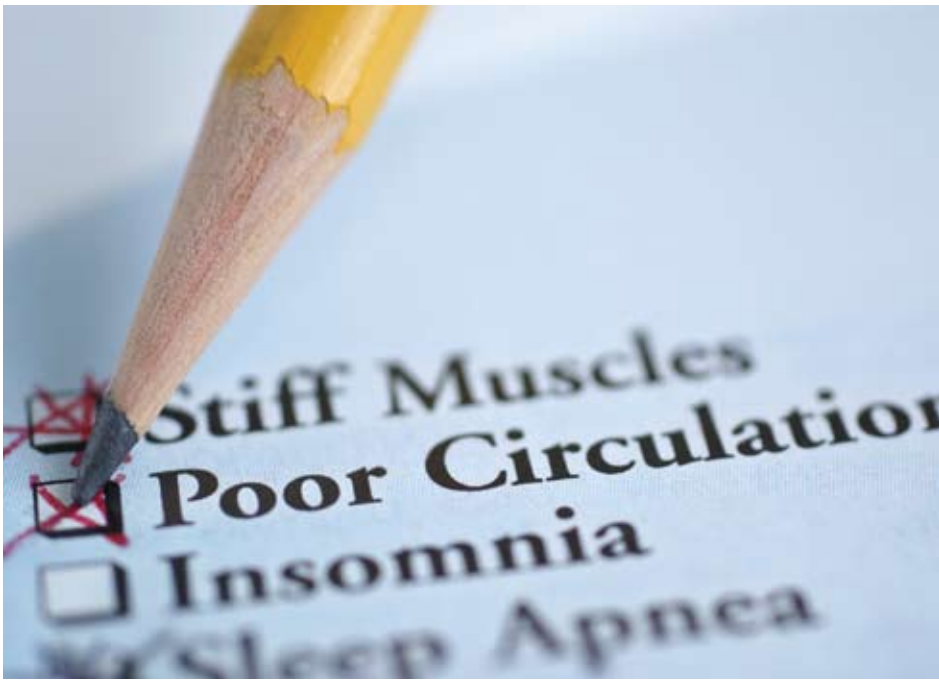
Chapter 2

Obesity in the Fire Service



Weight Gain I Disease Risk I Physical Fitness I Body Fat I Hypertension I Healthcare Costs

How Common is Obesity in the Fire Service?

Not unlike the nation at large, firefighters are struggling with their body weight and physical fitness. Scientists have recently looked at the body composition of both career and volunteer firefighters across the nation, and the trends are troubling. Rates of overweight and obesity range from 73 percent to 88 percent, depending on the study.[1-10] Rates of clinical obesity among firefighters have been determined to be between 30 percent and 40 percent, rates similar to the general American public. The rates of overweight and obesity in the general public are considered alarmingly high; firefighters should not be mimicking these trends given the dangerous and strenuous nature of their work.

Skepticism as to whether BMI is a valid measure of obesity in firefighters has led some to question if the obesity rates found in the fire service are accurate. Skeptics point out that very muscular firefighters may have a high BMI but low body fat and be incorrectly labeled as obese. This concern has not held up when evaluated in scientific studies. For example, the team at the National Development and Research Institutes evaluated rates of misclassification of obesity status based on three body composition measures in firefighters including BMI, waist circumference, and measured body fat percentage. The evaluation found that BMI was an accurate way of classifying the weigh status of firefighters when compared to other, more clinical-based measures.

Research also shows that many firefighters are not physically fit. With respect to fitness levels and the relationship between obesity and fitness, Donovan and colleagues found that 25 percent of the firefighters in their study did not meet the minimal fitness threshold suggested by NFPA 1582 and that, as a result, the firefighters were suffering from a number of metabolic syndrome symptoms.[2,11] In a large study funded by FEMA's Assistance to Firefighters Grant program, the National Development and Research Institutes discovered that over 90 percent of obese career and volunteer firefighters failed to meet even minimal standards of fitness.

As firefighters gain more weight, research has found that cardiorespiratory fitness plummets and the risk of cardiovascular disease increases.[7] There is solid evidence that suggests physical fitness is related to job performance and the performance of simulated firefighting tasks (e.g., hose and ladder carry, donning SCBA, climbing three flights of stairs, rescue and body drag, etc.). The fact that so many firefighters are not fit is troubling.[12-14] This situation may be at least partially due to lack of agreement over fitness and body composition standards in the fire service and the fact that few departments engage in regular monitoring of body composition and physical fitness in their firefighters.[2]

Weight Gain Among Firefighters

Many firefighters experience dangerous increases in body fat throughout their fire service career. One study found that from 1996/1997 to 2001, the rate of obesity in their firefighters increased from 33.7 percent to 40.4 percent, a 1.15 pound per year increase over the course of five years.[9] Other studies have found that firefighters gain an average of about 3.4 pounds each year.[15] This level of weight gain may not sound problematic, but one must remember that over the typical fire service career span of 25 years this constitutes a weight gain between approximately 29 to 85 pounds. That is a lot of extra weight to haul up a ladder!

Several factors may increase a firefighter's risk for weight gain and obesity. First, firefighters engage in shift work and may develop unhealthy diets or eating patterns structured around responding to emergencies. Shift work has been associated with weight gain and obesity risk, and it has been suggested that eating patterns may be negatively impacted by chronic sleep deprivation and irregular meal times.[16-18] Shift work and sleep disruption also may interrupt or interfere with regular physical activity, both on and off duty.[17] In addition, research has shown that most firefighters engage in less than 150 minutes of moderate or greater aerobic activity per week – the minimum amount recommended by public health guidelines for all adult Americans. This amount of activity is lower than what should be expected for firefighters to be prepared to carry out their rigorous and physically-demanding duties.[19]

There are no nationally-enforced fitness or physical activity requirements for firefighters, which may lead to inconsistent physical fitness training within fire departments, substandard fitness levels, and greater obesity risk among firefighters.[2,4,7] For example, the National Development and Research Institutes found that only 38.7 percent of career and 23.6 percent of volunteer firefighters met the fitness threshold suggested by NFPA 1582.[4,11] Finally, firefighting is a stressful job and it has been characterized as a high demand but low control profession.[17] A number of studies have found positive associations between job strain/stress and increasing obesity.[16-17]

Impact and Costs of Obesity to the Fire Service

The epidemic of obesity among firefighters is one of the most critical issues facing the fire service because it is associated with disease and a decreased ability to do the job. In addition, obese firefighters cost more healthcare dollars, miss more days of duty, and have a greater risk of disability.

Increased Disease Risk

Given how many firefighters struggle with their weight, it is no surprise that firefighters suffer from a high rate of diseases related to obesity and low fitness. Heart attack is the leading cause of firefighter line-of-duty death, accounting for about half of all firefighter deaths each year.[20] This rate is substantially higher than those found for police (22 percent), other emergency medical service providers (11 percent), and on-the-job deaths for all occupations (15 percent).[20-21] A number of studies have examined obesity-related heart disease risk factors among firefighters and have found strong links between medical issues such as hypertension and unhealthy cholesterol and increasing BMI.[6] Evidence also suggests that firefighters with high BMIs have greater arterial stiffness, where the artery walls begin to fray because of mechanical stress.[22] Arterial stiffness puts firefighters at risk for heart attacks and stroke.

When obese firefighters are compared to firefighters of a normal weight, a large number of troubling differences are apparent.[4, 9, 23-24] Obese firefighters are much more likely to suffer from the following:

- Hypertension
- Low HDL (good) cholesterol
- High low-dense LDL (bad) cholesterol
- High triglycerides
- Significant yearly weight gain
- Lower cardiorespiratory fitness
- Reduced muscular strength
- More frequent fatal cardiac events

It seems obvious that being overweight and/or obese results in substantial suffering for firefighters.

Increased Healthcare Costs

Researchers have only recently begun studying the impact obesity has had on missing work and increased healthcare costs among firefighters; however, the few studies that have been conducted provide bad news about the costs of obesity in the fire service. Researchers at Harvard Medical School found that firefighters who received a heart presumption retirement (retiring with the assistance of disability awards due to cardiovascular conditions and diseases) in Massachusetts were more likely to be obese than a comparison group of active firefighters.[25]

Soteriades and his team prospectively evaluated CVD and risk of any type of short-term or permanent disability in a group of 358 male firefighters over more than six years and reported several interesting findings.[8] First, they found that the percentage of the firefighters who were obese increased from 33.7 percent to 40.4 percent. Next, they found that obesity predicted which firefighters would receive disability; each BMI unit increase was associated with a 5 percent increase in the likelihood a firefighters would be disabled. This could be particularly problematic for volunteers since their disability benefits vary from state-to-state. In some cases the state itself does not offer these benefits, but instead mandates departments to provide coverage.

National Development and Research Institutes examined the relationship between obesity and missed work days due to injury in a large group of male, career firefighters in the Midwestern U.S.[26] Obese firefighters missed between 2.7 and 5 times (depending on how obese they were) the number of days due to a work injury compared to normal weight firefighters, even when adjustments were made for things that could potentially confound the relationship between weight and lost time at work. Next, the economic costs of absenteeism for firefighters who were at increasing levels of overweight and obesity compared to normal weight firefighters was determined. Compared to normal weight firefighters, the additional costs to departments because of the greater missed days of work after injury in firefighters who were overweight, class I obese, and class II and III obese over the last year were estimated to be $74.41, $254.00, and $1,682.9 per firefighter, respectively.[26] For volunteers, obesity can result in inadequate staffing from members missing shifts due to injury or poor health.

Current Efforts to Address Obesity in the Fire Service

While there are not currently any programs directly focused on weight loss for the fire service, there are several programs that focus on improving health and wellness in a general sense.

NFPA Standards

Two NFPA standards exist that are relevant to health and wellness: NFPA 1583: Standard on Health-Related Fitness Programs for Fire Department Members and NFPA 1582: Standard on Comprehensive Occupational Medical Programs for Fire Departments.[27,13]

NFPA 1583 provides a guide for departments to set up fitness programs with the goal of preparing firefighters to safely and effectively perform their job duties. The standard recommends designating a fitness coordinator who can serve as the link between the department members and the department's occupational medicine staff or subject matter experts as well as be the coordinator for fitness evaluations. It also discusses the work of peer fitness trainers (PFTs), who are department members that receive certification as a trainer and then can train other members of their department on fitness and nutrition.

The standard outlines fitness programs as including:

- Exercise prescriptions through work with PFTs
- Education on warm-up exercises and appropriate cool down
- Instruction on aerobic, muscular resistance, and flexibility exercises
- Appropriate lifting techniques and back health training
- Instruction on safety and injury prevention

In addition, the standard outlines a health promotion program that should include information about:

- Risk reduction
- Health maintenance in general
- Education about the importance of fitness
- Occupation injury prevention
- Accident and injury prevention
- Current information about firefighter fatalities

NFPA 1582 provides an outline for departments focused on developing and implementing medical screenings for candidates and incumbent firefighters. A detailed outline presents the components of a comprehensive medical evaluation that fire departments should complete on an annual basis. Within each body system or area (e.g. neck, cardiovascular, etc.), conditions are identified as either Category A conditions that should preclude firefighters from job duties or Category B conditions which can be allowed as long as the firefighter "…can perform essential job tasks without posing a significant safety and health risk to themselves, members, or civilians."[13]

The standard recommends annual evaluations as well as evaluation after occupation-related exposures, injuries, or illnesses as a means of monitoring health and/or disease. In addition, the standard outlines mandatory but non-punitive fitness testing for current firefighters with the intent of helping firefighters monitor their own abilities. The evaluation outlined in 1582 includes:

- Body composition
- Aerobic capacity
- Grip, leg, and arm strength
- Flexibility

The standard also recommends a process for tracking health-related fitness data as a means of monitoring individual and department improvements over time.

NVFC's Heart-Healthy Firefighter Program

The National Volunteer Fire Council (NVFC) launched the Heart-Healthy Firefighter Program in 2003 to focus on improving the cardiovascular health of the fire service through fitness, nutrition, and educational awareness about heart health and the risks facing firefighters. The program includes a number of components that are available to both volunteer and career firefighters. The program web site (**www.healthy-firefighter.org**) provides information and resources about heart health, fitness, nutrition, health behaviors (e.g. occupational risks, smoking, stress, and alcohol), and starting a health and wellness program.

In addition to these resources, the program has several additional components including:

- Heart-Healthy Firefighter booth at national and state trade shows, which includes free health screenings for firefighters and their families as well as information on improving heart health
- The Fired Up for Fitness Challenge, which is a web-based program to help firefighters develop and track a personal fitness plan
- The *Heart-Healthy Firefighter Cookbook* and online recipe archive to provide first responders with healthy menu options
- The *Heart-Healthy Firefighter Resource Guide*, which contains information to start first responders on the path to a heart-healthy lifestyle

- Health and Wellness Advocate program, which trains firefighters to serve as an advocate for health and wellness within their department, establish a successful health and fitness program, and motivate department members to get and stay healthy
- The Put it Out smoking cessation program, which provides tools and resources to help first responders quit smoking as well as resources for families, departments, and state associations to support smoking cessation initiatives and develop department no-smoking policies
- Webinars on a variety of health and wellness topics, including functional exercise, nutrition, developing a department fitness program, heart health, and smoking cessation
- Motivational tools such as ideas for monthly department health challenges, health and wellness tips sheets, and success stories of firefighters who have been able to lose weight, increase their fitness, improve their health, and serve as examples for other firefighters
- National Firefighter Health Week, which is an annual event to educate the fire service about a variety of health issues that affect first responders and motivate firefighters to take the steps to improve their health and wellness
- *Securing Sponsors for Department Health and Wellness Programs* guide that helps resource-constrained departments identify, reach out to, and follow up with potential sponsors and donors of department health and wellness programs

Mentioned above, the Health and Wellness Advocate program trains department personnel to act as the proponent for health and fitness in their department. Participants learn basic principles behind developing a sound health and fitness program and how to advocate for health and wellness in their department and in the fire service. As Health and Wellness Advocates, they encourage and motivate their fellow fire and emergency personnel to adopt heart-healthy behaviors.

The NVFC partnered with ACE-certified instructors from L&T Health and Fitness, an award-winning fitness and health management company, to develop the Health and Wellness Advocate Workshop. The workshop mixes classroom components with hands-on learning to equip participants with the tools and knowledge they need to succeed as a Health and Wellness Advocate. It includes an overview of fitness and looks at the areas of anatomy, physiology, and biomechanics, which are the building blocks for designing a safe and effective exercise program. Advocates are given guidance on establishing health and fitness goals, safety and injury prevention, exercise and stress management, and how to develop a safe exercise program utilizing five components of fitness. Lessons on nutrition, healthy eating, and weight management are also topics of focus as they relate to health and wellness.

At the end of the workshop, the Advocates participate in a demonstration of functional training exercises which can be easily utilized at the firehouse with minimal equipment. Advocates leave with a workshop curriculum and other resources to assist in improving upon or beginning a health and wellness program within their department.

IAFF/IAFC Wellness Fitness Initiative

In 1996, the International Association of Fire Fighters (IAFF) and the International Association of Fire Chiefs (IAFC) collaboratively published the first edition of *The Fire Service Joint Labor Management Wellness/Fitness Initiative* (WFI). Now in its 3rd edition, the program outlines a comprehensive approach departments can take to address the health and wellness of their members.[28] Components of the WFI include medical evaluations, fitness, rehabilitation guidelines, injury prevention, and behavioral health components.

The WFI recommends annual medical evaluations with a fire service experienced occupational medicine physician. It is suggested that the exam include vital signs and a systems based evaluation. In particular, due to the negative health implications of obesity, the WFI recommends evaluations that include regular assessment of body composition through skin fold assessment. Additional recommended tests include a full blood panel, hearing examination, pulmonary function test, ECG, cardiopulmonary testing, cancer screening, an update to immunizations, and an infectious disease screening.

The WFI discusses the importance of fitness for firefighters and recommends allotted time for all fire service personnel. The WFI also provides certification for peer fitness trainers (PFTs) through the completion of training courses and a certification exam. The model developed by the WFI suggests a Fitness Committee with representatives from labor, management, the department's physician, and an exercise specialist to oversee the PFTs and their work designing and implementing personalized fitness programs for the members. Another role of the PFTs is to conduct annual fitness evaluations with

incumbent firefighters that are confidential and non-punitive. The evaluations, according to the WFI, should include an assessment of body composition, aerobic capacity, strength, and muscular endurance. Nutrition and the importance of a balanced diet are also highlighted.

The WFI recommends a comprehensive approach to rehabilitation, including not only medical concerns but also fitness training, physical therapy, occupational therapy, and behavioral health. Injury prevention from the beginning of the firefighter's career is also identified as necessary for departments.

The final domain identified by the WFI is the behavioral health of firefighters. The WFI advocates a comprehensive program be made available to firefighters with annual screenings performed for all incumbent firefighters. It is recommended that each department work with a behavioral health specialist to provide services, direct counseling efforts when necessary, and make appropriate referrals. The use of a department chaplain in times of crisis and to assist with spiritual needs of the firefighters is also recommended.

As part of its WFI efforts, the IAFF hosts the Fit to Survive web site (**www.iaff.org/hs/fts/ftsdefault.asp**) which provides health tips for firefighters, as well as resources such as a menu planner, healthy food choices when eating fast food, information controlling blood pressure, and tools for smoking cessation.

PHLAME Firefighter Study

There have been a limited number of research-based programs designed and tested in the fire service to improve firefighter health. Arguably one of the most notable is the Promoting Healthy Lifestyles: Alternative Models' Effects (PHLAME) Firefighter Study.[15] The program was designed to encourage fitness, healthy eating, and healthy body weights among firefighters.

The study captured a baseline assessment (questionnaire and physical testing) of the participants at the beginning of the study and then repeated the tests at one year. During the study, the participants were divided into the following two treatment interventions and a control group: (1) team centered, peer led trainings, (2) individual lifestyle counseling with motivational interviewing, and (3) a control group who only received their test results with a brief explanation and listing of normal values. Participants in the two interventions received the PHLAME manual with information on physical activity, nutrition, and health conditions affected by lifestyle. For team-centered sessions, one firefighter from the crew was trained on the intervention and charged with conducting trainings. For the lifestyle counseling, trained counselors met with firefighters on an individual and ongoing basis to illicit behavior change.

While all groups gained weight across the one-year follow-up, those in the intervention conditions gained less weight then the control group and also reported eating more vegetables at follow-up then the control group.

Firefighters and Wellness: Building a Healthy Future Through Partnership and Science

The Johns Hopkins Bloomberg School of Public Health (JHBSPH) partnered with the National Volunteer Fire Council to conduct a three-year research project with funding from a FEMA Fire Prevention & Safety Grant. The study addresses a direct need for effective programs and policies intended to reduce on-duty deaths among firefighters, particularly those related to heart disease and heart attacks.

The goals at the outset of the project were to explore the firefighter culture of fitness and wellness; to identify barriers to and facilitators for health and wellness among firefighters; and to develop, implement, and evaluate a pilot intervention program that addresses those health barriers and facilitators. Fifteen focus groups with a total of 98 firefighters and fire service leaders were conducted in 2009 to learn about culture, barriers, and facilitators for health among firefighters. More than half of the focus group participants identified themselves as overweight (46 percent) or very overweight (8 percent). When selecting food and beverages, 48 percent of participants reported that they avoid fats (e.g. trans fats and saturated fats) and 42 percent avoid junk food. When asked how closely they watch what they eat for weight control, 52 percent of participants reported moderately (44 percent) or very closely (8 percent).

This information was then used to develop, implement, and evaluate a pilot diet and nutrition intervention program to reduce cardiac risk factors among firefighters. Eight fire stations in Maryland were enrolled in the pilot intervention program; with two stations serving as the control group (these stations will receive the intervention program at the end of the study). Those in the intervention group received five monthly education sessions on nutritional topics such as fats, sugar, whole grains, and portion sizes that included cooking demonstrations, books, handouts, posters and other resources related to healthy eating and creating a healthy eating

environment. Half of the intervention stations had two-three firefighters trained by the Johns Hopkins Weight Management Center to be peer advocates for health and nutrition. Discounts at local eateries for healthier menu items were offered, and information on healthier vending machine items, local area farmers markets, and community supported agriculture programs were provided to increase access to healthier foods. Additionally, a "Biggest Loser" type of competition was held between fire stations.

The pilot intervention program was implemented from December 2010 through June 2011, and the data collected includes weight, body fat percentage, waist circumference, BMI and blood pressure at baseline, two months and six months as well as cholesterol and glucose at baseline and at six months. Firefighters filled out surveys at different times throughout the process, answering questions regarding diet, exercise, alcohol, smoking, stress and nutrition knowledge among others. Final results will be collected in December 2011 (six months post intervention). The data is currently being analyzed.

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Chapter 3

Why Is There An Epidemic of Obesity in the Fire Service?

Snacks | Nutrition | Environment | Portion Size | Sugar | Sleep | Processed Carbohydrates

Why Obesity Is So Common

There are a number of well-written articles and books which attempt to explain the rapid rise of obesity in the U.S. and other industrialized countries (for example, Cutler et al.).[1] This section examines the major contributing factors to obesity in the fire service. The three areas covered include:

1. The nutrition environment in the firehouse
2. The role of processed carbohydrates and sugar in the diet
3. Work schedules and sleep

In addition, the limitations in the role physical activity plays with regard to body composition will be examined.

The Nutrition Environment in the Firehouse

There is very little research available about the nutrition environment in the fire service. In order to better understand food choices, eating habits, and opinions about nutrition among firefighters, the National Development and Research Institutes conducted a qualitative study funded by the American Heart Association (the Heart Healthy Heroes Study) that included, among other health topics, a focus on the firehouse nutrition environment.[2]

For the study, interviews and focus groups were held with firefighters, fire chiefs, medical directors, and health promotion personnel from 34 fire departments across the country.[3] Questions ranged from broad (e.g., "What do you consider the biggest health challenges in the fire service?") to specific questions on various health topics (e.g., nutrition, physical activity, mental health). All interviews and focus groups were recorded and transcribed. Using scientific methods for textual analysis, the following major themes emerged.

Bonding Over Meals

One of the most consistent findings was that food decisions and the nutrition environment in the firehouse were as much about bonding as nutrient intake. Firefighters and chiefs consistently reported that meal times are a time for bonding and building relationships. Often, meal times were referred to as "family time" for the crews. Some representative examples of the statements made by firefighters include:

> ***"You want to eat with your family at home, so you eat with your family at work."***
>
> *Firefighter in the Central U.S.*

> ***"Whether it's eating, us working together, us playing together, I think all of that makes us become a better crew together and understand how to deal with each other."***
>
> *Firefighter in the Western U.S.*

> ***"When you're dealing with a group of guys who do a food kitty, and you say, 'I'm going to eat on my own.' That kind of puts a wedge between - it's like, 'Oh what? You don't want any part of the group?'"***
>
> *Firefighter in the Central U.S.*

Meal times were consistently noted as a way of monitoring the interpersonal relationships of the crew.

> ***"I kind of can tell the climate of the station, whether if it's good or bad, by how they cook."***
>
> *Fire Chief in the Western U.S.*

> ***"But you go to the stations and they're eating out a lot or they're eating out of cans, usually something – something's going on."***
>
> *Firefighter in the Western U.S.*

> ***"You know, they have problems in their groups and they don't seem to cook up as much. Just like guys that don't get along together."***
>
> *Firefighter in the Central U.S.*

> ***"In the fire service here in the city, those who eat together, stay together."***
>
> *Firefighter in the Central U.S.*

Food choices and preparation were points of pride for several firefighters who reported that preparing good meals was a form of bonding and caring for their crew members.

> ***"I had a disastrous meal the other day. We were supposed to eat burgers, they turned out Sloppy Joe's – it was embarrassing. I was truly ashamed of that meal."***
>
> *Firefighter in the Western U.S.*

Portion Size

A common topic related to healthy eating in the firehouse was portion size. While the portion size of some foods, like vegetables, may not have a negative effect on body composition and health (it's hard to eat too much broccoli!), foods identified as being served in high quantity were often high carbohydrate and high sugar foods.

> ***"Give me a plate with spaghetti. I want a plate full of spaghetti type things."***
>
> *Firefighter in the Eastern U.S.*

"[It's a] competitive eating club. You know, where everybody wants to get their share."

Firefighter in the Central U.S.

Several firefighters also discussed the challenge of not knowing what the day would bring and how that contributed to eating larger meals as a way to counteract hunger throughout the day.

"I think that's why, in some cases, we overeat – because you might get a meal this morning and be gone the whole day."

Firefighter in the Western U.S.

"Speaking specifically of the fire department – there's a sense that we could be called out for many hours so people don't want to short themselves like they could do at home."

Firefighter in the Western U.S.

Both volunteer and career firefighters discussed the challenges of finding time to cook and eat healthy meals. Many discussed the unpredictability of emergency calls as a unique challenge, stating that they tend to eat when they can and choose foods that are convenient rather than healthy.

"You eat when it's convenient and not necessarily when it's the best thing for you. And nine times out of ten you're eating when you can."

Firefighter in the Central U.S.

Meal Planning

In firehouses across the country, firefighters talked about the challenge of meal planning within a budget and how meal decisions were often made based on cost at the local grocery store that day. Several indicated that cost led to decisions to choose less healthy options.

"It's quantity over quality sometimes. So, you can make a lot of spaghetti with garlic bread and stuff like that for pretty cheap."

Firefighter in the Eastern U.S.

"What they're going to do is they're going to look at the ads and see what's on sale and how they can get the most from the money that they have."

Chief in the Eastern U.S.

"The cost of the groceries decides the menu that day. We try to see what's on sale."

Firefighter from the Western U.S.

"Trying to get a meal that fills you up for three bucks is not necessarily as healthy of a meal if you spent another couple extra bucks and got organic stuff – the healthier stuff is not the least expensive stuff."

Firefighter in the Eastern U.S.

"A lot of lasagna, spaghetti, Sloppy Joes, and French fries….That's the stuff that, you know, goes a long way."

Firefighter in the Eastern U.S.

Eating at the Firehouse

There were mixed reports on the types of food firefighters eat on duty or at the firehouse compared to their home eating habits. Some reported that they eat better at the fire station because the schedule allows more thoughtful meal planning. Others discussed the positive impact of crew level decisions to eat healthy. On the other hand, many firefighters reported that they eat less healthy at the firehouse, particularly during slow periods when there is more time for cooking. One firefighter remarked, "If I'm going to have a really unhealthy meal, this is where I'm going to have it."

Peer Pressure

Several personnel discussed peer pressure at the firehouse. At times, firefighters discussed trends toward healthier eating as being a positive influence on their own eating habits. On the other hand, some discussed the difficulty with suggesting healthier alternatives and stated that, particularly for new recruits, having a different opinion about food and refusing to eat with everyone is difficult and could be viewed as not wanting to be a part of the crew.

"If you're working with that crew, it can be difficult if you're at the lower rank to eat healthy unless you bring your own meal, but then you're kind of an outcast for doing that."

Firefighter in the Western U.S.

"If the crew has an attitude of eating healthy, then everyone tends to follow along that same path. If the crew attitude or mentality is every meal that we have in our shift is going to be at McDonalds or Jack in the Box, or whatever, then it's very difficult, particularly for younger firefighters, to buck that mentality."

Firefighter in the Western U.S.

Snacking

Snacking was identified as a particular challenge at the firehouse. Having an abundance of high sugar or high carbohydrate snacks around the firehouse was consistently reported as being a big challenge.

> ***"You have that downtime, you know, and it's easier to have M&Ms, a Snickers bar in the firehouse than it is to have a carrot or celery."***
>
> *Firefighter in the Central U.S.*

Another challenge is the number of treats and desserts available at the firehouse from community members.

> ***"What kills us sometimes is during, like, holidays or like, 9/11, families around the fire station bring in food. And they mean the best intentions, but they bring in the worst food for you – cookies, cake, and stuff."***
>
> *Firefighters in the Eastern U.S.*

Making Changes

There were mixed opinions about firefighters who wanted to improve their health through better eating. While some crews indicated they were open to changes, many said that recommending major dietary changes was seen as inflammatory and was, at times, taken personally.

> ***"When everybody is eating together, and all of a sudden somebody decides, 'Man, I know I shouldn't be doing that, but how am I going to tell them I don't want to eat biscuits and gravy? I want to have oatmeal, or cereal.' You know you're going to take a little bit of ribbing. You bite the bullet and do it if you really feel like you have to."***
>
> *Firefighter in the Central U.S.*

Traditions

Another common theme focused on the "traditions" associated with eating at the firehouse. A number of firefighters discussed how ingrained food traditions served as a difficult barrier to improving diet. While the particular traditions varied by region and department, several crews around the country had rules, traditions, or social norms with buying desserts – often ice cream or donuts – based on different activities. For example, in several cases new recruits were expected to bring donuts when they started working with a new crew. Purchasing ice cream or cake for fellow crew members often served as a "punishment" for mistakes, accidents, or poor performance.

> ***"You hit a curb, you lose a game, you do something stupid, and you owe ice cream."***
>
> *Firefighter in the Central U.S.*

Moving Towards Healthier Food Choices

Several crews reported trends within their departments toward healthier food choices. Many were convinced that firefighters are working toward better health.

> ***"Guys are starting to look at their diet a little bit more. And so we're more health conscious."***
>
> *Firefighter in the Western U.S.*

Volunteer Firefighters

Volunteer firefighters often discussed challenges associated with healthy eating that were unique to their situation. For example, many volunteer firefighters referenced time demands as a factor in limiting their ability to prepare healthy meals.

> ***"The paid people have time to work out and, you know, they hopefully are cooking properly. But we don't have that set up here. You're on your own, you do your own thing, and you fly by the seat of your pants. You don't have a set schedule of workout times or shopping for proper groceries."***
>
> *Firefighter in the Eastern U.S.*

> ***"You're not going to sit there and say, 'Well, somebody will take that call. We'll have a nice dinner.' It's not going to happen."***
>
> *Firefighter in the Eastern U.S.*

While some volunteer firefighters discussed eating at the firehouse on a regular basis, many others said they didn't spend any extra time at the fire station because their volunteer activities already consumed a great deal of their time.

In summary, the challenges facing firefighters with regard to healthy eating habits include pressures to purchase inexpensive foods and consume large portions, the temptations of unhealthy snacks at the firehouse, and peer pressure. Despite these challenges, there also appears to be some evidence of an increased awareness of the need for firefighters to have a healthy diet and to support quality food choices.

Processed Carbohydrates and Sugar

For the past several decades the scientific community and government bodies have provided a simple, consistent message about how to manipulate diet to be lean and healthy: lower dietary fat intake and consume fewer calories. Health promotion messages encouraged

the consumption of fewer calories from fats for foods such as meat, eggs, and butter and more calories from vegetables, fruits, and grains including wheat and corn. The most recent version of the United States Department of Agriculture (USDA) Nutrition Guidelines (see www.choosemyplate.gov/) continues to promote the message that your diet should primarily come from carbohydrates, including a large amount of grains, and to limit fat intake. For the most part, Americans have dutifully followed these dietary recommendations. According to the Centers for Disease Control and Prevention, during the period from 1971 to 2000, the amount of calories in our diet that comes from fat decreased in the American diet, although the overall caloric intake increased slightly; however, this increase appears to be due to consuming more carbohydrates.[4]

Given the health messages promoted over the past several decades, it is not surprising that Americans are now ingesting more carbohydrates and, in particular, have dramatically increased the amount of processed carbohydrates and sugar they consume. Until recently, if you went to a medical practitioner or diet center for help losing weight, they would inevitably suggest that you eat a low-fat, high carbohydrate, low-calorie diet. A barrage of low-fat products was created by the food industry, from low-fat cookies to low-fat hamburgers.

This morning, many well-intentioned parents served their children (and some firefighters served themselves) a "healthy" breakfast consisting of Honey Nut Cheerios or some other processed, sugar-sweetened, yet "whole grain" cereal and skim milk. One serving (3/4 cup – but who actually only eats 3/4 cup of cereal?) of Honey Nut Cheerios provides 22 grams of carbohydrates and only 2 grams of protein and 1.5 grams of fat. If you read the side of the box, you will notice that the second, fourth, and fifth ingredients are added sugars. Adding skim milk to your bowl will add another 12.3 grams of carbs (in 1 cup) and only 8.7 grams of protein (a single egg provides 12.6 grams of protein). Not to worry, the cereal box reassures you that eating what tastes curiously like a dessert is heart healthy. Your great-grandparents would make a funny face if they looked at this breakfast – it probably would not even look like food to them. In 1977, the average person consumed about 122 pounds of refined sugar per year (already way too much) – by 2000 that total had risen to nearly 154 pounds!

In fact, 75 percent of all the calories we now consume are in the form of highly processed foods, mostly packed with carbohydrates.[5]

Why Conventional Diets Fail

The result of Americans reducing the amount of fat they eat and consuming more carbohydrates, particularly from refined grains and sugar, has been a rapid increase in the prevalence of obesity and metabolic disorders. It is not unusual for a firefighter to eat over 300 grams of carbohydrates per day (one Einstein bagel has over 70 grams of carbohydrates; one medium Coke at McDonalds has 86 grams). This has likely contributed to an epidemic of obesity in the fire service. Ironically, the "fats are evil, carbs are good" claim has never been proven, and a growing body of scientific data now suggests that is it misguided. Even leading scientists writing in the *Journal of the American Dietetic Association*, the flagship journal for our country's dietitians, are admitting that the war on dietary fat was likely a mistake.[6] So why were we told that fat intake was responsible for us getting fat and out of shape?

The story of how "fat is bad" became conventional wisdom and continues to be propagated is probably best told in the bestselling book *Good Calories, Bad Calories*, by science writer Gary Taubes.[7] In short, a dynamic and highly eloquent scientist working at the University of Minnesota named Ancel Keys promoted the hypothesis that eating fats, particularly saturated fats from animal products, leads to higher cholesterol levels and ultimately to heart disease. This hypothesis was based on several "facts" that have now been called into question, including the claim that countries where fat intake is low have lower rates of heart disease than countries where fat intake is high, and that heart disease was rare until the 1920's when Americans shifted their diets from plant-based foods to animal foods which were high in fat.

The U.S. government adopted Keys' hypothesis as their official view on diet and ever since has set out to both prove its basic tenants (through government-funded research) and to change the eating habits of Americans. Dietary recommendations are influenced by a number of interests, not just the science of nutrition, and conventional wisdom is difficult to change.[8] However, a large chorus of respected scientific studies now question the conventional wisdom and our understanding of what constitutes a "healthy diet" is in transition. A few examples:

> The **Framingham Heart Study** failed to support key elements of Keys' hypothesis. It found no relationship between dietary cholesterol and blood cholesterol and participants who ate the most saturated and total fat

weighed the least and were the most physically active.[9]

- The **Multiple Risk Factor Intervention Trial**, one of the largest human trials ever conducted with a staggering cost of $115 million, had participants in their intervention cut dietary cholesterol, saturated fats, and total calories. The study found no significant impact on coronary heart disease or total mortality.[10]
- The largest randomized trials of women to date, the **Women's Health Initiative**, randomly assigned over 48,000 women to either a low-fat diet high in fruits, vegetables, and grains or to general dietary education. At the end of the eight-year intervention, the authors concluded that the low-fat diet did not reduce the risk of coronary heart disease or stroke in women.[11]

Given the results from these landmark studies, it was no surprise when researchers reviewed the literature on obesity interventions for both adults and children and found disappointing results, particularly in the long-term.[12] While large, well-conducted studies were discovering that low-fat, low-calorie diets were ineffective at improving health in the long-term, scientists began looking at whether it was wrong to adopt Keys' assumptions about diet and health. Some of their findings included:

- Processed carbohydrates and sugar were introduced into our diets only recently, and our bodies are healthier without them. Jarod Diamond, a Professor of Geography and Physiology and author of several bestselling books, wrote extensively about how we evolved eating a wide variety and wild plants and animals. Although our bodies still crave this diet, we have replaced it with lower-quality foods that are easy to produce cheaply: "While farmers concentrate on high-carbohydrate crops like rice and potatoes, the mix of wild plants and animals in the diets of surviving hunter-gatherers provides more protein and a better balance of other nutrients…The farmers gained cheap calories at the cost of poor nutrition. (Today just three high-carbohydrate plants – wheat, rice, and corn – provide the bulk of the calories consumed by the human species, yet each one is deficient in certain vitamins or amino acids essential to life.)"[13]
- People from non-industrialized areas often eat diets high in fat and protein and low in carbohydrates, and they are healthier. Anthropological studies find that non-industrial groups such as the residents of the Tokelau Island or the Inuits consume diets very high in fats, including saturated fats, and do not have high rates of obesity and heart disease. In fact, when residents of the Tokelau Islands migrated to other countries and adopted Westernized diets lower in fat and higher in carbohydrates, their rate of heart disease and obesity significantly increased.[14]
- Compelling research is emerging which challenges the conventional wisdom that fat causes obesity or that saturated fat is a cause of heart disease.[15] On the contrary, saturated fat appears to be, at worse, neutral in its impact on our heart while poly-unsaturated fats are heart healthy. A meta-analysis (a mathematical combination of several individual studies) published in a 2010 issue of *American Journal of Clinical Nutrition* found that among almost 350,000 people studied, there was no significant connection between saturated fat intake and heart or vascular disease.[15] Although you may have been told that saturated fat can increase your overall LDL ("bad" cholesterol) levels, you should know that LDL consists of many sub particles. Studies suggest that saturated fat primarily increases large LDL particles (which are widely considered harmless) and not small LDL particles (which are linked to heart disease). On another positive note, dietary fat intake tends to increase HDL, or good cholesterol.
- Low-carbohydrate diets appear to be effective in reducing weight and positively impact risk for cardiovascular disease.[16] For example, results from the A to Z Weight Loss Study published in the *Journal of the American Medical Association* found that the Atkins diet (which is very low in carbohydrates) resulted in twice the weight loss of the other diets tested and did a superior job of improving heart disease risk factors. Even when prescribed along with an effective weight loss medication (Orlistat), a low-fat diet failed to produce better results than a low-carbohydrate diet which did not include medications.[16]
- Calorie restriction, which is typically a component of low-fat diets, results in a disproportionate decrease in energy expenditure and metabolism. Thus, weight loss by following a reduced calorie diet can only be maintained by permanent calorie restriction, which has proven to be difficult for most people.
- Clinical trials comparing low-fat diets with low-carbohydrate diets generally ask participants in the low-fat group to restrict their total caloric intake (usually 1,500 calories or less for women and 1,800 for men) while those on the low-carbohydrate diet are not asked to restrict their calories. Even so, the low-carbohydrate diet generally outperforms the low-fat, low-calorie diet without prescribing that the dieters semi-starve themselves.[17]

- Low-fat, low-calorie diets, even if effective for weight loss in the short term, tend to lower HDL (good cholesterol) and result in less fat loss in the trunk region (where body fat is more dangerous) compared to low-carbohydrate diets. In one study, a very low-carbohydrate diet resulted in three times the body fat loss in the trunk region compared to a low-fat diet.[18] Low-carbohydrate diets seem to result in more fat loss and less muscle loss during weight reduction compared to low-fat, calorie-restricted diets.
- High total carbohydrate consumption is related to oxidative stress and can cause inflammation. Reducing carbohydrates has a more favorable impact on the metabolic condition than a low-fat diet. Low-carbohydrate diets have even been found to improve attention deficit hyperactivity disorder, autism, diabetes, and epilepsy.[19]

The results for low-carbohydrate diets (particularly diets low in processed carbohydrates and sugar) are so impressive that two of the most highly regarded scientists in the area of nutrition, Dr. Jeff Volek and Richard Feinman, concluded that metabolic syndrome could be defined as "a set of markers that responds to CHO [carbohydrate] restriction."[20] They point out that a reduction in carbohydrates results in lowering fasting glucose, insulin, triglycerides, and blood pressure and raising HDL. While there are still plenty of scientists and medical practitioners who continue to advocate low-fat, low-calorie diets, the tide seems to be turning. Why does carbohydrate restriction result in these health improvements? The answer partially lies in its role in the regulation of insulin and impact on insulin insensitivity.

Insulin 101 for Firefighters

There are three main macronutrients in the food that we eat: protein, fat, and carbohydrate. Your body uses these macronutrients for fuel. If you take in too much fuel, the body will attempt to store the excess for times when the fuel might not be readily available. Throughout history there have been times of plenty and times of famine, so the ability to store fuel was critical to survival as a species. Insulin plays a critical role in the body's ability to store fuel. Understanding the role of insulin is imperative to adopting a healthy diet.

Insulin's role in fuel storage was initially discovered by German scientist Paul Langerhans when he noticed particular cells in the tissues of the pancreas. These cells had the appearance of small islands and were therefore called the islets of Langerhans. These beta cells in the pancreas have the ability to produce insulin. Although insulin plays an important role in our health, too much insulin negatively affects the body.

All consumed carbohydrates are eventually converted to a form of sugar called glucose. Although there are no "essential carbohydrates," some carbohydrates are healthy and will support the active lifestyle of a firefighter. That is why it is best if to choose certain high-quality vegetables and some fruits to maximize the quality and reduce the total amount of carbohydrates in your diet. For example, 100 grams of raw broccoli has only 6.6 grams of carbohydrate and is packed with nutrients, while 100 grams of white bread has a whopping 50.6 grams of carbohydrate and is nutritionally anemic compared to most vegetables. A diet that consists of too many processed carbohydrates and sugars results in the body having more glucose than it needs for fuel. This can become toxic and the body needs a way of getting the glucose out of the bloodstream.

It is critical to note that carbohydrates largely control insulin; protein and fat do not produce as much of an insulin response. The beta cells of your pancreas monitor the amount of blood glucose in your body, and when it gets too high, they will secrete insulin. The more glucose in your body, the more insulin will be secreted by your pancreas. Insulin allows glucose to be stored in muscle and liver cells, up to a certain point. Once these cells are full, the remaining glucose gets converted into triglycerides in the liver and stored in fat cells.

If the body is forced to deal with too many carbohydrates, the muscle and liver cells respond by being less responsive to insulin and, as a result, more glucose remains in the blood stream. In medical terms, they become insulin resistant and stop responding to insulin's message to store glucose. The beta cells of the pancreas notice that there is too much glucose in the blood and pump out even more insulin, resulting in more triglycerides being stored in fat cells. Bombarding our bodies with carbohydrates results in an increase of insulin insensitivity in muscle and liver cells – unless you are exercising at a very high level like a marathon runner. Unfortunately, this means fat cells will continue to grow as they store the excess glucose. Given the high amount of carbohydrates we are eating, it is not surprising that obesity is an epidemic!

In time, even our fat cells resist storing more glucose. When this happens, glucose stays in your blood longer which signals your pancreas to work harder and harder

to produce more insulin. Eventually, this results in blood glucose toxicity, chronically high levels of insulin, and nonfunctioning beta cells. All of this leads to high levels of inflammation, diabetes, and heart disease.

Chronically high levels of insulin has many negative effects on the body, including a decreased metabolic rate, lower testosterone and other sex hormones, lower energy throughout the day, and reduced cognitive functions. Feed your body lean, high quality meats, vegetables, fruits, nuts, and seeds and it will thank you.

Short-Term Effects of a High-Carbohydrate Meal

Not only can a high-carbohydrate diet lead to poor long-term health, it will also set a biological roller-coaster into motion leading to hunger, fatigue, and poor mood. For example, a high-sugar or high-carbohydrate meal for breakfast leads to tiredness and hunger throughout the day. The body will rapidly break down the carbohydrates, resulting in a sharp increase in blood sugar. In response, the pancreas will release a large amount of insulin and the blood sugar levels will decrease to the point where three or four hours later hypoglycemia (low blood sugar) sets in. This process occurs over and over during the day when following a low-fat, high carbohydrate meal plan.

In contrast, a meal consisting of a vegetable omelet and a bowl of blueberries (a balanced amount of fat, protein, and carbohydrate) stabilizes blood sugar and insulin levels and prevents the sharp drop in glucose levels. The fat in the meal will keep the body feeling full and energetic and will not spike insulin production. Followers of a diet moderate in carbohydrates coupled with plenty of healthy fats and protein report feeling less hungry and more energetic throughout the day.

Glycemic Index

What should we eat if diets high in carbohydrates, particularly from processed carbohydrates and sugar, can lead to bad health outcomes? One helpful tool is to focus on foods with a low glycemic index, which are typically meats, vegetables, some fruit, nuts, and seeds.[21]

The glycemic index is a measure of a food's impact on blood sugar. Carbohydrates that result in rapid rises in blood sugar have a high glycemic index (typically foods like cereals, pasta, bread, chips, and desserts), while those that break down relatively slowly during digestion and do not cause blood sugar to sharply increase have a low glycemic index. The glycemic index is based on giving a score of 100 to glucose, and other foods are depending on a score above or below 100 given their propensity to raise blood sugar relative to glucose. Medical studies have found that people who concentrate their diets on foods with low glycemic scores have significantly lower rates of heart disease, diabetes, gallbladder disease, and breast cancer compared to those who regularly consume foods with a high glycemic index.

A number of lists providing the glycemic index of common foods are readily available on the Internet. Low glycemic index foods are primarily meats, vegetables, some fruits, nuts, and seeds, while high glycemic foods include starches, breads, pasta, rice, potatoes, grains, and sweets. Eating more low glycemic and less high glycemic index foods is an easy way to dramatically improve the quality of your diet. The chart below provides examples of low (GI < 55) and high (GI > 70) glycemic index foods.

Low Glycemic Foods

Eggs	Tomato	Blueberries
Turkey	Onion	Broccoli
Chicken	Mushrooms	Nuts
Salmon	Spinach	Salsa
Shrimp	Eggplant	Pineapple
Lamp	Asparagus	Cauliflower
Pork	Strawberry	Green beans
Lettuce	Zucchini	Milk, Whole
Apple	Cherries	Peach

High Glycemic Foods

Beets	Bagels	Muffin
Baked Beans	Raisins	Tortillas
French Fries	Biscuit	Potato Chips
Peas	Granola	Ice Cream
Potato	Cereal	Pancakes
Waffles	Grits	Bread
Dates	Corn	White Rice
Cornflakes	Rice Cakes	Jelly Beans
Puffed Wheat	Graham Crackers	Udon Noodles

One limitation of the Glycemic Index is that it does not consider the amount of carbohydrates a food has a typical serving. Charts listing the glycemic index of foods frequently standardize the amount of carbohydrates one obtains from each item (typically 50 grams). It takes a lot of some foods to get 50 grams of carbohydrates while for other foods have a large amount of carbohydrates in a small serving. This means that foods that are unlikely to provoke a large insulin response given the amount that is typically eaten, such as watermelon, have a high glycemic index. To provide fair comparisons among foods, many charts also provide the glycemic load of a food, which is the glycemic index multiplied by the amount of carbohydrates in a usual serving. One of the best web sites to compare the glycemic index and glycemic load among food items is www.glycemicindex.com.

Shift Work and Sleep

Emergency calls are not confined to the normal working hours of 9am to 5pm. Firefighters have to be ready 24 hours a day to respond to an alarm. This also means responding to calls in the middle of the night and interrupted sleep. Career firefighters have set duty days, while volunteers may be on call at any time and may experience more frequent interrupted sleep.

Shift work and interrupted sleep can be challenging for a number of reasons, including putting people at greater risk for obesity. For instance, researchers in Australia looked at a sample of nurses and midwives and found that, even after controlling for other variables, shift workers were 15 percent more likely to be overweight or obese then their peers who only worked days.[22] Studies in the U.S. have also found that people who sleep less than seven hours each night have a higher likelihood of becoming obese than those who sleep seven or more hours.[23]

The exact mechanisms that link sleep disturbance and obesity are not completely understood, but several pathways have been suggested including circadian disturbances that result in metabolic disruption.[24] The circadian rhythm is the physiological cycle the body and hormones go through in a 24-hour period. Disruption to the cycle by being awake and introducing light when the body expects to be asleep and in the dark can cause interruption to the typical cycle. As an example, glucose tolerance has a naturally decreasing cycle across the course of a day, which means that foods consumed at night are processed differently than the same meal during the day.[25,26] Lipid concentration also seems to follow a circadian rhythm, with meals eaten at night leading to higher serum triglyceride levels and less concentrated cholesterol lipoproteins when compared with daytime meals.[27]

Another hormone that seems particularly important in the link between sleep and obesity is ghrelin. Ghrelin is produced in the stomach and is a circulating hormone that, along with leptin, signals hunger. Ghrelin increases before meals to let your body know you are hungry and decreases after meals to let your body know you are full. Interruptions in the circadian rhythms of ghrelin mean that the body signals that you are hungry even when you are not. Studies have found that, if sleep is interrupted, hormonal patterns are altered and people feel more hungry.[28, 29]

Another likely reason shift work and interrupted sleep may be related to obesity in the fire service is the food intake that occurs before or after nighttime calls. As several participants in the Heart Healthy Heroes study discussed, there is often an abundance of high-carbohydrate, high-sugar foods at the fire station. Many firefighters discussed habits of snacking after calls during the night and excess intake that would not occur if they had not been awake at odd hours.

Physical Activity

We all know that exercise is important for good health. There is scientific evidence that exercise/physical activity also helps with weight maintenance or prevention of weight gain, but many people believe that if we exercise enough, then diet does not matter as much.[30-32] This is a sentiment that has been repeated by a large number of firefighters from all over the country. For example, one firefighter in the Heart Healthy Heroes study stated:

> ***"I think everybody kind of thinks, well, I can eat this way here at work and eat healthy at home and work out also and it curbs a lot of that bad."***
>
> *Firefighter in the Central U.S.*

Another notion that has been discussed broadly in the popular media and scientific circles is that the current epidemic of obesity can be largely attributed to the gradual decline in physical activity over the last several decades. The following will review the evidence for these ideas, starting with the belief that physical activity levels have declined over the last several decades, and includes a review of the current rates of different

levels of physical activity. The section will conclude by answering the question about whether exercise can counteract a bad diet.

How Much Does Activity and Exercise Affect Weight and Obesity?

Most scientists and public health experts agree that physical activity and exercise are important for overall health and that most Americans are not active enough. The Centers for Disease Control and Prevention conducts an annual telephone survey of randomly selected Americans and found that that nearly one-quarter of adults were mostly inactive in 2004.[33] However, they also reported that since 1990 (when they started collecting physical activity information consistently) the percentage of Americans meeting current public health activity recommendations – which says all Americans should engage in at least 150 minutes per week of moderate-intensity physical activity – has been gradually increasing. Less than 25 percent of adult Americans engaged in the recommended levels in 1990, but this figure increased to over 26 percent by 2000, more than 40 percent by 2005, and nearly 51 percent by 2009.[34,35-37] Despite these improvements, almost 50 percent of Americans are either irregularly active or not active at all.

Activity levels related to work and transportation also appear to have declined over the last several decades. A study that examined trends in occupationally-related physical activity found that only 20 percent of jobs now require at least moderate-intensity activity where it was closer to 50 percent in the 1960s.[38] The net result was estimated to be a 124 and 140 calorie reduction in energy output for women and men, respectively. This change reflects the shift away from jobs in manufacturing or agriculture and towards those that are mostly sedentary, i.e., sitting at a desk all day. Taken together, this has led some scientists to conclude that there has been an overall trend towards less physical activity over time and that this may help to explain the obesity epidemic in the United States.[39]

In contrast, other scientists using more precise methods of measuring physical activity energy expenditure have found that activity levels have not really changed since the 1980s (when these methods became widely available for human activity studies). For example, Westerterp and Speakman pulled together data from a number of studies that used a method called Doubly Labeled Water (DLW) to measure energy output.[40] Put simply, hydrogen or oxygen ions in water are replaced with non-radioactive tracing ions. Energy expenditure is estimated by measuring the rate at which these tracer ions move through the body and are expelled through urine and expiration (CO2). Westerterp and Speakman found that from 1988 to 2006, physical activity energy expenditure slightly increased in both the European and North American samples. In that same time period, they reported that obesity rates increased from 5 percent to 10 percent in the same European region and from 8 percent to 22 percent in North America.[41] It has been suggested that data from energy expenditure studies better reflect actual trends in energy output over time.

Another interesting study using DLW evaluated activity-related energy expenditure, physical activity level, and changes in BMI among 40 healthy, non-obese adults who were followed for an average of 11 years (the study began with an average age of 27 years).[41] There were several interesting findings: 1) participants who had high baseline physical activity levels gained more fat at the follow-up than those with lower baseline activity levels; and 2) fat mass changes occurred even among participants who had not changed their physical activity levels between baseline and follow-up to the tune of about ½ pound per year, which was associated with aging. The authors concluded that when people change from a physically active lifestyle to a less active one over time, they do not appear to also reduce their food intake, even though they need less energy.[41] These examples are not all inclusive; there are several other studies examining energy expenditure that have produced very similar results.[42]

The Problem of "Compensation"

Why does it appear that physical activity may not play as big of a role in weight loss or the current obesity epidemic? A study by researchers at the Pennington Biomedical Research Center in Baton Rouge, LA, provided some insight.[43] Their study compared people who did not exercise with those who exercised for increasing amounts of time each week (72, 136, and 194 minutes per week with a personal trainer, respectively). At the end of the six month study the data suggested that there were no statistically significant differences between the groups with regard to actual weight loss; in other words, all groups lost weight (even the non-exercise group) and the differences between the groups were very small. Specifically, the non-exercise group lost about two pounds, while the group exercising the most (194 minutes per week) lost a little more than three pounds.

So, what happened here? Why were there minimal differences between the participants in the exercise groups and those in the non-exercise group? Why did the participants who exercised the most actually lose less weight than those in the 136 minutes per week group (they lost about four and a half pounds)? The researchers found that a high proportion of participants who exercised compensated for their exercise-related caloric output by increasing the caloric intake or decreasing their expenditure in other ways, perhaps by eating more because the extra activity increased their appetite, rewarding themselves with food for exercising, or engaging in less household or other physical activity.[43]

It should be noted that most experts do not promote exercise or physical activity alone as a primary method for weight loss.[30-32] Eric Ravussin, an internationally renowned obesity researcher at the Pennington Biomedical Research Center, was quoted in a 2010 *New York Times* article as saying: "In general, exercise by itself is pretty useless for weight loss."[44] The amount of recommended activity related to improving health (i.e., at least 150 minutes of moderate-intensity activity) has generally not been associated with substantial or clinically important weight loss that is comparable to what would be considered successful as an obesity intervention. Additionally, the energy expenditure needed to produce weight loss is very high and difficult for most people to maintain for any length of time.[31] Physical activity levels between 150-250 minutes per week produces modest weight loss (4-7 pounds) and more than 250 minutes per week is needed to produce clinically significant weight loss (11-16 pounds).[31-32] This means that if you worked out five days per week, you would need to exercise between 50-80 minutes per session to achieve any meaningful weight loss.[31,32]

Exercise Does Not Increase Metabolism as Much as You Think

The current exercise guidelines to promote health from the American College of Sports Medicine and the American Heart Association[34] (and the 2008 Physical Activity Guidelines for American; see **www.health.gov/paguidelines**) recommend at least 150 minutes per week of moderate-intensity aerobic activity or between 60-75 minutes per week of vigorous aerobic activity, or some combination of both. The guidelines also call for an additional two days or more of resistance/strength training completing 8-10 exercises.[34,45] Following these requirements will likely result in a moderate increase in muscle mass and perhaps a small weight loss.[30-32] However, it should not be assumed that greater muscle mass will produce a substantially higher resting metabolic rate and protection from weight gain in the absence of a good diet. The metabolic rate for muscle at rest is about six calories per pound, while the rate for fat is even lower at two calories per pound.[46,47] Thus, if five pounds of fat was replaced with the same amount of muscle, the resting metabolic rate will be boosted by only about 20 calories per day - the equivalent of eating about one-sixth of a Birthday Cake Mini Doughnut at Starbucks.

As another example, consider how much exercise would be needed to compensate for eating a typical firehouse meal. Consider the recipes provided at **www.firehousechef.com**, a forum where firefighters can exchange recipes. The recipes list serving sizes separately for firefighters (e.g. a potato soup recipe states "feeds 6-8 people or 4-6 firefighters"). Many of the recipes on the Firehouse Chef site have very high calorie counts and often are very high in processed carbohydrates, which rapidly raise insulin levels and are full of fat. Crews reported they would normally eat potato soup from the aforementioned recipe with biscuits and a dessert. Just one serving of soup with two biscuits, a piece of cake, and a soda would result in consuming 1,699 calories in one meal per firefighter. It would require a 170 pound firefighter to engage in some form of vigorous exercise (e.g., running, stair climbing, full-court basketball, swimming, rowing) for 90-120+ minutes to offset the caloric load of this one meal, depending on the activity.[48]

Additionally, fast foods such as pizza, burgers, etc. are also considered staples in many firehouses. A slice of hand-tossed pepperoni pizza from Pizza Hut has 230 calories (see **www.pizzahut.com/Files/PDF/PH_WSNationalBrochure4.13.10.pdf**). A serving of three to four slices, not unrealistic for a firefighter, has between 690-920 calories. A person weighing 180 pounds would need to run for between 33-44 minutes at a rate of 10 miles per hour (about a six-minute mile pace) to "burn off" that meal, while a person weighing 130 pounds would have to run at the same pace for 45-61 minutes. Weight influences how many calories are burned. Heavier people use more calories to support their greater mass; therefore, lighter people must exercise longer to expend the same amount of calories.

Diet is Important!

Exercise alone cannot overcome a poor diet. There is very strong evidence that what we eat has greater influence over weight and body composition than exercise alone. Combining exercise with a healthy diet is the

best way to combat obesity." And then add a paragraph break so the next paragraph begins with "A study that examined changes in the food energy supply and the weight of Americans between the 1970s and 2000s found that adult caloric intake had increased by nearly 500 calories per day – 353 calories per day for children.[49] The findings were very consistent with actual measured weight gains among Americans participating in a national health study during the same time period.

Large lifestyle changes over time, participating food intake, can also explain American increases in obesity.[50] In the early 1970s, women who began participation in a national study in the 20-29 age group had an average BMI of 23. By the time they were in the 50-59 age group, during 1999-2002, the average BMI had increased to 29. This change represents a 35 pound weight gain over a period of 28 years and could be accounted for by an average increase of 370 calories per day.

Finally, one might wonder if the increase in total caloric intake occurred because of increased intake of all foods or just a particular type or category of food. That issue was addressed by a group of government scientists at the National Center for Health Statistics. Their findings were recently published in the CDC's Morbidity and Mortality Weekly Report.[51] They analyzed nutrition data gathered from 1971-2000 from a nationally-representative sample of thousands of adults aged 20-74 and found that total caloric intake increased an average 168 calories for men and 335 calories for women. More importantly though, they also examined which macronutrients accounted for this increase in caloric consumption and found statistically significant increases in the mean percent of calories from carbohydrates; from 42.4 percent to 49 percent for men and 45.4 percent to 51.6 percent for women, while the percent of calories from fat and saturated fat decreased for both genders.

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6 See Zelman, K. (2011). The great fat debate: a closer look at the controversy – questioning the validity of age-old dietary guidance. *Journal of the American Dietary Association*, 111, 655-658.

7 We highly recommend that you read this book. Taubes book focuses on two basic tenets of health promotion in the past several decades: (1) that dietary fat and especially saturated fat causes health disease and (2) that obesity is a problem of the will caused by caloric excel and/or under activity. He argues that neither of these tenets are true and that interventions based on them underlie the obesity epidemic. Taubes, G. (2007). *Good calories, bad calories: fats, carbs, and the controversial science of diet and health*. New York, NY: Anchor Books.

8 For a highly entertaining video about the politics of nutrition and diet see the move Fat Head (www.fathead-movie.com/). Be sure to see the "No-Bologna Facts" on the movie website. Jared Diamond http://anthropology.lbcc.edu/handoutsdocs/mistake.pdf

9 For example, the Framingham Heart Study found an inverse association between dietary fat intake and stroke in men. That is, the more fat, including saturated fat, the participants consumed the lower their risk of ischemic stroke. Gillman, M.W., Cupples, L.A., Millen, B.E>, Ellison, R.C., & Wolf, P.A. (1997). Inverse association of dietary fat with development of

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11 Howard, B.V., et al., (2006). Low-fat dietary pattern and risk of cardiovascular disease: The women's health imitative randomized controlled dietary modification trial. *Journal of the American Medical Association*, 295, 655-666. It is an interesting exercise to examine how research explains the lack of association between fat intake and health which has been demonstrated in a large number of influential studies. This has been lampooned in many books and websites, including Tom Naughton at: **www.fathead-movie.com/index.php/2010/01/21 /from-a-sows-ear/**. For a more scholarly critique of attempts to explain-away the lack of relationship between dietary fat and obesity, see: Willett, W.C. (1998). Dietary fat and obesity: an unconvincing relation. *American Journal of Clinical Nutrition*, 68, 1149-1150.

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Chapter 4

Innovative Trends in Obesity and Fitness Research

Natural Whole Foods I CrossFit® I Fruits I Nuts and Seeds I Spices I Slow Food Movemen

This chapter will review three promising trends in diet and nutrition in the United States: the importance of natural whole foods, the Slow Food Movement, and ancestral eating. In addition, it will look at a significant trend in exercise among industrial athletes such as military, police, and firefighters – high intensity training (HIT), which focuses on functional exercises (FE) or movements. This includes an overview of CrossFit®, a popular FE workout in the fire service.

Natural Whole Foods

In his book *Food Rules: An Eater's Manual*, nutrition and health writer Michael Pollan lists 64 rules to follow if you want a healthy diet.[7] His simple rules include:

- Don't eat anything your great-grandmother wouldn't recognize as food.
- Avoid food products containing ingredients that no ordinary human would keep in the pantry.
- Avoid foods that have some form of sugar (or sweetener) listed among the ingredients.
- Avoid foods that contain more than five ingredients.
- Avoid food products containing ingredients that a third-grader cannot pronounce.
- Avoid food products that make health claims.
- Avoid food products with the word "lite" or the terms "low-fat" or "nonfat" in their names.
- Avoid foods that are pretending to be something they are not (for example, margarine).
- Avoid foods you see advertised on television.
- Shop the peripheries of the supermarket and stay out of the middle.

Most of the products at a fast food restaurant or in the middle aisles of a grocery store would not comply with any of these rules. Take a look at a typical bag of potato chips or a pre-prepared dinner in the frozen food aisle. Pollan calls these types of food "edible foodlike substances" to distinguish them from real foods (think broccoli, shrimp, or an apple). They may be tasty, but they have been engineered by food scientists to trick the body into craving them and think they taste great.

For example, examine the ingredients in a Ham and Cheese Hot Pocket®. Are you ready? Breathe in deeply and try to read this list before taking another breath:

> unbleached enriched flour (wheat flour, malted barley flour, niacin, reduced iron, thiamin mononitrate, riboflavin, folic acid), water, ham water added ground and formed, natural smoked flavor added (cured with water, sugar, salt, sodium phosphates, natural smoke flavor, sodium erythorbate, sodium nitrite), part skim mozzarella cheese with modified food starch (part skim mozzarella cheese [pasteurized milk, cultures, salt, enzymes], modified food starch, flavor, annatto), imitation cheddar cheese (water, modified food starch, casein, soybean oil, whey, contains 2% or less of salt, sodium aluminum phosphate, sodium phosphate, lactic acid, sodium citrate, natural flavor, sorbic acid [preservative], artificial color), seasoning (whey, cheddar cheese [milk, cheese cultures, salt, enzymes], buttermilk, enzyme modified cheddar cheese [milk, sodium citrate, cheese culture, salt, enzymes, potassium sorbate], salt, reduced lactose whey, coconut oil, maltodextrin, disodium phosphate, blue cheese [milk, cheese culture, salt, enzymes], citric acid, lactic acid, extractives of annatto and turmeric [color]), contains less than 2% of: palm oil (with soy lecithin, artificial flavor, beta carotene), modified food starch, seasoning (toasted bread crumbs [wheat flour, sugar, yeast, soybean oil, salt], cheddar cheese [milk, cheese cultures, salt, enzymes], salt, whey, dextrose, dehydrated onion, natural flavor, soybean oil, garlic powder, reduced lactose whey, disodium phosphate, citric acid, lactic acid, disodium inosinate & guanylate, spice, blue cheese [milk, cheese cultures, salt, enzymes], extractives of paprika & annatto), sugar, seasoning (whey, partially hydrogenated soybean oil, maltodextrin, cheddar/blue cheese [pasteurized milk, cheese cultures, salt, enzymes], salt, nonfat milk, sodium caseinate, sodium citrate, natural flavors, citric acid, extractives of annatto, paprika and turmeric [color]), partially hydrogenated palm kernel oil (with soy lecithin, citric acid as preservative), salt, dough conditioner (calcium sulfate, distilled monoglycerides, salt, l-cysteine hydrochloride, garlic powder, tricalcium phosphate, enzymes, ascorbic acid, citric acid, BHT), yeast, dried egg yokes, lactic acid, dried whey, soy flour, dried egg whites.[8]

Whew! For fun, look up some of the more interesting-looking ingredients. Learn about delectable additives such as L-cysteine (usually derived from human hair or duck feathers) and BHT (which also shows up in the ingredient lists for cosmetics and jet fuel). The same long list of ingredients certainly would not be found in a healthy serving of spinach sautéed in olive oil or a piece of fresh, wild-caught grilled salmon.

The scientifically-engineered taste and convenience comes with a huge price. If there is one fact in nutritional science that nearly everyone agrees on (and there are few), it is that with a Western diet full of processed foods including refined grains, sugar, and difficult-to-pronounce ingredients, diseases such as obesity, cardiovascular disease, cancer, and diabetes explode. Those who eat traditional diets usually do not suffer from these diseases, even when they live long lives. If all of Pollan's rules could be condensed down to one, it would be: Eat real food, not processed food.

> ***"All of our uncertainties about nutrition should not obscure the plain fact that the chronic diseases which now kill most of us can be traced directly to the industrialization of our food: the rise of highly processed foods and refined grains; the use of chemicals to raise plants and animals in huge monocultures; the superabundance of cheap calories of sugar and fat produced by modern agriculture; and the narrowing of the biological diversity of the human diet to a tiny handful of staple crops, notably wheat, corn, and soy."***
>
> *Michal Pollan, In Defense of Food: An Eater's Manifesto*[9]

Eating real meats, vegetables, fruits, nuts, and seeds, primarily those that are raised or grown near where you live, will dramatically improve diet and health. There is a good reason that farmer's markets, community-supported agriculture (CSA), and eating foods free of additives and chemicals are all the rage among the health and fitness crowd. Staying away from those middle food aisles can lead to better health, more energy, and will help to achieve or maintain a healthy weight. Refer to the chart for examples of real foods.[10]

Mix these tasty, nutritious foods and spices in limitless combinations that are sure to satisfy the taste buds.

Avoid foods that required a factory to produce, including cooking oils (e.g., canola, corn, soybean, safflower) that are hydrogenated or partially hydrogenated; trans fats; sugary beverages like energy drinks; sports drinks; high-fructose corn syrup; sweetened teas and sodas; bread products like bagels, biscuits, pancakes, croissants, crackers, and donuts; white rice; fast foods; deeply fried foods, particularly those that are coated in white flour before frying; foods that come in a box or wrapper such as cereals; granola bars; pretzels; chips; rice cakes; and sugary desserts such as cookies, cake, pie, ice cream, etc. All of these foods are recent additions to the human diet and have contributed to the epidemic of obesity.

REAL FOODS

Fruits

Apples, pomegranates, watermelon, pineapple, bananas, cherries, melons, berries, pears, papayas

Don't overdo fruit given their high sugar content, and favor berries. Locally grown and organic fruit are best

Nuts and Seeds

Almonds, walnuts, pistachios, Brazil nuts, and macadamia nuts (note: peanuts are not nuts, they are legumes)

Also try almond butter and almond flour for a tasty alternative to less healthy foods. These are highly nutritious and filling

Oils

Coconut oil, butter (much healthier than margarine and much tastier!), olive oil

Try first press olive oils…they are delicious!

Spices

Parsley, sage, rosemary, thyme, curry, paprika, cumin, cinnamon, garlic, ginger, nutmeg

Learn about the many health benefits and taste pleasures of spices. They make food delicious while promoting health!

Dairy

Use dairy in moderation or not at all if you are lactose intolerant

Focus on organic versions of milk and cheese. Beware that many yogurts, even those advertised as healthy, contain high-fructose corn syrup

There are many substitutes to these foods that can be found in health-focused cookbooks or on the Internet. For instance, spaghetti squash provides a delicious and healthy substitute for processed flour noodles, and there are recipes based on cauliflower which are great substitutes for traditional, high-glycemic mashed potatoes. Desserts such as ice cream used to be considered "treats" and not a staple of one's diet. If you have ice cream, eat the best quality ice cream you can find, have it only on special occasions, be careful about the portion size, and savor every bite. You might find that

you enjoy it even more when focusing on high-quality versions during special occasions.

The Slow Food Movement

An interesting segment of the increasing focus on real foods is the Slow Food Movement, which was founded in 1986 by Carlo Petrini.[11] The Slow Food Movement encourages the preservation of traditional and regional cuisine, an interest in food including where it comes from and how it tastes, and the farming of plants, seeds, and livestock characteristic of the local ecosystem. This movement hopes to swing the pendulum away from "fast food" and our decreased emphasis on traditional food preparation.

The Slow Food manifesto states that we are missing out on one of the most pleasurable, healthy parts of our life by abandoning traditional eating and real food. Most people, particularly in the United States, give very little thought to what they eat, where their food comes from, or what impact it will have on their health. Given the large role food plays in our health and happiness, the Slow Food Movement says that it is time to refocus on food. Rediscovering the tastes of real foods cooked in traditional ways can reignite taste buds that have been hijacked by fast foods, highly-processed foods, and foods loaded with sugar and chemicals.

Doing anything with the word "slow" in it may seem like a tricky task for members of a profession where emergencies and time pressures often are the norm. However, refocusing on real, traditional food is possible in the firehouse and there are plenty of firefighters from busy departments that are doing it.

Ancestral Eating

When biologists study the natural world, one of the most important lenses they use in their work is evolution acting through natural selection. In the language of science, a genetic trait that is "concordant" with environmental pressures tends to be good for an organism and his or her offspring while "discordant" traits typically spell trouble. When there is a permanent change in environmental conditions, organisms may experience a period of evolutionary discordance that can lead to disease and death. Dr. Loren Cordain, a professor at the Colorado State University and prominent nutrition scientist, argues that this is exactly what has happened over the last few hundred years to humans.[12]

Our hunter-gatherer (HG) ancestors suffered few of the diseases that currently plague us. Common medical problems such as cavities, degenerative diseases, cancer, diabetes, cardiovascular disease, and even acne were virtually nonexistent. They had surprisingly low infant mortality rates and despite being more susceptible to accidents, predators, and infectious disease and no access to modern medicine, between 10 and 20 percent lived into their sixties. They were physically fit even late into life and often had bodies that would rival an Olympic athlete. Even the elderly HGs were lean and muscled and were very fit despite diets which were typically loaded with animal foods and high in dietary fat. These findings have been confirmed in existing groups of hunter-gatherers (e.g., !Kung, Lufas, Eskimos, Yanomamo Indians) which have been extensively studied by anthropologists.[13]

Cordain and colleagues report that the following foods were rarely, if ever, eaten by our HG ancestors: dairy products, cereal grains, refined sugars, refined vegetable oils, salt, and fatty factory-raised meats.[12] Adopting a diet consistent with evolutionary history is an exciting trend in health and fitness. A large number of fitness experts, professional athletes, and firefighters have reported dramatic improvements in fitness by adopting a similar diet to the one consumed by our HG ancestors. It is not surprising that a diet focused on organic meats, vegetables, fruits, nuts, and seeds (Paleolithic foods) promote health while diets that are high in processed carbohydrates and sugar (Neolithic foods) result in obesity, diabetes, cancer, and cardiovascular disease. Diets based on eliminating Neolithic foods have even been recommended as effective treatments for problems that frequently plague children (and some adults) such as acne, autism, and attention deficit hyperactivity disorder.[14]

Firefighters' Fitness Needs

There is no doubt that firefighting is physically demanding and strenuous. Firefighters are required to lift heavy objects, drag hoses, breach doors, use heavy extrication equipment for rescues, lift and transport patients with emergency medical needs, etc. Often, these activities are performed in less than optimal or even extreme conditions while wearing up to 50 pounds of protective equipment – increasing the risk of exertion, heat stress, and dehydration. There is wide agreement that firefighters must maintain high levels of fitness due to: 1) strenuous job requirements, 2) cardiovascular disease (CVD), which is the leading cause of line-of-duty death, and 3) high injury rates that cost an estimated $2.7-$7.8 billion dollars per year.[16,17,18,19]

Despite this reality, a large percentage of firefighters are overweight or obese.[20] Even more, many firefighters are not demonstrating high levels of fitness.[21,23,26] This is probably at least partly related to the fact that less than 30 percent of fire departments have any structured fitness monitoring or improvement programs available to their firefighters.[21] Solid research consistently finds that physical fitness is related to job-relevant and simulated firefighting tasks, with fitter firefighters demonstrating better performance.[28-30] For example, one study found that firefighters who were more fit were able to complete the tasks (e.g., hose and ladder carry, donning SCBA, climbing three flights of stairs, rescue and body drag, etc.) much faster than those who were less fit.[28] Research has also found that fitter and stronger firefighters are much better able to complete job performance tasks such as hose pulls, stair climbs carrying equipment, and victim drags.[30]

Physical fitness is also related to a number of other important health parameters relevant to firefighters. For example, studies in related occupational groups such as the military find that those who are very fit are less likely to be injured and have lower stress symptoms related to their job.[31-33] The medical literature has demonstrated that a high level of fitness reduces the risk for premature death and disease (e.g., CHD, stroke, colon cancer) and can even lower some risk associated with being overweight.[34,42]

Current public health recommendations suggest that all Americans should get at least 150 minutes per week of moderate-intensity aerobic activity or 75 minutes per week of vigorous aerobic activity, or some combination of both, along with an additional two days or more of resistance/strength training that involve all major muscle groups to promote health. Additional health benefits can be achieved by increasing to 5 hours (300 minutes) a week of moderate-intensity aerobic physical activity, or 2 hours and 30 minutes a week of vigorous-intensity physical activity.[43] It is not clear whether the basic activity recommendations for all adult Americans would be sufficient for meeting the needs of firefighters beyond just promoting health. It can be argued that, firefighters, as well as military service members and other first-responder groups, are more appropriately viewed as "Industrial Athletes" for whom high levels of fitness should be the norm.[43-45] For example, firefighters often have to perform at peak levels during activities that may involve lifting heavy objects or people, climbing ladders or flights of stairs while wearing 50 pounds or more of protective equipment, or engaging in high levels of anaerobic activity requiring substantial muscular endurance, all while under conditions of heat stress and dehydration and with little or no "warm-up time" before maximal efforts.[44-46]

Given the physical demands of firefighting, it has been suggested that the minimum physical activity recommendations suggested for promoting general health would not be rigorous or job-specific enough to accomplish the fitness requirements necessary to successfully engage in many or most of the strenuous tasks involved in firefighting and rescue activities.[44,46] Several experts in fire service fitness suggest that firefighters need to develop and maintain high levels of general physical preparedness, muscular strength, muscular endurance, cardiovascular endurance, anaerobic endurance, and job-specific strength and endurance capacities (e.g., specialty fitness skills related to fire suppression and rescue activities) in order to safely and capably perform the variety of tasks involved in the profession.[30,44,47] Others have suggested that at a minimum, a firefighter should be able to engage in activity at the intensity level approximately equivalent to running at 7 mph on a flat hard surface.[21,47]

Only two studies that attempted to improve fitness in firefighters using traditional exercise prescriptions were identified for this report. Both primarily focused on improving a variety of health behaviors as well as aerobic endurance and subsequently failed to significantly improve firefighter fitness. A study by Reid and Morgan tested interventions designed to improve adherence and aerobic conditioning over six months.[48] Firefighters were randomly assigned to a control group or one of two exercise groups. The exercise interventions were based on providing general exercise principles and designing the program to fit the needs of each individual. Primary outcomes included adherence to the exercise program and improvements in aerobic exercise. At the end of six months, there were no significant differences between the two exercise groups and the control participants, who did not get any exercise programming, with respect to maintaining an exercise program or aerobic endurance.

More recently, Elliot and associates compared two versions of a health promotion intervention with a large group of firefighters in their Promoting Healthy Lifestyles: Alternative Models' Effects (PHLAME) Firefighter Study, one that provided a group-based curriculum program and one that provided each firefighter with individualized motivational counseling.[49] These conditions

were compared to a control group that was assessed in a manner similar to the other groups, but did not receive any of the health promotion intervention components. Participants in both intervention groups received a manual that provided information on physical activity, nutrition, and other health issues. While participants in both intervention groups had greater increases in the number of sit-ups performed in one minute (1.7 for team program, 1.4 for individual counseling, 0.8 for the control group), there were no improvements based on group status on outcomes such as aerobic endurance or a measure of healthy physical activity behaviors.

Introduction to High Intensity Training and Functional Exercise

High Intensity Training (HIT)

HIT is a method of exercising that has been demonstrated to improve athletic performance, improve endurance and strength in non-athletes, and to safely aid in the rehabilitation of individuals with significant medical conditions (e.g., heart failure).[50-52] It has been suggested that HIT may be an economical, time-sensitive, and effective method for improving the fitness and health of first responders such as firefighters, EMS professionals, law enforcement officers, and military personnel.[53] Research suggests that HIT confers many of the outcomes associated with traditionally higher volume and time-intensive aerobic and resistance training protocols with substantially less training time and lower volumes of work.[54-55]

HIT Methodology

As the name implies, a principle characteristic of any HIT approach is that the exercise period should be performed at a high level of effort and will often be accomplished in shorter periods of time. In addition, these intense and brief exercise efforts generally are interspersed with periods of rest or lower-intensity activity that allow for recovery so that the individual can engage in further HIT exercises.[51] For instance, one popular HIT approach is called the "Tabata Protocol" and involves eight repetitions of 20-second intervals consisting of a very high-intensity activity separated by 10-second rest periods.[56] Approaches to HIT utilize a variety of exercises and methods of implementation including a mixture of both resistance and non-resistance aerobic interval training.[50] Exercises used have included, but are not limited to, sprinting, rowing, skiing, weightlifting, cycling, etc.[50,56]

Effectiveness of HIT

HIT provides numerous benefits including important metabolic and physiological adaptations such as improvements in cardiovascular health, lowered blood pressure, improved body composition, and improved glucose and insulin levels.[51,55,57] Importantly, HIT does not appear to compromise power, speed, and strength or promote the "wear and tear" to the body that is often experienced with sustained aerobic workouts.[58]

Because HIT is performed at substantially higher intensities than typical aerobic or resistance training, it can be implemented in considerably briefer training periods.[54,56,59,61-62] It appears that HIT can accomplish many of the outcomes associated with traditionally higher volume and time-intensive aerobic and resistance training with substantially less training time and lower volumes of work.[54,55,56,59-62] Given the time pressures on firefighters, this is an important benefit.

Health Benefits of HIT

The medical literature on the health benefits of HIT is impressive. Compared to moderate activity or "long and slow" aerobic training, HIT:

- Results in greater improvements in blood pressure and the health of the heart muscle.[51, 55]
- Produces substantial reductions on VLDL cholesterol and triglycerides.[63]
- Significantly increases muscle oxidation, which can increase fat oxidation and thus lower your body fat.[54, 61-64]
- Improve your $VO2_{max}$ - maximum capacity of an individual's body to transport and use oxygen during incremental exercise - as much as those long traditional aerobic sessions with substantially shorter training times.[56,61]
- Unlike those long traditional aerobic sessions, HIT does not negatively impact anaerobic capacity and strength.[56,66]
- HIT has been shown to produce impressive improvements in athletes on outcomes such as explosive movements, endurance tests, and strength.[50, 67-69]
- HIT has been found to be safe and effective when used with medically compromised individuals, such as those with coronary artery disease, chronic obstructive pulmonary disease, and even heart failure.[51, 52, 70]

Evaluations of HIT-Oriented Programs for Firefighters

Roberts and colleagues evaluated a 16-week HIT-oriented program for 115 newly hired firefighter recruits.[47] The program was conducted three days per

week for one hour per session that included warm-up and stretching; high intensity aerobic conditioning including sprint intervals, strength, core, and muscle endurance training with traditional and job-related equipment (e.g., hoses, obstacle course, victim drag/rescue); and finished with cool-down and stretching time. Program outcomes included changes in aerobic capacity, muscular strength and endurance, flexibility, and body composition. At the end of 16-weeks, recruits experienced significant improvements in aerobic capacity (a 28 percent increase in $VO2_{max}$), muscular endurance, and flexibility. It should be noted that recruits' average aerobic capacity at baseline ($VO2_{max}$ = 35.0 mL/kg/min) was substantially below levels suggested as the minimal necessary for fire suppression activities and that the intervention resulted in improving the group average to the acceptable level.[21, 47] The HIT-oriented program also resulted in reductions in body fat percentage and increases in lean muscle mass, and all of these improvements occurred with a total training time of three hours per week including warm-up, stretching, training, and cool-down time.

Functional Exercise (FE)

Functional movements are defined as "natural" movements that require universal motor recruitment patterns found in everyday life. Functional movements are typically multi-joint or compound movements and are irreducible, i.e., the functional movement of squatting cannot be effectively broken down into smaller parts. Thus, while it would be difficult to develop a strong squat by limiting oneself to doing seated leg press, leg extensions, and calf raises, an individual with a strong squat also will be strong when they perform leg presses, leg extensions, and calf-raises. In addition, functional movements are transferable to other tasks while isolated movements are less transferable.

Olympic Lifting (OL) and Powerlifting exercises are highly functional and mimic activities firefighters will face in the field, albeit under more controlled circumstances. Thus, a firefighter is able to test his or her strength and ability to perform functional movements similar to job-related tasks in a controlled environment. Furthermore, the literature is rich with studies that demonstrate the health benefits of weightlifting. For example, weightlifting has been documented to induce muscular growth (hypertrophy), partially due to its ability to elicit acute hormonal responses that enhance tissue remodeling.[72] Lifts that mobilize large numbers of muscle groups, like squats, deadlifts, etc. and their various training progressions are the most efficient method for eliciting favorable muscle growth.

Weightlifting can result in improvements in aerobic and anaerobic endurance, body composition, and bone density. For example, Sentija, Marsic, and Dizdar evaluated the effect of a 12-week, 3x/week OL program in moderately active men.[73] After the program, participants demonstrated significant improvements in anaerobic and aerobic endurance and also experienced a small increase in their BMI. In another study, the combination of HIT-OL and jogging resulted in developing optimal muscle strength and lean body mass without decrements in aerobic capacity.[74] In addition, Olympic weightlifters demonstrate significantly greater bone mineral density at all measured sites when compared to age-matched controls.[75]

Concerns about injuries related to weightlifting and/or physical training have been raised by members of the fire service. However, injury rates associated with weightlifting, particularly when individuals are provided adequate training and supervision, are likely to be low. Jones and colleagues examined 20-year trends (1978-1998) in weight training injuries that were reported by emergency departments in U.S. hospitals to the National Electronic Injury Surveillance System.[76] While weightlifting injuries increased 35 percent over 20 years, the U.S. population also increased about 20 percent during the same time period. The most common causes of injuries were unsafe behavior, equipment malfunction, and lack of supervision. While the group most likely to get injured were adolescent/young adult males (ages 15-24), there were also increases in injury rates among females and older males. Taken together, the data suggests that the increases were largely a result in U.S. population growth and greater participation rates among groups that typically did not engage in weightlifting in the past. Weightlifting in general, and OL in particular, provides a safe and highly effective form of functional exercise for firefighters.

CrossFit® : A Useful Method of HIT and FE Training for Firefighters

Given that many firefighters may suffer from low levels of physical fitness, it is incumbent on leaders in the fire service to seek out and evaluate effective methods for promoting high levels of fitness among their personnel.[21,23,26] One fitness program that has become popular among firefighters is CrossFit®. The increasing interest in CrossFit is entirely a grassroots phenomenon with no

known endorsement by any national fire service organization. Several fire departments have facilities supporting CrossFit workouts, and firefighters who do CrossFit have organized national training sites on the Internet. For example, personnel from a number of different fire departments in the U.S. have developed their own web sites that introduce interested personnel to CrossFit programming and prescribe "workouts of the day" (WODs) for firefighters.[77]

Three recent issues of the *CrossFit Journal* focused on how firefighters in a number of fire departments have used CrossFit in an effort to increase the fitness levels of their personnel.[78-80] Police and fire service personnel in the Kirkland, WA, and Springfield, MO, areas compete in annual CrossFit competitions and several firefighters own CrossFit gyms. Finally, as part of three large ongoing studies of fire departments across the United States, the authors of this report have witnessed a large number of firefighters who use CrossFit as their core fitness program.

CrossFit utilizes exercise (e.g., weightlifting, plyometrics, gymnastics, etc.), progressions, and interval approaches from such a wide variety of sources, there is no limit to the number of combinations that can be developed for WODs that will be challenging, novel, and promote ongoing strength and conditioning for firefighters at no cost to individual firefighters or their departments. In addition, the workouts often require minimal or no equpment. Given the apparent popularity of CrossFit among firefighters and the fact that programming is free and open-source (see www.crossfit.com), as opposed to other HIT-oriented approaches (e.g., P90X, Insanity, etc.), it is incumbent on fire chiefs, training officers, Health and Wellness Advocates, and Peer Fitness Trainers to have a basic understanding of fitness programs to implement within the department.

Overview of CrossFit

The aim of CrossFit is to create broad, general, and inclusive fitness in the program's participants.[81] Elements of CrossFit training include a blend of metabolic conditioning, gymnastics, and weightlifting within an environment of sport and competition. In addition, CrossFit encourages participants to adhere to a dietary plan that they believe maximizes performance and health, the two most popular being the Zone and the Paleo diets.[82,83] CrossFit often is referred to as the "Sport of Fitness" because of the use of competition and group camaraderie to motivate participants to achieve higher levels of performance and skill.

CrossFit was founded by Greg and Lauren Glassman in 1995. Since the opening of the first CrossFit gym in Santa Cruz, CA, the number of affiliated gyms has grown to over 3,000 worldwide (as of June, 2011). Although one may join a CrossFit gym or take a training course on elements of CrossFit, it is essentially a free program. CrossFit's main web site, www.crossfit.com, contains almost everything one would need to learn regarding the basics of the fitness program or to be an active part of the CrossFit community. In addition, CrossFit workouts often require minimal (e.g., free weights, pull up bar) or no equipment (e.g., bodyweight workouts) making it an attractive option for fire departments with limited budgets. Each day the CrossFit web site posts a "Workout of the Day" (WOD) and hundreds of people post their comments and performance on these WODs to the community blog provided on the site. A large number of WODs have been designed specifically for firefighters and these routines can be "scaled" or modified to more closely match the skill level or physical limitations of participants.

CrossFit uses three overlapping standards to define fitness, all of which are designed to emphasize broad and general fitness rather than specialization. The first CrossFit fitness standard suggests that a firefighter would only be adequately fit if they are competent in all 10 of these skills:

1. **Cardiovascular/respiratory endurance** – The ability of body systems to gather, process, and deliver oxygen.
2. **Stamina** – The ability of body systems to process, deliver, store, and utilize energy.
3. **Strength** – The ability of a muscular unit, or combination of muscular units, to apply force.
4. **Flexibility** – the ability to maximize the range of motion at a given joint.
5. **Power** – The ability of a muscular unit, or combination of muscular units, to apply maximum force in minimum time.
6. **Speed** – The ability to minimize the time cycle of a repeated movement.
7. **Coordination** – The ability to combine several distinct movement patterns into a singular distinct movement.
8. **Agility** – The ability to minimize transition time from one movement pattern to another.
9. **Balance** – The ability to control the placement of the body's center of gravity in relation to its support base.
10. **Accuracy** – The ability to control movement in a given direction or at a given intensity.

CrossFit workouts are designed to positively impact all of these skills and to not overemphasize any to the exclusion of the others.

The second standard of fitness is based on the assumption that highly fit individuals will be able to perform well at every physical task imaginable. For instance, a highly fit firefighter may not have the fastest time in a 5 kilometer run or possess a record-setting deadlift, but they would perform as well or better than anyone other than a "specialist" (e.g., Olympic runner or champion power lifter) in both running and weightlifting tasks. Because of this, CrossFit workouts are highly varied and encourage training in both familiar and unfamiliar tasks in varying combinations.

CrossFit's third standard of fitness is based on the three metabolic pathways that provide energy for human activity. These systems provide energy for short, high intensity activities such as a100-yard dash (phosphagen system), moderate powered activities such as a 400 meter sprint (glycolytic system), or more lengthy, less intense activities such as a marathon (oxidative system). Although no energy system provides all of the energy required to perform an activity, the degree to which each contributes is primarily determined by the intensity of the exercise followed by its duration.[84] Although CrossFit prescribes workouts that stress all three energy systems, there is an emphasis on activities which are primarily powered by the glycolytic system given its generalizability to a broad range of activities.

CrossFit's methodology emphasizes performing functional movements at high intensity and to continually vary the specific workouts performed over time. CrossFit argues that this methodology results in a high level of general fitness, shorter exercise times and less boredom, and requires relatively low-cost exercise equipment. Workout programming can be modified to accommodate the unique schedules of firefighters.

Given that CrossFit programming is provided without charge on the CrossFit.com website, requires relatively low-cost equipment, and reduces the time-commitment required for exercise compared to typical workout programs, it is an attractive option for fire departments. In addition, CrossFit incorporates the health benefits of HIT and weightlifting while increasing a firefighter's ability to perform functional movements commonly encountered in the field and on the fire ground.

Notes

1. See the guidelines on the ACSM website at: www.acsm.org/AM/Template.cfm?Section=Home_Page&TEMPLATE=/CM/HTMLDisplay.cfm&CONTENTID=7764`
2. The National Physical Activity Plan can be found at: www.physicalactivityplan.org/theplan.php
3. Information about the IAFF/IAFC Wellness Fitness Initiative can be found at: www.iaff.org/hs/wfiresource/default.html
4. The NFPA Standard on Health-Related Fitness Programs for Fire Department Members: www.nfpa.org/aboutthecodes/AboutTheCodes.asp?DocNum=1583&cookie_test=1
5. USDA Nutrition Guidelines: www.choosemyplate.gov/
6. AHA Diet and Lifestyle Recommendations: www.heart.org/HEARTORG/GettingHealthy/Diet-and-Lifestyle-Recommendations_UCM_305855_Article.jsp
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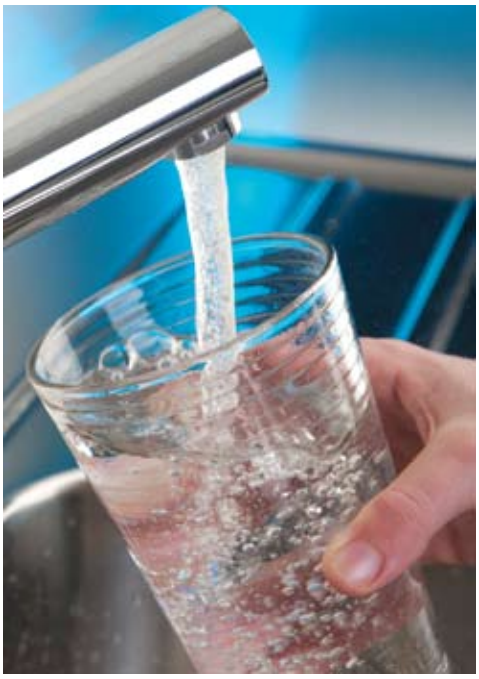
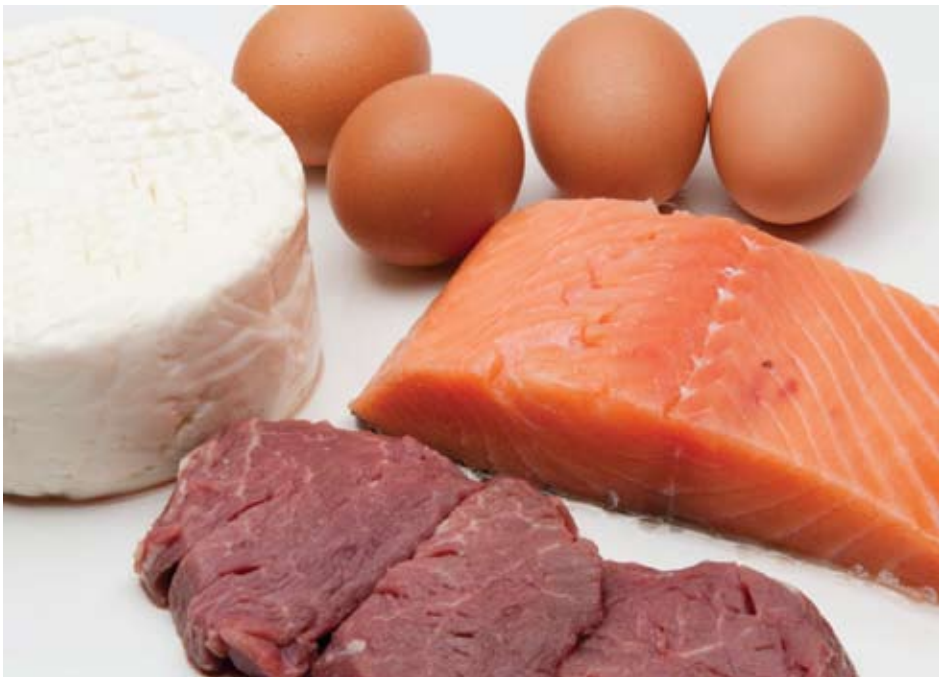
Chapter 5

Recommendations for the Fire Service for Combating Obesity and Increasing Fitness





Nutrition I Fitness I Water I Meats I Eggs I Fish

There are a number of initiatives that could dramatically improve the health and fitness of firefighters and significantly reduce the rate of overweight and obesity in the fire service. The recommendations in this chapter will focus on two issues that can propel the fire service into a more positive future in terms of health and fitness: 1) nutrition in the firehouse, and 2) fitness assessments and guidelines.

These recommendations will require firefighter buy-in, in addition to leadership endorsement. Fortunately, the culture in the fire service is ready for a paradigm shift when it comes to fitness and nutrition. This can be seen in changes already being made. For instance, there was a time when many, if not most, firefighters smoked cigarettes, but today the culture in many areas of the country has shifted radically. If this trend continues, it won't be long before it will be rare to find a firefighter who smokes, and tobacco use will be considered incompatible with the job duties. Similar paradigm shifts have happened in matters of firefighter safety, including wearing seatbelts and the use of SCBAs, in a number of regions. It is time for this same paradigm shift to occur regarding the diets and fitness of firefighters – who should see themselves as industrial athletes that must be ready for any contingency.

Nutrition Recommendations

Healthy nutrition is one of the most important components of health and fitness. It is difficult, if not impossible, to overcome the negative impact of an unhealthy diet with physical activity. A change in eating habits is critical to reversing the obesity epidemic facing our nation's fire service.

Eating has become a cultural phenomenon which has meaning well beyond how food nourishes the body or protects against disease. To complicate things further, many firehouses are in areas of the country where it is difficult to access healthy foods, and some firefighters face financial hardships that make it harder to afford healthier food options. Healthy eating can be even more challenging without the support of friends and family. As a result, eating an "ideal" diet may seem out of reach for some.

Despite the challenges, it is important to remember that nutrition will either enhance or inhibit a firefighter's readiness. Many individuals in the fire service, even those in very challenging circumstances, have transformed their eating habits and are now reaping the rewards of improved health. Learning about nutrition and developing healthy eating habits is an important investment for your health, family, and crew.

Firefighters need to shift their nutrition, as much as possible, toward natural, whole foods and away from processed carbohydrates and sugar. Although an occasional celebration can be harmless, regularly eating foods that are toxic to your body will only worsen the epidemic of obesity and low fitness that plagues the fire service.

Here are 10 steps to take control of your nutrition:

1. Decide to get serious about nutrition. Think carefully about what you eat, plan ahead, and stock the kitchen at the firehouse with healthy foods and snacks. It is difficult to maintain a healthy diet when "what's for dinner" is determined at the last moment by what is on sale at the local market. We have been misled to believe that food should be fast, cheap, and require little thought – a belief that is wreaking havoc on our health. The community is counting on firefighters to be ready to respond, and having a proper diet plays a large role in physical readiness.

2. Get informed. Regularly visit reputable nutrition web sites by individuals who have worked and/or are popular with firefighters and other industrial athletes. Some of these include:

> **Mark's Daily Apple** (www.marksdailyapple.com). Mark Sisson is a former high-level endurance athlete and the author of one of the most popular nutrition sites on the Internet. There are firehouses that follow his dietary advice.

> **Robb Wolf: Revolutionary Solutions to Modern Life** (www.robbwolf.com). Robb Wolf, the co-owner of NorCal Strength and Conditioning, is one of the leading experts on performance nutrition and has worked with many firefighters on their diet and fitness.

> **The Paleo Diet** (http://thepaleodiet.com/). This is the web site of Dr. Loren Cordain, Professor in the Department of Health and Exercise Science at Colorado State University and author of *The Paleo Diet for Athletes*.

> **Gary Taubes** (www.garytaubes.com/). Guy Taubes is the author of *Good Calories Bad Calories and Why We Get Fat*. He regularly blogs on nutritional issues.

> **Food Inc.** (www.foodincmovie.com/). This is the official web site of the identically-named documentary and contains nutritional advice.

There are many other quality nutrition sites on the Internet. Be sure to conduct thorough searches and weigh the pros and cons of each site and its recommendations. Take the initiative to expand your nutrition education.

3. Encourage a culture of healthy eating in the department. It is difficult to maintain good nutrition when efforts are met with negativity from others. Publically support a firefighter who suggests having healthier snacks at the firehouse. Ask local dietitians or fitness professionals to come speak about healthy eating at department meetings to discuss ways to overcome barriers to healthy eating such as cost and access. Plan a series of discussions about nutrition and the fire service during department training. Start a movement to limit junk food in the firehouse to reduce temptation, and share ideas about how to eat healthy with your fellow firefighters.

4. Reduce the amount of processed foods (e.g., foods that come in a wrapper or box) and refined sugars in the home and the firehouse. In particular, avoid white flour, white flour products, and white rice. Most people report that after about two to four weeks of restricting these unhealthy, processed carbohydrates, their cravings for them substantially lessen. Stop drinking sodas and other sweetened beverages, including sports and energy drinks. These products are often expensive and detract from overall health and fitness. For example, if you drink two 20-oz Cokes and two 8-oz cans of Monster Energy Drink per day, you are consuming over 180 grams of sugar in drinks alone! Drinks filled with mystery ingredients are not necessary to feel energetic once an improved diet is adopted.

5. Eat high-quality vegetables and fruits. Focus on eating the highest-quality food that you can find. Food is one area where cheap is not a bargain; you will pay dearly in how you feel, your health, and your quality of life if cost is the only consideration for what you eat. Many people will not hesitate to spend money on alcohol, cigarettes, entertainment, etc., but will insist that their food be inexpensive. Some departments may lack access to, or the resources for, quality produce. Keep the following suggestions in mind to make the best decisions for you and your department:

First Choice: Home-grown fruits and vegetables. There are many benefits to growing at least a portion of your food. Start a garden either at your home or the firehouse and learn to freeze and preserve food for off-season use. Growing food brings families and fire crews together around an activity that will inevitably lead to a higher quality of life.

Second Choice: Locally-grown fruits and vegetables. Although eating organic products has many benefits, some local farms do not have the resources to be certified organic even though they use progressive farming practices. Go to a local farmers' market, get to know a farmer, and ask the community to donate food they grow to the firehouse. Eat local, organically-grown food whenever possible. Plug your zip code into the Eat Well Guide's search engine at **www.eatwellguide.org** and visit the farmer's markets and purchase a share in Community Supported Agriculture.

Third Choice: Fresh frozen fruits and vegetables. Most often fruits and vegetables are frozen at their peak of freshness. Do not let the lack of access to fresh produce deter you from eating plenty of fruits and vegetables. Focus on variety, particularly greens and berries, but limit high-glycemic index starches such as white potatoes.

Fourth Choice: Fruits and vegetables shipped over long distances to your community. The bottom line is that it is better to fill your diet with fruits and vegetables than to avoid them because your community has limited access to higher-quality produce. Just be sure to wash all vegetables and fruits thoroughly before eating them.

5. Focus on high-quality meats and eggs and limit processed meats. Select meats and eggs that are naturally (e.g., grass-fed beef, wild caught fish, hormone free) and locally produced when possible. Try to avoid highly-processed meats such as cold cuts.

6. Round off your diet with nuts and seeds. Great options include almonds, macadamia nuts, and walnuts. Nuts and seeds are packed with healthy nutrients and help to keep you feeling full and energetic. Try to avoid eating peanuts – which are not technically nuts – since they lack the same nutritional value and are associated with peanut allergies.

7. Eliminate trans-fats and high-fructose corn syrup from your diet. This is getting easier to do as more and more food manufacturers eliminate both of these problematic ingredients in their products. However, they are still out there so read the food labels.

8. Be sure to drink plenty of water and unsweetened tea. Come to work hydrated and stay that way throughout the day.

9. Take a multivitamin/antioxidant supplement and omega-3 fish oil capsules. Choose high-quality products, including mercury-free fish oil. Many discount stores now carry high-quality supplements at affordable prices.

10. Rethink treats and snacks. Michael Pollan wrote in his book *Food Rules* that we should "treat treats as treats."[1] Behavioral scientists talk about using "stimulus control" to help change a habit. For example, if you are trying to change a habit like eating candy, then do not keep candy around. It is much more difficult to stay healthy in a firehouse filled with unhealthy food. Talk to your crew about filling your environment with healthy foods and getting rid of those that will ultimately make you sick. Saving treats for truly special occasions will allow them to be appreciated and savored.

Fitness Assessments and Guidelines

Currently, there are no mandatory national standards for fitness that set specific requirements for firefighters. Carefully developed guidelines would serve to educate fire service personnel on what fitness domains are important to their work, how to achieve sufficient performance in those domains, and provide motivation to maintain the desired level of fitness. Departments should consider adopting fitness guidelines and conducting fitness assessments for personnel. The fire department should work to create and sustain a culture of health and wellness and support personnel as they pursue their fitness goals. Fitness assessments and guidelines can be designed to reflect the capabilities and needs of the department and do not need to be costly or require expensive equipment.

While some firefighters have expressed concerns about the adoption of fitness standards, many fire service leaders and occupational health experts have noted the growing negative impact of an absence of a consistent and comprehensive approach to fitness in the fire service.[2-3] In addition to contributing to the epidemic of obesity and low fitness among firefighters, having an inadequate focus on fitness is a safety risk. Even a simple fitness assessment program would provide valuable information on fitness domains where a firefighter may need remediation, which would result in lower rates of injury and increased occupational effectiveness.[4]

It is clear that many firefighters are ambivalent regarding mandatory fitness standards. For example, the National Development and Research Institutes' research team recently completed a national qualitative study of firefighter and fire service leadership perception about general health, wellness, and safety with 332 career and 95 volunteer firefighters from 34 different departments across the US.[5] When asked about their feelings regarding fitness testing, many responded with concerns about how test results would be used, the repercussions of not passing, and the validity or applicability of different fitness tests to actual firefighting tasks. It also should be noted, however, that many firefighters felt that low fitness was a definite problem in the fire service and that something needed to be done to address it. There is a palpable tension between the widely acknowledged fact that effective firefighting requires high levels of fitness and the epidemic of low fitness and obesity in the fire service.

Adopting fitness guidelines may be difficult for some volunteer and career fire departments to implement due to lack of funding or support, particularly with regard to providing fitness training facilities and equipment. For example, outfitting a traditional gym that includes a treadmill, elliptical trainer, and a universal weight machine or similar multitasking resistance equipment could cost thousands of dollars, making it completely out of reach for many fire departments. Luckily, expensive equipment is unnecessary for a quality workout. Many exercises that can improve firefighter fitness and job performance can be conducted using equipment already found at the firehouse or nearby free resources. These may include old hoses, empty oxygen tanks, sandbags, old tires, ladders, sledgehammers, training towers, stairwells, local high school tracks, and stadium stairways.

Minimal equipment can be used to significantly improve fitness and meet the rigorous demands of the fire and emergency services. Underfunded fire departments can develop fitness programming by emphasizing functional movements performed at high intensity and utilizing bodyweight movements. Cost should not be a barrier to implementing a fitness program for your department. An excellent fitness program can be developed with virtually no additional cost or space while engaging in many of the challenging activities for which firefighters must be prepared, such as breaching doors, tearing down walls and ceilings, rescuing and carrying victims, running up and down multiple flights of stairs, etc.

Unlike traditional approaches, this type of fitness program does not require a substantial financial investment or space. For example, a typical workout could include stair climbing, sprint intervals while carrying hoses, pull-ups on a door jamb, flipping a tractor tire, pulling bundled hoses up several stories with ropes, pushups, and sit-ups. None of the equipment used in this workout needs to be purchased. This sample workout is challenging, mimics actual firefighting activities, and could be completed by several firefighters simultaneously, allowing a crew to be able to benefit from camaraderie and competition. The difficulty and intensity level could be easily increased by having firefighters wear their turnout gear. In addition, a functional workout such as this is time-efficient because of the emphasis on performing at high intensity while hitting multiple important fitness domains (e.g., aerobic and anaerobic endurance, muscle strength and endurance, etc.). Examples of different workouts can be found for free at Crossfit.com.

To adopt fitness guidelines or standards, departments can find guidance from the Fire Service Joint Labor Management Wellness/Fitness Initiative (WFI), the National Volunteer Fire Council's Health and Wellness Advocate Program, and NFPA 1583: Standard on Health-Related Fitness Programs for Fire Department Members.[6-8] These resources suggest that, at a minimum, the following fitness domains should be assessed annually: 1) aerobic capacity, 2) body composition, 3) muscular strength, 4) muscular endurance, and 5) flexibility. They also provide guidance to fire departments and firefighters on how to structure comprehensive fitness programs, develop and utilize peer fitness trainers or advocates, and how to conduct fitness assessments of each of the five fitness domains. Departments should look to these resources for guidance when developing and adopting fitness guidelines that fit their needs and capabilities.

In addition, anaerobic endurance, a domain that is not discussed in the WFI, should also be included. Anaerobic endurance involves engaging in maximum work efforts without oxygen for short periods of time so the that the body is working hard enough that the demands for oxygen and fuel exceed the rate of supply and the muscles have to rely on the stored reserves of fuel. Rhea and associates identified anaerobic endurance as being strongly associated with all tested job performance measures for firefighters (e.g., performance total, hose pull, victim drag, stair climb, and equipment hoist). This domain can be tested with a short distance sprint (400m) and can be trained for by including sprint intervals, plyometric drills, etc., into a firefighter's fitness program. Anaerobic endurance was found to be a more powerful predictor of firefighter job task completion than aerobic capacity and most muscular endurance tests.[4]

Any fire service fitness assessment program should be composed of tasks that are functional and mimic actual firefighting activities. Test domains should follow firefighting, rescue, and emergency medical functions so that all firefighters develop a level of fitness that prepares them for a variety of relevant tasks, situations, and environments. This is consistent with previous recommendations for firefighter fitness in that multiple fitness domains will be assessed, but evaluating domains using more ecologically valid and job-relevant tasks would be more compelling to firefighters without necessarily sacrificing quality.

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