THESIS

PREDICTORS OF HEALTH BEHAVIORS AND CARDIOVASCULAR DISEASE RISK FACTORS FOR PROFESSIONAL FIREFIGHTERS

Submitted by

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In partial fulfillment of the requirements

For the Degree of Master of Science

Colorado State University

Fort Collins, Colorado

Spring 2014

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ABSTRACT

PREDICTORS OF HEALTH BEHAVIORS AND CARDIOVASCULAR DISEASE RISK FACTORS FOR PROFESSIONAL FIREFIGHTERS

Although the leading cause of mortality among all Americans is cardiovascular disease (CVD), accounting for about 32% of deaths, the risk among firefighters is even higher. About 45% of on-duty firefighter deaths result from CVD. While their strenuous job duties most often precipitate the CVD-related events, almost all of these incidents are occurring in firefighters with underlying risk factors for CVD. Health behaviors such as diet and exercise are known to have large impacts on known CVD risk factors; however, the dietary habits of firefighters have not been extensively studied. Also the impact of various work-related factors on diet and exercise has not been quantitatively documented. Therefore, the purpose of this cross-sectional study was to elucidate the association between health behaviors and CVD risk factors among firefighters and to analyze predictors for these health behaviors including call volume, social norms and other factors associated with the fire station environment.

Subjects included 42 professional firefighters (mean age 41.0 ± 9.6 years, 95.2% male) who participated in the Heart Disease Prevention Program (HDPP) at Colorado State University. These evaluations provided data on body fat percentage, body mass index, waist circumference, blood pressure, blood lipids, C-reactive protein, cardiorespiratory fitness, overall coronary risk, and records of on-duty and off-duty diet. These individuals and 40 more Colorado firefighters (mean age 41.0 ± 8.7 years, 92.5%

male) completed a questionnaire on motivations for health behaviors. Of these 82 firefighters, 46 completed an on-line dietary screener.

Most participants displayed risk factors for CVD, including increased rates of obesity, systolic blood pressure, and triglycerides. Diet records also showed reason for some concerns and correlation with CVD risk factors. Firefighters reported consuming about 37% of their daily calories from fat. Diet records showed sodium intake of 65% more than the tolerable upper level (UL) and fiber intake 25% lower than the adequate intake level (AI). The American Heart Association goals were met for fruits and vegetables by about 26% of participating firefighters, for whole grains by about 28%, for sugar-sweetened beverages by about 35%, for sodium by 0%, and for physical activity by 43%. Sodium intake was positively correlated with systolic blood pressure (SBP) ($p<.05$) and physical activity was negatively correlated with SBP ($p<.05$). Increased consumption of added sugar showed correlation with increased body fat percentage, triglycerides, and overall coronary risk ($p<.05$).

The volume of emergency calls showed minimal association with CVD risk factors, diet and exercise. Aspects of social norms and group cohesion appeared to have some correlation with diet and exercise behaviors. Convenience and the availability of unhealthy snacks at the fire station were commonly reported and showed associations with the diet. Emotional eating cues and cost were not shown to be strongly related to eating habits. Certain family and home environment factors appeared to also be strongly connected with health behaviors. In conclusion, these findings suggest there are work-related predictors of health behaviors and CVD risk for firefighters, but the home environment showed associations with health behaviors, too.

ACKNOWLEDGEMENTS

This study would not have been possible without the involvement of all of the firefighters, battalion chiefs and other fire department personnel. I would like to extend a big thank you to all of them for being willing to share information about themselves for the sake of this research.

I would also like to thank Dr. Tracy Nelson for all of her time, guidance and encouragement. Thank you also to Tiffany Lipsey for the ideas, knowledge of the population, and resources. Thank you to Dr. Dan Graham for all of his feedback, time and effort, as well. I would also like to thank Dr. Jim zumBrunnen for his assistance with understanding the statistical analyses.

An enormous thank you to my sweet husband, Steve, for all of his prayers, encouragement, patience, understanding, and support. Thank you also to my family and friends for believing in me, encouraging me, and praying for me.

And thank you to my Lord and Savior, to whom I owe all that I am. By His grace I have been greatly blessed. To Him be all glory.

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CHAPTER I

INTRODUCTION

Cardiovascular disease (CVD) is the leading cause of death in the U.S., and firefighters are at a four times greater risk for developing cardiovascular events than the general public (Carey, Al-Zaiti, Liao, Martin & Butler, 2011). However, the majority of cardiovascular disease is caused by risk factors that can be detected and controlled, modified or treated. Major risk factors include hypertension, overweight and obesity, dyslipidemia, physical inactivity, smoking, diabetes and unhealthy diets. Obesity, inactivity and unhealthy diets are particularly significant because they are independent risk factors and directly affect other risk factors. Rates of overweight and obesity among firefighters are even higher than those in the general public. Previous research indicates that 73 to 88 percent of firefighters are overweight, and 40 percent are classified as obese (Durand et al., 2011; Haddock, Poston & Jahnke, 2011). This is particularly concerning because firefighters are required to perform strenuous and dangerous work.

It is likely that there are numerous and complex factors increasing a firefighter's risk for weight gain and obesity. This research attempts to describe some of the reasons for excess weight and associated risk factors for cardiovascular disease (CVD) in the fire service. Factors to be considered include the effect of the volume of emergency-response dispatch calls, the fire station environment, and the various effects of social cohesion and group norms on the health behaviors of diet and physical activity. By analyzing what firefighters are doing as individuals and collectively to have superior and inferior health outcomes, the larger firefighter population may be informed on practical ways to minimize their risk for obesity and CVD.

Statement of Problem

The purpose of this study was to describe the variables including: volume of emergency-response dispatch calls, the fire station environment, and social cohesion and group norms that are correlated with diet and exercise behaviors and the CVD risk factors in firefighters, a population at high risk for cardiovascular disease.

Research Hypotheses

1. Poor health behaviors (diet and physical activity) among firefighters are positively correlated to increases in cardiovascular disease risk factors, namely overweight/obesity, dyslipidemia, hypertension, low cardiorespiratory fitness, and increased inflammation. ($p<0.05$)
2. The volume of emergency-response dispatch calls received are correlated with firefighters' health behaviors and cardiovascular disease risk. ($p<0.05$)
3. Social norms and the fire station environment are correlated with the firefighters' health behaviors, and these vary by obesity status. ($p<0.05$)

Delimitations, Limitations, and Assumptions

The study included professional firefighters from Colorado. A limitation was that most of the subjects were Caucasian, limiting the external validity. The results may not be generalized to other races or outside a firefighter population. Internal validity may be weak due to confounding variables that affect individual health behaviors that this cross-sectional, descriptive epidemiological study cannot control. In addition, temporality cannot be inferred for any of the observed relationships between motivations, health behaviors and cardiovascular risk factors, nor can a direct link be assumed between these variables and the high prevalence of sudden cardiac death among firefighters. There was a potential for non-response bias as participation in the study was completely voluntary and not compensated. Those who chose to respond may differ from the general population of Colorado firefighters.

It will be assumed that subjects provide accurate information on their diet, physical activity, and motivational cues affecting their health behaviors. It is also assumed that the fitness tests and measurements were administered correctly and consistently across all subjects and the data recorded is accurate and current. The researcher is also assuming that subjects have been at their current station for sufficient time to allow any environmental or social cohesion effects to occur.

CHAPTER II

LITERATURE REVIEW

For the past century, cardiovascular disease (CVD) consistently accounts for more deaths in the United States than any other major cause of death. In 2010, CVD was the cause of about 32% of all deaths in the United States (Go, et al., 2013). CVD includes cerebrovascular disease, coronary heart disease, peripheral artery disease, atherosclerosis, cardiomyopathy and heart failure, hypertension, angina pectoris, and congenital cardiovascular defects (Go, et al., 2013). Atherosclerosis, the underlying cause of most cardiovascular disease, involves an ongoing process of inflammation and buildup of fatty deposits, scar tissue and cells within the arterial walls. Coronary heart disease (CHD) is the leading cause of death, responsible for about 17% of U.S. deaths (Go, et al., 2013). Sudden cardiac death (SCD), commonly resulting from CHD or hypertensive heart disease, is the unexpected and sudden death from a cardiac cause that occurs shortly after the onset of symptoms without a previous condition that seemed fatal. SCD accounts for about 63% of all CVD deaths in the U.S (Zheng, Croft, Giles, & Mensah, 2001). About 6.4% of American adults have CHD, and the prevalence of myocardial infarctions is 2.9%. While CHD is prevalent in the general population, firefighters have an even higher risk for cardiovascular morbidity and mortality. High rates of CVD events have been found to be due to the interaction of work-related stressors on preexisting CVD risk factors. Some of the well-known risk factors for heart disease include obesity, hypertension, dyslipidemia, poor diet and low levels of physical activity. Numerous studies have found these risk factors to be prevalent among firefighters. However, the specific reasons these risk factors are increased among the population of firefighters have not been fully researched. Therefore, the purpose of the present literature review is to elucidate the CVD risk among firefighters and analyze a variety of work-related variables that may be associated with firefighter health behaviors and CVD risk factors.

Firefighters and Cardiovascular Disease

Firefighters have one of the highest occupational fatality rates, ranked 13th out of 263 occupations with a mortality rate estimated at 51 per 100,000 workers (Fabio, Ta, Strotmeyer, Li, & Schmidt, 2002). About 100 firefighter's lives are lost on-duty every year, and cardiovascular disease (CVD) is responsible for about 45% of these deaths (Baur, Christophi, Tsismenakis, Cook & Kales, 2011; Carey et al., 2011). Sudden cardiac death is consistently the leading cause of on-duty firefighter fatalities. The number of sudden cardiac deaths has gone down from an average of 60 deaths per year from 1977 to 1986 to an average of 37 per year since 2000, but 42% of on-duty deaths are still a result of sudden cardiac death (Fahy, LeBlanc & Molis, 2013). In addition, every year many firefighters suffer from nonfatal CVD events. There are approximately 17 non-fatal on-duty CVD events for every on-duty sudden cardiac death (Smith, Barr & Kales, 2013). Nearly one in 1,000 United States firefighters have fatal or nonfatal on-duty cardiovascular disease events each year (Durand et al., 2011). The mean age of U.S. firefighter on-duty mortality from a CHD event is only 50.4 ± 7.6 years (Geibe et al., 2008). About 70% of firefighters in the United States are volunteers and 30% are career firefighters. Generally, the frequency and cause of on-duty fatalities are similar and proportionate between the two groups (Smith et al., 2013). However, in

2012, a near equal number of career and volunteer firefighters died of sudden cardiac death (Fahy et al., 2013).

The term *on-duty* includes the time while responding to or returning from an alarm, at the scene of a fire or non-fire incident, and while participating in any fire department duties. An on-duty fatality includes one that involves an injury or illness for which the exposure or onset of symptoms occurred while on duty (Fahy et al., 2013).

Physical exertion, dangerous duties, and responding to emergencies are factors that contribute to this increased risk, but these factors also affect people in other occupations that do not have as high of CVD mortality rates. The percentage on-duty deaths caused by CHD among police officers is 22% or half that of firefighters. The proportion of on-duty CHD deaths of emergency medical service workers is 11% or one-fourth that of firefighters (Durand, et al., 2011; Kales, Soteriades, Christophi & Christiani, 2007).

Physical and Physiological Job Demands and Risks

The physical job demands on a firefighter are high. Firefighters often wear 50 pounds of personal protective equipment while carrying 20-40 pounds of tools. They are required to then climb ladders, move heavy hoses and drag or carry victims (Durand et al., 2011). This maximum physical exertion often occurs immediately following a sedentary period, thus physical exertion is very irregular and does not allow time for gradual adjustments. In addition, the insulating personal protective equipment limits heat dissipation resulting in an increase in core temperature by about 1.5˚ C (Smith et al., 2013). This increase in temperature can cause heat stress, increases metabolic heat production and increases the cardiovascular strain. Profuse sweating and dehydration can result in a loss of about 1.1% of body mass (Smith, et al., 2013).

Short-term firefighting activities have been shown to reduce stroke volume by 35% and plasma volume by 14.8% (Smith et al., 2013). This hypovolemia increases blood viscosity and causes a pro-coagulatory state that can increase the risk of thrombus formation. In addition, firefighting activities were shown to increase platelet number, aggregation, and function in healthy, young firefighters, further increasing the risk of thrombus formation (Smith, et al., 2011).

Between the physical exertion and the emergency response, there is a sudden adrenergic surge that places a high demand on the cardiovascular system (Baur, et al., 2011). Sympathetic activation is further increased by the noisy environment, sense of urgency, and life-threatening conditions. It is common for a firefighter to reach his maximally predicted heart rate during an emergency and then sustain that high heart rate for prolonged periods of time (Soteriades, Smith, Tsismenakis, Baur & Kales, 2011). During a simulated fire suppression and person rescue, firefighters' heart rate approached and exceeded age-predicted maximum and even exceeded the max heart rate reached during exercise stress tests while wearing gear. In addition to near maximal heart rates, live firefighting has been estimated to have a metabolic demand of 9.6 to 14 metabolic equivalents (METS) (Fahs et al., 2011). Considering studies using simulated drills do not even include common factors like receiving a call suddenly, unpredictable risks and the burden of real lives, it is reasonable that fire suppression requires an even higher level of cardiorespiratory fitness and puts a firefighter at great risk for a coronary event (Angerer, Kadlez-Gebhardt, Delius, Raluca & Nowak, 2008).

In addition, firefighters are exposed to smoke and chemicals. The carbon monoxide (CO) and particulate matter present in fire smoke can complicate conditions. Inhaled CO binds with hemoglobin to form carboxyhemoglobin, which then limits the availability of hemoglobin to transport oxygen to the tissues, potentially resulting in tissue hypoxia and increased risk of myocardial ischemia in susceptible firefighters (Smith et al., 2013). Particulate matter may contribute to increased blood pressure, potential for heart arrhythmias, formation of free radicals, blood coagulability, endothelial dysfunction, and atherosclerosis (Smith et al., 2013).

The fact that more on-duty CVD events occur at certain times of the day and during more strenuous duties support the understanding that the specific physical and physiological demands of firefighting increase the risk for CVD. The circadian pattern of deaths from CHD parallels the pattern of emergency-response dispatches. Although for the general population, the peak period for cardiovascular events is in the morning hours, among firefighters 67-77% of on-duty CVD deaths occurred between noon and midnight, as did more than 60% of the emergency responses (Mbanu et al., 2007).

The risk of CVD events varies greatly based on the duties being performed. Firefighters are at 12-136 times greater risk of a CVD event during fire suppression than during non-emergency duties (Mbanu et al., 2007). While fire suppression involves only 1-5% of a firefighter’s annual professional time, it is correlated with one-third of all coronary heart disease deaths (Mbanu et al., 2007). About 32% of CVD deaths occur during fire suppression, 13.4% while responding to an alarm, 17.4% when returning from an alarm, 12.5% during physical training, 9.4% while responding to a nonfire emergency, and 15.4% while performing nonemergency duties (Kales et al., 2007).

Most on-duty CVD events result from strenuous duties, but the CVD events are not distributed evenly among all firefighters. Some individuals are more susceptible because they have underlying diseases or many risk factors (Baur et al., 2011).

CVD Risk Factors among Firefighters

The reasons firefighters are more likely to be at risk for CVD events are numerous and complex, but studies have shown that firefighters who had a pre-existing CHD diagnosis had a 15-fold increase in risk for an on-duty fatal cardiovascular event (Geibe et al., 2008). About 90% of the fatal and non-fatal CVD events among firefighters are due to pre-existing coronary heart disease (Baur et al., 2011; Durand et al, 2011). Cardiovascular events almost always occur among susceptible firefighters with underlying CVD, some of which were previously diagnosed while others may have been unrecognized (Soteriades et al, 2011). So although the strenuous duties often trigger a CVD event, the underlying disease and contributing risk factors usually developed gradually over many years. Risk factors for heart disease include obesity, hypertension, dyslipidemia, physical inactivity, diabetes, smoking, male gender, heredity, age, stress, and elevated C-reactive protein. Not only do firefighters have a higher prevalence of heart disease than the general public, they also display higher levels of many of these risk factors.

Optimal cardiovascular health factors include systolic blood pressure below 120 mmHg, diastolic blood pressure below 80 mmHg, total cholesterol under 200 mg/dL, fasting plasma glucose under 100 mg/dL, abstinence from smoking, and body mass index (BMI) below 25 kg/m^2 (Lloyd-Jones, et al., 2010). These health factors have been found to be associated with a reduction in risk for CVD death (hazard ratios 0.00-0.20) and risk for fatal or nonfatal CVD event (hazard ratios 0.00-0.19) in men and women (Lloyd-Jones, et al., 2010). The Framingham Heart Study found that optimal levels of these health factors correlated with only a 5% risk of CVD, but with two or more of these risk factors, women had a 50% risk of CVD and men had a 69% risk (Lloyd-Jones et al., 2010).

Overweight/Obesity

Obesity is commonly considered a major independent risk factor for heart disease and a factor that directly affects other risk factors. Obesity predisposes individuals to insulin resistance, diabetes, and atherogenic dyslipidemia. Excess visceral fat releases free fatty acids that stimulate the synthesis of triglyceride-rich lipoprotein VLDL in the liver (Libby, Ridker & Maseri, 2002). In addition, adipose tissue produces and releases cytokines that promote inflammation that enhances atherogenesis (Libby et al., 2002). The AHA considers Body Mass Index (BMI) less than 25 kg/m^2 as a component of ideal cardiovascular health. In 2010, about 31% of American adults met this criterion. NHANES found 73% of men and 64% of women to be overweight (BMI 25-29.9 kg/m^2) or obese (BMI $\geq$ 30 kg/m^2) and 35% of men and 36% of women to be obese (Go et al., 2013). Obesity negatively impacts arterial function in particular by decreasing endothelial function, increasing arterial stiffness, and increasing blood pressure (Fahs et al., 2011). The distribution pattern of increased body fat around the abdomen, or android obesity, puts individuals at an even greater risk of hypertension, diabetes, dyslipidemia, metabolic syndrome and CVD, so measurements of waist circumference provide valuable information in assessing risk. Waist circumference above 102 centimeters for men or above 88 cm for women is correlated to an increased disease risk (ACSM, 2010). In addition, body composition can be measured to estimate body fat percentages through use of skinfold testing, hydrodensitometry, and dual-energy x-ray absorptiometry (DEXA). Health risk based on body fat percentage varies by age and sex. Risk is considered elevated when it is above 20% for men 20-39, above 22% for men 40-59, above 33% for women 20-39, and above 34% for women 40-59 (ACSM, 2010).

In 2012, 40% of the victims of sudden cardiac death who were studied were obese (Fahy et al., 2013). Evidence indicates that rates of overweight and obesity are even higher in the fire service than in the general public. In 2002, firefighters (grouped with police officers) ranked third highest in the prevalence for obesity among 41 US male occupational groups (Choi et al., 2011). This high propensity for overweight and obesity is considered an accurate reflection of high body fat among firefighters since multiple measurements have been performed on this population through BMI, skinfold testing, waist circumference, and DEXA with similar assessment of prevalence (Choi et al., 2011; Durand et al., 2011; Kay, Lund, Taylor & Herbold, 2001). Although the duties of a firefighter require high levels of fitness, 73% to 88% of firefighters are classified as overweight and 30% to 40% are considered obese (Baur et al., 2011; Carey et al, 2011; Durand et al., 2011). A previous study on male career firefighters undergoing evaluation through the Heart Disease Prevention Program at Colorado State University showed that 75% of firefighters were overweight/obese and 19% were obese based on BMI, and 19% were obese based on waist circumference greater than 102 cm (Donovan, Nelson, Peel, Lipsey, Voyles & Israel, 2009). The average BMI was 27.6

kg/m^2, the average body composition was 21% fat, and the average waist circumference was 93 cm (Donovan et al., 2009).

Body mass index (BMI) has steadily been increasing among firefighters. In the early 1990s, average BMI was 25.4-26.7 kg/m^2, by 2001 the average BMI was 29.7 kg/m^2; the rate of obesity increased from 33.7% to 40.4% kg/m^2 (Soteriades, et al., 2011). While among American adults the average is an increase of about one pound per year, studies have found that firefighters may gain an average of 1.15 to 3.4 pounds per year of active duty with the rate of weight gain increasing over time (Go, et al., 2013; Soteriades, et al., 2005; Haddock, et al., 2011). Younger firefighters (under 45 years) were noted to gain twice as much as older firefighters, and firefighters who were already extremely obese gained the most (1.9 pounds per year) (Soteriades et al., 2005).

Obesity among firefighters is associated with lower work performance, disability retirement and mortality. A one-unit increase in BMI has been associated with a 5% increase in the risk for job disability. Obese firefighters are two times more likely than nonobese firefighters to experience a job disability event (Soteriades, Hauser, Kawachi, Christiani & Kales, 2008). In addition, obesity and low levels of fitness exacerbate the thermal strain of firefighting (Soteriades et al., 2011).

Since firefighters are first responders, their obesity may jeopardize their own safety and public safety (Soteriades et al., 2005). Although the increasing weight within the fire service is reflective of the general population, the duties of a fire fighter require a higher level of fitness, a fact which firefighters and administrators also expressed a belief in during focus group discussions. As one fire chief said "'we're expecting to perform like athletes, but with bodies of couch potatoes'" (Jahnke, Poston, Jitnarin &

Haddock, 2012, p. 114). However, many firefighters also have misconceptions regarding obesity. According to a survey of firefighters, 84% of subjects were overweight but only 44% of them considered themselves overweight, with 84% also reporting adequate levels of physical activity (Kay et al., 2001). Furthermore, the National Fire Protection Association (NFPA) does not provide specific BMI target levels nor consider extreme obesity to be a disqualifying condition with respect to fitness for duty (Soteriades et al., 2005; NFPA, 2013). The NFPA 1582 *Standard on Comprehensive Occupational Medical Program for Fire Departments* only specifies that body weight and composition should be recorded annually. Even extreme obesity (BMI ≥ 40 kg/m^2) is not considered a category A condition that would exclude a firefighter from active duty nor a category B condition that may be exclusionary depending on its severity (NFPA, 2013).

Obesity, in the general population and among firefighters, directly affects other CVD risk factors, as well. With obesity, firefighters were found to have an average of 1.8 additional CVD risk factors, such as hypertension, low high-density lipoproteins (HDL) and high serum triglycerides. With extreme obesity (BMI ≥ 40 kg/m^2), firefighters had 2.1 additional CVD risk factors, while normal-weight subjects had only 1.5 CVD risk factors (Soteriades et al., 2005; Soteriades et al., 2002). As body weight increases, generally arterial function decreases and central blood pressure increases, both predictive of cardiovascular mortality (Fahs et al., 2009). A study of 110 relatively young, apparently healthy firefighters determined that central and peripheral blood pressure and aortic and carotid artery stiffness increased nearly linearly with increasing BMI, from normal weight to overweight to obese (Fahs et al., 2009). Increased arterial stiffness is associated with atherosclerosis and is a strong marker of cardiovascular risk (Fahs et al., 2009).

Hypertension

Hypertension (high blood pressure) is a major risk factor for CVD. Inflammation contributes to the pathophysiology of hypertension, and hypertension is a risk factor for atherosclerosis (Libby et al., 2002). High blood pressure in the general population has an adjusted estimated attributable fraction for CVD mortality of about 41% (Go et al., 2013). About 69% of first heart attacks occur in individuals with blood pressure over 140/90 mmHg (Go et al., 2013). In addition, people with prehypertension were 1.65 times more likely to have at least one additional risk factor for cardiovascular disease than those with normal blood pressure, with the most likely added risk factors being high cholesterol and high BMI (Go et al., 2013). About 33% of American adults are hypertensive (BP≥140/90) and another about 36% are prehypertensive (blood pressure ≥130/85 mmHg) (Go et al., 2013). Risk factors for hypertension include age, ethnicity, genetics, increased weight, low levels of physical activity, tobacco use, psychosocial stressors, sleep apnea, and dietary factors. Dietary factors that contribute to hypertension include increased consumption of dietary fats, sodium, and alcohol and low consumption of potassium (Go et al., 2013).

The recommendation of NFPA is that uncontrolled or poorly controlled hypertension is a Category A medical condition that should preclude a firefighter from participating in training and emergency situations, but high blood pressure is still reported prevalent in the fire service (NFPA, 2013). Studies have shown about 50% of firefighters have prehypertension and 20-30% are hypertensive (Carey et al., 2011;

Soteriades et al., 2011). In a cohort of Colorado career firefighters, 55% had prehypertension or hypertension (SBP ≥ 130 mmHg or DBP ≥ 85 mmHg), and the average blood pressure was 129/83 mmHg (Donovan et al., 2009). Hypertension is a strong predictor of on-duty cardiovascular events in firefighters, as well. In 2012, 70% of firefighter victims of sudden cardiac death who were studied were hypertensive (Fahy et al., 2013). Among firefighters, hypertension is an independent predictor with a 3-fold increase in the risk of heart disease-related disability retirements, CHD events, nonfatal myocardial infarctions, and on-duty CHD fatalities (Kales, Tsismenakis, Zhang & Soteriades, 2009). The majority of CVD events occur in prehypertensive to mildly hypertensive firefighters (average blood pressure in the range of 140-146/88-92 mmHg) (Soteriades et al., 2011). Guidelines for blood pressure screening and management for firefighters should take this into consideration. One study found that 74% of subjects with hypertension were not adequately controlled even after a four-year follow up (Soteriades, Kales, Liarokapis & Christiani, 2003). Chronically uncontrolled hypertension has been found to be a major risk factor for left ventricular hypertrophy (LVH), or increased wall thickness and mass that is a strong predictor of fatal arrhythmias and cardiovascular mortality (Geibe et al., 2008; Smith et al., 2013). Men with LVH were found to have a six times greater risk of sudden cardiac death than those without LVH (Smith et al., 2013). Autopsies of firefighters who died from CVD showed that 56% had left ventricular hypertrophy (Geibe et al., 2008). Even small reductions in blood pressure can decrease CHD risk by 6% (Baur et al., 2011). Blood pressure is greatly affected by obesity. A 22-pound increase in weight can lead to a 3.0 mmHg increase in systolic blood pressure and a 2.3 mmHg increase in diastolic blood pressure (Haddock et al., 2011).

Dyslipidemia

The American Heart Association (AHA) identified total cholesterol under 200 mg/dL as a component of ideal cardiovascular health and high cholesterol as a major risk factor for CVD. In 2010, 47.3% of adults met this criterion, but at least 13.8% have cholesterol levels of 240 mg/dL or higher. Dyslipidemia, or abnormal levels of lipids, refers to a low level of high-density lipoproteins cholesterol (HDL-C) and a high level of low-density lipoproteins cholesterol (LDL-C). The average LDL-C for American adults is about 116 mg/dL, and the prevalence of high LDL-C (≥ 190 mg/dL) is about 28% (Go et al., 2013). Optimal HDL-C levels are above 40 mg/dL for males and above 50 mg/dL for females. HDL-C is able to protect against atherosclerosis through reverse cholesterol transport and by transporting antioxidant enzymes that can break down oxidized lipids to reduce inflammation (Libby et al., 2002). A low level of HDL-C is an independent risk factor for CVD and also a modifiable factor. The average HDL-C for American adults is 52.5 mg/dL (Go et al., 2013). A fasting triglyceride (TG) level of 150 mg/dL or greater is a risk factor for CVD. The geometric mean TG level for American adults is about 130 mg/dL, and about 27% of adults have high triglycerides (Go et al., 2013).

In a study by Soteriades et al. (2002), a concerning proportion of firefighters have high LDL-C levels (52% high and 36% above optimal) and low HDL-C (25%), and the majority (78%) were not taking medications even after four years of repeated screening (Soteriades et al., 2002). A large study of Midwestern career firefighters showed 28.5%

had high triglycerides or were on lipid-lowering medication and 40.8% had low HDL-C (Baur, Christophi & Kales, 2012). In the study of career firefighters in Colorado, 21% had hypertriglyceridemia and 31% had low HDL-C (Donovan et al., 2009).

A study including 597 firefighters determined that a low level of HDL-C is correlated with increased carotid intima media thickness (CIMT), which is an early indication of atherosclerosis and CHD (Burgess et al., 2012). In subjects under 30 years, the risk of CHD events within 20 years is 2.5 times greater in subjects with high CIMT. Measures of CIMT indicate that LDL-C of 100-129 mg/dL in firefighters under the age of 45 is also associated with an increased risk of CHD events. The risk for CVD in firefighters would be significantly lowered through aggressive lowering of LDL-C to reach optimal levels of less than 100 mg/dL (Burgess et al., 2012). Both aerobic exercise and dietary interventions have been proven to independently improve lipoprotein profiles. There is a positive linear relationship between dietary saturated fat and refined carbohydrate intake with total cholesterol and LDL-C and CVD risk. High levels of *trans* fatty acids negatively affect both LDL and HDL cholesterol and increase the risk of developing CVD (Huffman et al., 2012).

High blood glucose and diabetes

Diabetes mellitus is considered a major risk factor for cardiovascular disease. Hyperglycemia can lead to production of proinflammatory cytokines and promote inflammation in vascular endothelial cells, contributing to atherosclerosis (Libby et al., 2002). Death rates from heart disease are about two to four times higher for adults with diabetes than those without (Go et al., 2013). Type 2 diabetes is also associated with various other CVD risk factors. Among adults with diabetes, there is a 75-85%

prevalence of hypertension, 70-80% prevalence of high LDL, and 60-70% prevalence for obesity (Go et al., 2013). Fasting blood glucose below 100 mg/dL has been identified by the AHA as a component of ideal cardiovascular health. In 2010, 57.4% of adults met this criterion (Go et al., 2013). About 12% of American adults have diabetes mellitus and about 38% have prediabetes, defined as fasting blood glucose of 100 to 125.9 mg/dL (Go et al., 2013). Lifestyle risk factors for diabetes include low levels of physical activity, poor dietary habits, smoking, alcohol use, and increased adiposity (Go et al., 2013).

In a cohort of 957 career firefighters in the Midwest, about 26% displayed high blood glucose (≥100 mg/dL) (Baur et al., 2012). In the study of career male firefighters in Colorado, one percent showed hyperglycemia (Donovan et al., 2009).

C-reactive protein

Although lipoproteins are commonly used to measure risk for CVD, only about half of all myocardial infarctions occur in individuals with high cholesterol, and about one-fifth of the CVD events occur in individuals without any of the major risk factors. Fortunately, there are other plasma biomarkers involved in the atherosclerotic process that can easily be measured and used in risk stratification and prognosis of CVD. One such example is the inflammation marker, C-reactive protein (CRP), a very sensitive, acute-phase reactant (Koenig et al., 1999). High-sensitivity C-reactive protein (hs-CRP) has been shown to be a reliable and accurate measure of inflammation and is expressed in the smooth muscle cells of atherosclerotic arteries. A measurement of chronic low-grade vascular wall inflammation represented by elevated hs-CRP indicates progression and complications of atherosclerosis and is a strong, independent predictor of myocardial infarction, stroke, cardiovascular death and peripheral arterial disease in apparently healthy asymptomatic individuals (Blake & Ridker, 2001). Multivariate analysis showed hs-CRP to be the most powerful predictor of CVD risk over all other inflammatory and lipid markers (Pearson et al., 2003).

CRP is normally present in the serum at a level of less than 2 mg/L in healthy individuals but can increase rapidly in response to infection or inflammatory conditions (Li & Fang, 2004). However, its plasma half-life is only about 19 hours (Koenig, et al., 1999). CRP is produced by hepatocytes and possibly within arterial tissue and regulated by cytokines, including interleukin-7 (IL-6), interleukin-1 (IL-1) and tumor necrosis factor-α (TNF-α) in response to tissue injury, inflammation, and infection (Blake et al., 2001; Koenig et al., 1999). High levels of IL-6 strongly predict subsequent myocardial infarctions, and CRP very strongly correlates with IL-6 as it is the main stimulus for CRP production (Blake et al., 2001). CRP, a ligand-binding protein, binds to the plasma membrane of damaged cells, LDL, and very low density lipoprotein (VLDL) and thus can contribute to atherogenic accumulation (Koenig et al., 1999). CRP can also contribute directly to the proinflammatory state by stimulating the monocyte release of IL-1, IL-6 and TNF-α, stimulating phagocytic cells, and causing endothelial cells to express intercellular adhesion molecule-1 (ICAM-1) and vascular adhesion molecule-1 (VCAM-1) which then regulate the attachment and migration of leukocytes (Blake et al., 2001).

In 2010, the American College of Cardiology Foundation and the AHA updated the recommendation that for asymptomatic intermediate-risk men under age 50 and women under age 60, measurement of CRP may be a reasonable marker of cardiovascular risk (Greenland et al, 2010). When an individual has acute inflammation from an active infection or trauma, hs-CRP levels may exceed 10 mg/L, so values over 10 mg/L should not be included in evaluating CVD risk (Pearson et al., 2003). Values below 1 mg/L are considered low risk, values 1.0 to 3.0 mg/L are considered average relative risk, and a level of hs-CRP greater than 3 mg/L indicates high risk, with the high-risk tertile being associated with a two-fold greater relative risk compared to the low-risk tertile (Pearson et al., 2003).

Several other CVD risk factors are associated with elevated CRP levels. Obesity is associated with high CRP because adipocytes secrete IL-6, which results in increased CRP production. Hypertension, obesity, high triglycerides, low HDL, metabolic syndrome, diabetes and smoking are associated with elevated CRP (Blake et al., 2001; Pearson et al., 2003). However, when CRP levels are elevated, LDL levels may be normal or low, but the risk of CVD is likely still high.

Metabolic Syndrome

Metabolic syndrome is a multicomponent risk factor for cardiovascular disease. Different clinical definitions exist for metabolic syndrome, and estimated rates of prevalence vary based on the criteria used. However, a consistent definition was developed in 2009 that establishes metabolic syndrome to be diagnosed when an individual meets at least three of five risk factors. These risk factors are: HDL below 40 mg/dL for men or below 50 mg/dL for women; waist circumference greater than 102 cm for men or greater than 88 cm for women; fasting plasma glucose of 100 mg/dL or higher; triglyceride levels of 150 mg/dL or higher; and systolic blood pressure of 130 mmHg or higher or diastolic blood pressure of 85 mmHg or higher (Go et al., 2013).

These factors are still considered risks if they are within the limit but being controlled through drug treatment. About 35% of men and 33% of women met the criteria for metabolic syndrome in 1999-2006 (Mozumdar & Liguori, 2010). It is understood that these risk factors work synergistically to increase the risk of CVD. The relative risk of developing CVD when an individual has metabolic syndrome is 1.78 to 2.36 (Go et al., 2013). The combined metabolic syndrome components of elevated blood sugar, central obesity, and hyperglycemia results in the highest risk for CVD and mortality (Go et al., 2013). There are numerous risk factors that have been found to contribute to metabolic syndrome. Some of these risk factors are low levels of physical activity, obesity, weight fluctuations, smoking, consumption of diet and non-diet sodas, skipping breakfast, consumption of carbohydrates, fat, meat, and fried foods, and long-term stress at work (Go et al., 2013). Only about eight percent of individuals with metabolic syndrome have a normal BMI, but overweight men are about six times and obese men are about 32 times more likely to be diagnosed with metabolic syndrome (Haddock et al., 2011).

A cohort of 957 career firefighters with an average age of 39.6 years and BMI of 29.3 kg/m^2 showed a high prevalence (28.3%) of metabolic syndrome (Baur et al., 2012). Although this prevalence is a little lower than the national rate, the average age for this cohort was much lower than the general population and the healthy worker effect was largely missing. This study found that the most common factor contributing to metabolic syndrome for these firefighters was low HDL (41%). A study of 214 male career firefighters in Colorado showed 15% diagnosed with metabolic syndrome, and high blood pressure (55%) was the most prevalent abnormality observed. (Donovan et al., 2009).

Health Behaviors that Affect CVD Risk among Firefighters

Low Levels of Physical Activity

Physical inactivity is considered a major independent risk factor for heart disease. About 12% of the global burden for myocardial infarction is due to physical inactivity after accounting for other CVD risk factors (Go et al., 2013). The AHA identifies 150 or more minutes of moderate-intensity activity or 75 or more minutes of vigorous-intensity activity to be a component of ideal cardiovascular health. In 2010, about 41% of American adults reported meeting this criterion (Go et al., 2013). Infrequent physical activity and inadequate amounts of exercise are commonly reported among firefighters (Durand et al., 2011).

Less than 25% of firefighters reported meeting the AHA physical activity recommendation (Baur et al., 2011). From focus groups, firefighters report workouts at the fire station focusing more on strength training or “bulking up” and not much on building cardiovascular fitness (Jahnke et al., 2012). The National Fire Protection Association notes that the safe performance of firefighting requires individuals to have at least a maximal rate of oxygen consumption (VO_{2max}) of 42 ml/kg/min, or 12 metabolic equivalents of task (METs) (NFPA, 2013). Their recommendation is that if a firefighter tests below 12 METS he/she should be counseled to improve his/her fitness. This is also classified as a “Category A Medical Condition”, meaning that it would prohibit a firefighter from participating in training or emergency environments due to the safety and health risks to him/herself and others (NFPA, 2013). If the aerobic capacity is below 8 METs, the NFPA recommends that the individual is prescribed a required aerobic fitness program and that there are restrictions placed on job tasks that would expose him/her to physical exertion (NFPA, 2013). However, in a cohort study only 44% of firefighters met or exceeded NFPA's minimum cardiorespiratory fitness (CRF) standard, and only 10% exceeded 14 METs (Baur et al., 2011). Among 214 career male firefighters in Colorado, 25% did not meet the NFPA fitness standard, and the average fitness level was 13.2 METS (46.2 ml/kg/min) (Donovan et al., 2009).

Frequency and total physical activity is strongly associated with other CVD risk factors. Physical activity and cardiorespiratory fitness have been shown to lower the risk of CHD, improve body composition, and reduce risk factors for CVD. Fitness also protects against development of atherosclerosis and the effect of acute, exertion-triggering events (Baur et al., 2011). Each one metabolic equivalent (MET) improvement in aerobic capacity is associated with a 15% decrease in cardiovascular disease and 12% decrease in mortality risk (Baur et al., 2012; Go et al., 2013). Physical activity levels are positively associated with levels of HDL and negatively associated with levels of triglycerides and insulin resistance (Durand et al., 2011). Increasing aerobic fitness above the NFPA guideline of 12 METS could lower BMI by 1.6 units, increase HDL by about 5 mg/dL, lower triglycerides by more than 30 mg/dL, and lower blood glucose levels by about 9 mg/dL (Baur et al., 2011). Firefighters with high cardiorespiratory fitness (METS ≥14) have high HDL (about 53.8 mg/dL) and low body fat (16.4%), while firefighters with low fitness (METS ≤10) have low HDL (about 38.6 mg/dL) and high body fat (24.9%) (Baur et al., 2011). In addition, there is a strong inverse correlation between cardiorespiratory fitness and metabolic syndrome (Donovan et al., 2009). For every additional MET of CRF, the risk of metabolic syndrome was reduced by 31% even after adjusting for age (Baur et al., 2012). Physical activity can also reduce inflammatory markers. A six-week training program was shown to reduce CRP levels by about 24% (Go et al., 2013). However, despite low levels of fitness among the majority of firefighters, more than 70% of fire departments still lack programs to promote health and fitness, and most departments do not require exercise or regular medical examinations (Kales et al., 2007). This suggests that this may continue to be a serious issue in the fire service.

Eating Habits

It is believed that up to one-third of coronary disease could be prevented with healthy eating habits (Moe et al., 2002). Obesity is largely attributed to overeating. The estimate for average daily caloric intake for American adult men is about 2500 calories and about 1800 for adult women (Go et al., 2013). However, since energy balance is based on the average calories consumed versus expended, many factors in addition to calorie consumption contribute to energy balance. There can be wide variations in body size, physical activity level, and underlying basal metabolic rate, all of which affect energy needs and expenditure. However, energy balance, or appropriate caloric intake for weight control, is a critical factor in cardiovascular health, so a practical method to determine positive energy balance is adiposity or weight gain (Lloyd-Jones et al., 2010). A positive energy balance is often a result of large portion sizes, increased consumption of fast food, greater television watching, and lower average amounts of sleep (Go et al., 2013).

In addition, the quality of the diet is important as certain foods and beverages have been found to be closely linked to weight gain. Potatoes, white rice and bread, low-fiber breakfast cereals, sugar-sweetened beverages, sweets and desserts, and red and processed meats have all been positively linked to weight gain (Go et al., 2013). Higher consumption of sugar-sweetened beverages has been shown to be associated with increased visceral fat, increased risk of type 2 diabetes, and cardiovascular disease (Go et al., 2013). The Nurses' Health Study showed a 23% increased incidence of CHD with consumption of one serving of sugar-sweetened beverages per day and a 35% increased incidence with two or more servings per day compared to less than one serving per month (Fung et al., 2009). Also, a pooled analysis revealed that for every 5% increase in energy consumption from carbohydrates in exchange for saturated fat, there was a 7% increase in risk for CHD (Jakobsen et al., 2009). A meta-analysis further revealed that an increased consumption of refined complex carbohydrates, sugars and starches was associated with a significantly greater risk of CHD, with the highest category having a 36% higher risk than the lowest category (Dong, Zhang, Wang & Qin, 2012). Increased consumption of sodium has shown a trend toward higher risk of CVD (Go et al., 2013).

On the other hand, fruits, vegetables, nuts, yogurt, and whole grains have been linked to weight loss (Go et al., 2013). Meta-analyses revealed that for every daily serving of fruits or vegetables there was a 4% lower risk of CHD (Go et al., 2013). In addition, there was a 21% lower risk for CVD events with consumption of 2.5 servings per day of whole grains compared to 0.2 servings (Go et al., 2013). Increased consumption of fruits, vegetables and whole grains can contribute to satiety which can have a positive effect on energy balance (Lloyd-Jones et al., 2010). Nut consumption has been shown to improve blood lipid levels, with about 67 grams per day reducing total cholesterol by about five percent, reducing LDL by about 7%, and reducing triglyceride levels by about 10% (Go et al., 2013).

Although there are multiple factors that contribute to the powerful effect of diet on cardiovascular health, the American Heart Association carefully selected five dietary goals that have the strongest evidence for having causal effects on cardiovascular events, obesity, and/or diabetes (Lloyd-Jones et al., 2010). Based on a 2000 kcal diet, their recommendation is to consume at least 4.5 cups of fruits and vegetables per day, at least two 3.5-ounce servings of fish per week, at least three 1-ounce equivalent servings of fiber-rich whole grains per day, less than 1500 mg of sodium per day, and no more than 450 kcals (36 oz) of sugar-sweetened beverages per week (Lloyd-Jones et al., 2010). However, in 2010, less than one percent of Americans reported meeting at least four of five health dietary goals. Only about 12% met the goals for fruits and vegetables, 18% for fish, 7% for whole grains, less than 1% for sodium, 52% for sugar-sweetened beverages (Go et al., 2013). Among American adults, the average daily consumption of whole grains was 1.1 servings, fruits was 1.2-1.9, and vegetables was 1.3-2.2 servings. The average weekly consumption of sugar-sweetened beverages was 6-12 per week (Go et al., 2013). In 2010, American adults consumed on average 151 kilocalories per day of sugar-sweetened beverages (Go et al., 2013). The AHA also named secondary dietary metrics that would support cardiovascular health. These are consuming at least four servings of nuts, legumes and seeds per week, consuming no more than two servings of processed meats per week, and limiting saturated fat to less than 7% of total energy intake without compensating by increasing consumption of refined carbohydrates (Lloyd-Jones et al., 2010).

With a larger number of firefighters being considered overweight or obese, it is likely that overeating and/or poor food choices are issues that affect this population. A common schedule for professional firefighters is ten 24-hour work shifts per month, so about one-third of their days are spent on-duty, and about one-third of their meals are eaten at work. While on duty, firefighters generally eat together, so individual eating habits may largely depend on the fire station.

Reasons for Health Behaviors

Encouraging dietary change in the fire service depends on first developing a better understanding of the factors that govern food choice and eating habits. For all individuals, there are multiple factors that influence their decisions about the foods they eat and their level of physical activity; however, there may be some common variables among individuals belonging to this profession based on the nature of the job.

Volume of Emergency-Response Dispatch Calls

Not much research has yet been performed on the effect of call volume on CVD risk factors and health behaviors. Fire departments are receiving many fewer calls than in the past. Just from 1990 to 2010, the national percent of calls that were fire-related dropped from 14.7% to 4.7% (Dobson et al., 2013). It has been noted that over the years there are less calls for responding to fires and more calls for emergency medical response, which is not as physically demanding as firefighting. This indicates a probable reduction of work-related physical activity possibly increasing the energy imbalance and also augmenting the emotional demands and stress (Choi et al., 2011).

Also, firefighters of all ranks reported significant amounts of sedentary work, such as for computer-based training (Dobson et al., 2013).

Call volume may affect physical activity and sleep habits, which both influence CVD risk. Call volume can affect sleep habits by limiting uninterrupted hours of sleep. Eating patterns and physical activity may be negatively impacted by sleep deprivation and irregular meal times due to call volume (Haddock et al., 2011). Sleepiness and sleep disturbance have been correlated to increased weight gain (Poston, Jitnarin, Haddock, Jahnke & Tuley, 2012). Furthermore, firefighters reported snacking more at night to cope with fatigue and using energy drinks to stay alert during the day (Dobson et al., 2013).

Dietary habits may be negatively affected by the unpredictable nature of emergency work that often impinges on meal time and makes “fast-food” the easiest option (Soteriades et al., 2011). In addition, firefighters have reported feeling like they need to eat when they can and that meal preparation usually needs to be quick and easy because of the possibility of a call interruption or being busy (Dobson et al., 2013; Haddock et al., 2011).

Choi et al. (2011) indicated a difference in obesity between fire stations but did not provide information on the basis of these claims. They suggest that fire stations that are “slow”, or receive a lower number of calls, are more likely to have obese firefighters likely because of a reduction in work-related physical activity and a more sedentary work shift. However, they thought that extremely busy stations could also result in an increased obesity risk because of the added work stress and unhealthy behaviors that may be connected with the high call volume. Firefighters at very busy stations would typically be likely to eat fast because they were always anticipating being interrupted by a call (Choi et al., 2011). Through their focus group and during “ride-alongs”, Choi et al. (2011) noted that substantial variations in working conditions exist among firefighters. Call volume is a variable that may differ greatly among fire stations and may have an impact on health behaviors and the extent of physical and physiological work demands on the firefighters involved.

Firehouse Environment

Haddock et al. (2011) reported on the epidemic of obesity in the fire service. This report named major factors that contribute to obesity with the top two being the nutrition environment in the firehouse and a diet high in processed carbohydrates and sugar. Interview and focus groups that were part of a nationwide qualitative study provided information on the firehouse nutrition environment. Some firefighters reported eating better at the fire station because of more thoughtful meal planning and positive impact of crew level decisions to eat healthy, while others reported eating really unhealthy meals at work (Haddock et al., 2011). Firefighters reported significant nutrition-related issues that likely influence weight gain and obesity. One issue discussed is the tradition of unhealthy foods; they referred to a “firehouse culture” that involves recipes high in fat, processed carbohydrates and sugars (Poston, et al., 2012). A commonly discussed topic was large portion sizes especially of foods high in carbohydrates and sugar (Haddock et al., 2011). Sometimes firefighters indicated this is due to the tradition of feeling a need to fuel up in anticipation of needing energy to respond to a call, although the call volume is much lower than in the past (Dobson et al., 2013). Others reported that more healthy meals were being prepared, but there were still issues with eating too much (Jahnke et al., 2012). Focus groups were also held for firefighters of Orange County Fire Authority, and firefighters, engineers, captains and battalion chiefs named the fire station eating culture as the prominent cause of firefighter obesity (Dobson et al., 2013). The focus groups reported that the eating culture involved family-style meals meant to fill people up, eating out, high caloric snacking, and eating large quantities of foods. This qualitative research indicated that food choices first focused on meat and carbohydrates, and always desserts, and then possibly some vegetables (Dobson et al., 2013).

Firehouse food traditions reportedly often involve providing dessert food as a "punishment" for mistakes, poor performance, accidents, or for being recognized in public (Haddock et al., 2011; Poston et al., 2012). Firefighters also report there may be an abundance of unhealthy snacks available during downtime and that community members with good intentions offer gifts of treats and desserts (Frattaroli et al., 2012; Haddock et al., 2011). Unhealthy snacks present a frequent external stimulus to eat.

Social Cohesion and Group Norms

Firefighting involves a unique work structure. Firefighters at a station are part of a platoon, or a team, that commonly works about ten 24-hour shifts per month. They generally work together, eat together and sleep together throughout shift. In a study on the power of social influence over food intake, researchers noted that people commonly adjust their food intake directly to those with whom they are eating. In this way, the eating behavior of others acts as an external cue that stimulates food intake (Hermans et al., 2012). By eating as much or as little as those around them, people are consciously or subconsciously following socially derived norms. People tend to adhere to social norms and match behavior in attempt to increase social approval, to be liked, to facilitate social interaction and to enhance perceived similarity (Robinson, Tobias, Shaw, Freeman & Higgs, 2001). The Social-Cognitive Theory holds the belief that there are reciprocal interactions between a person's behavior, cognition and environmental influences, such as peer norms and vicarious observations (Elliot et al., 2007). People typically seem to eat larger amounts of food when in the presences of others than when they are alone (Pliner & Mann, 2004). People also tend to eat more around people with whom they are familiar than around strangers, and males eat more around other male friends (Salvy, Jarrin, Paluch, Irfan & Pliner, 2007). Overweight and obese people tend to show increased attention to food-related stimuli and are thus generally more vulnerable to food cues (Hermans et al., 2012). Social matching of food intake is a significant issue since many meals are eaten in social contexts, so obesity tends to spread across social networks (Robinson et al., 2001). Christakis and Fowler (2007) further showed that friends of the same sex and those who are more similar have greater influence on an individual's weight gain. This suggests that the influence of the social network among firefighters could be strong due to the fire service being composed mostly of males and having common characteristics for their profession. The way the social influence may be spread is through a feeling of overweight being acceptable thus affecting health behaviors (Christakis & Fowler, 2007).

Working together in a crew likely results in social cohesion (Carey et al., 2011). The PHLAME (Promoting Health Lifestyles: Alternative Models' Effect) study considered firefighters working together to display the characteristics of a team, based on shared activities, interdependence between members, similar responsibilities, successes and rewards and ongoing contact (Moe et al., 2002). In focus groups, firefighters reported nutrition-related issues that relate to social cohesion and group norms (Haddock et al., 2011). Firefighters view the meals together as a time of bonding, camaraderie, and a way to monitor the current interpersonal relationships (Haddock et al., 2011). Some firefighters reported that suggesting healthier alternatives or refusing to eat with everyone is viewed as not wanting to be a part of the crew (Haddock et al., 2011). New recruits report being trained to prepare filling meals and carry on the firehouse tradition and also to overeat to “prove” themselves and earn respect (Dobson et al., 2013). In the case of firefighters, poor eating habits and excess weight may be more prevalent within a unit, starting with a few individuals and proliferating through social cohesion.

On the other hand, a supportive health environment would be beneficial in promoting healthy behaviors and weight management among firefighters (Choi et al., 2011). Firefighters have given feedback that sometimes fire stations have trends toward healthier eating (Haddock et al., 2011).

Affect Regulation

Excessive eating, explained by the psychosomatic theory, is attributed to confusion between the internal emotional state and hunger and is probably based on early learning experiences. Emotional eating can be in attempt to alleviate or soothe emotions or in response to clearly labeled emotions (van Strien, Frijters, Bergers & Defares, 1986). Often, emotional eating interacts with “external eating”, as explained by the externality theory. According to this theory, people eat simply in response to food-related stimuli regardless of a state of hunger or satiety (van Strien et al., 1986). There is a positive relationship between the emotional eating scales and the external eating scales, meaning that emotional cues and visual cues can operate together to evoke an eating response (van Strien et al., 1986). In some studies, firefighters have reported a high level of physical, psychological and emotional stress (Frattaroli et al., 2012; Kales et al., 2007). The combination of emotional factors and external stimuli (availability of snacks) suggest that excessive eating could be a great concern for this population. However, reports on the focus group discussions do not mention issues of affect regulation on dietary habits so this may not be a significant issue currently in the fire service.

Price

In firehouses, meals are shared and because meals have to fit within a budget, reducing cost often leads to less healthy choices. In many stations, crew members contribute an amount of money toward two group meals per shift. Firefighters find it challenging to plan meals within the limited budget and report feeling a need to choose quantity over quality (Haddock et al., 2011). Focus groups reported looking for things on sale and choosing foods that are inexpensive and make people feel full. Vegetables were reportedly purchased only if money allowed (Dobson et al., 2013).

Leadership

Leadership is an important component of the fire service culture. The battalion chief and fire captains have crucial roles and influences among the firefighters. Choi et al. (2011) speculate that supportive leadership allows firefighters to experience less stress and to be more likely to maintain healthy behaviors. The health behavior of the group may be strongly affected by the leadership. The captain typically sets the tone, establishes the value placed on exercise and diet, sets the work schedule, and leads by example (Dobson et al, 2013). However, firefighters who participated in a focus group indicated that leaders should support but not mandate a health initiative (Frattaroli et al., 2012).

Other Motivations

It is likely that there are many factors that contribute to the health behaviors of firefighters. Research and focus groups have indicated that call volume, the firehouse environment, social norms, emotional stress, price, and leadership are variables that may commonly influence the eating and exercising behaviors among firefighters. However, these variables may affect different individuals to greater or lesser extents, and there may be additional factors that are also influencing healthy or unhealthy behaviors.

This research will also consider the influence of other factors that have been reported in the literature to affect an individual's eating behaviors. Factors that have been found to impact food choices include but are not limited to health, availability/access, cultural influences, social interaction, social status, taste or sensory appeal, likes and dislikes, habit and familiarity, weight control, environmental awareness, and stress and negative emotions. One food choice questionnaire showed the following order of motives for food choice from the most to least important: sensory appeal, health, convenience, price, natural content, weight control, mood, familiarity and finally ethical concern (Steptoe, Pollard, & Wardle, 1995). The Eating Motivations Survey assessed 15 triggers for eating with the average from 1,040 participants expressing the following rating from most to least often triggering eating: liking, habits, need and hunger, health, convenience, pleasure, traditional eating, natural concerns, sociability, price, visual appeal, weight control, affect regulation, social norms, and social image (Renner, Sproesser, Strohbach, and Schupp, 2013). It is likely that all of these motivations for eating affect firefighters as well, but the degree of importance that is placed on each may differ for this group based on factors associated with their unique work environment and by the individual's health status.

CHAPTER III

METHODS AND PROCEDURES

Prior to the recruitment of subjects, authorization was obtained from the Human Subjects Committee at Colorado State University. The study used data that was collected from professional firefighters who participated in the Heart Disease Prevention Program (HDPP) through the Human Performance Clinical/Research Laboratory (HPCRL) at Colorado State University. Firefighters participating in the program provided informed consent to allow data collected during testing to be used for research purposes (Appendix A).

Subject Selection

All firefighters who participated in the HDPP were free of diagnosed CVD and contraindications to exercise testing prior to all tests. In January and February 2014, firefighters who reported for testing were invited to participate in this study. In addition, twenty-five Colorado fire departments were contacted with an invitation to participate in the study. The eight departments that were interested were provided with study invitations and materials for their full-time professional firefighters (Appendix B). The following departments participated: Cañon City Area Fire Protection District, Lake Dillon Fire Rescue, Loveland Fire Rescue Authority, Poudre Fire Authority, Salida Fire Protection District, Vail Fire Department, Wellington Fire Protection District, and Westminster Fire Department. Participation by individual firefighters was voluntary and not compensated, and willing participants provided informed consent to participate in the study (Appendix C).

None of the individuals who volunteered to participate had serum CRP concentrations ≥ 10.0 mg/L so there were no exclusions based on values that more likely represented other inflammatory responses. Any individuals with missing data were excluded from analyses that required that data. Individuals with unrealistic diet data, such as a daily intake value of zero for fiber or a zero in multiple categories, were excluded from any analysis of diet. Only results from evaluations with the HDPP that had been collected within the past year were used for this research. Subjects included 82 individuals who completed the questionnaire about health behavior motivations, 42 of which also had a valid HDPP evaluation, 30 of which also had valid diet records, and 46 firefighters who completed a web-based dietary screener.

Procedures

Existing HDPP Procedures

As part of the evaluation in the HPCRL, firefighters complete a medical history questionnaire that provides demographic characteristics, personal and family history of chronic diseases, medication use, and alcohol and tobacco history by self-report. They also complete a four-day nutrition log including two shift days and two off days. Each diet record was analyzed using Axxya Systems Nutritionist Pro™ to determine average consumption per day of kilocalories, protein, carbohydrates, fat, sodium, dietary fiber, and sugar.

Before reporting to the HPCRL, each firefighter has a fasting blood sample drawn by venipuncture of an antecubital vein for blood chemistry analysis at an off-site contract laboratory. The analyses include hs-CRP, total cholesterol, triglycerides, HDL cholesterol and glucose assessed from unfrozen plasma samples using a Beckman

Coulter DxC 800 Synchron© Clinical System (Beckman Coulter, Inc., Fullerton, CA). For subjects with serum TG levels below 400 mg/dL, LDL-C concentration was calculated using the Friedewald equation: LDL-C = TC – [HDL-C + (TG/5)]. CRP concentrations were measured using a high-sensitivity, enzyme-linked, immunometric latex-enhanced assay. Blood chemistry results were then faxed to the HPCRL.

Height and weight were measured using a standard physician's scale and stadiometer, and body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared. Waist circumference was measured to the nearest quarter inch at the level of the umbilicus using a spring-loaded Gulick tape measure (Lafayette Instruments, Lafayette, IN). All measurements were taken twice, and the mean of the readings was calculated and recorded. Body composition was determined by using hydrodensitometry, and body density was calculated as described by Katch (1960) and percent fat was calculated using the Siri equation (1956). Residual lung volume was measured using the nitrogen dilution method (Saha, 1965) and factored into the calculation of percent body fat (MedGraphics, St. Paul, MN).

Systolic and diastolic blood pressure was measured according to standard protocol using a mercury sphygmomanometer with a constant deflation valve (Trimline Medical, Branchburn, NJ) (Chobanian et al., 2003). Blood pressure was taken with the subject is in a seated position prior to beginning the graded exercise test (GXT).

To assess cardiorespiratory fitness, a maximal graded exercise test (GXT) was performed on each firefighter using a Bruce protocol on a motor-driven treadmill. After a physical examination by the supervising physician, each subject was given detailed instructions regarding the testing procedure. The tests were run by trained testing technicians. A 12-lead electrocardiogram (ECG) was used to monitor the subject's heart rhythm and rate during the test. Exercising blood pressure and rating of perceived exertion (RPE) using the Borg scale were recorded every three minutes, and heart rate was recorded every minute by a trained technician (Borg, 1982). Subjects continued until volitional fatigue or until the test was terminated by the physician. After achieving maximal exercise capacity, the subject performed a five minute active cool-down by walking at a self-selected pace while heart rate and blood pressure were measured every minute. A final blood pressure and heart rate were taken after the subject sat in a chair for one minute. The supervising physician assessed the subjects' resting, exercise, and maximal ECG tracings for any indication of ischemia or other heart-related disorders. Any subject with a positive or nondiagnostic GXT was referred for further diagnostic testing and taken off-duty until medically cleared. The predicted maximal rate of oxygen consumption (VO_2max) was then calculated based on total GXT time using the formula: VO_2max (ml/kg/min) = 6.7 – 2.82 x (1 for men or 2 for women) + 0.056 x (duration of GXT in seconds). Cardiorespiratory fitness was converted to maximal metabolic equivalents (METS) (1.0 MET = 3.5 ml/kg/min). The final treadmill time from the Bruce protocol was converted to an estimated Balke treadmill time for use with the Cooper Clinic Coronary Risk Profile worksheet.

The ACCF/AHA strongly recommends using global risk scores that combine multiple traditional cardiovascular risk factors (Greenland et al., 2010). They explain that risk should be evaluated by calculating a single quantitative estimate of risk in all asymptomatic adults as there has been evidence from studies on the effectiveness of predicting risk in this way. For this study, a cardiovascular risk score was calculated for each subject using an adapted version of the Cooper Clinic Coronary Risk Profile worksheet (example shown in Appendix D) Risk was calculated based on the subject's Balke treadmill time, TC:HDL ratio, TG level, glucose level, percent body fat, systolic and diastolic blood pressure, personal history of heart attack, family history of heart attack, smoking habits, level of tension-anxiety, diagnosis of diabetes, age, and presence of resting and exercise ECG abnormalities. Each of these fifteen risk factors was associated with a score of zero to ten in some cases. The sum of these risk factors was used to determine the subject's total coronary risk in the following categories: very low (0-4), low (5-12), moderate (13-21), high (22-31), and very high (32+).

Only the results of HDPP evaluations from 2013 and 2014 were included in this study and only from the firefighters who also completed the study-specific procedures (N=42). These firefighters had all provided consent for their HDPP data to be used for research.

Study-Specific Procedures

Firefighters participating in the HDPP during the data collection period or employed with the participating departments were offered a consent form (Appendix C), a Motivations for Health Behaviors Questionnaire (Appendix E), and instructions for completing a web-based food frequency questionnaire.

On the Motivations for Health Behaviors Questionnaire, firefighters self-reported their current height, weight, and age. They also indicated at what department and station they were currently employed, and the length of time they had been there. Then they rated statements on why they ate what they ate with answers given on a 7-point rating scale from 1 'seldom' to 7 'usually'. This portion of the questionnaire was based on the brief version of The Eating Motivations Survey Questions (Renner et al., 2012). The 34 statements included eating motivations related to liking, habits, need & hunger, health, convenience, pleasure, sociability, price, weight control, affect regulation, and social norms. The next portion of the questionnaire asked firefighters to rate various statements about their eating and exercising habits and motivations with answers given on a seven-point scale from 1 ‘strongly disagree’ to 7 ‘strongly agree’.

Firefighters were also asked to complete the web-based version of the National Cancer Institute’s (NCI) Dietary Screener Questionnaire (DSQ). The DSQ collects data on the intake of fruits and vegetables, dairy, whole grains/fiber, red meat, processed meat and added sugars over the past month. The DSQ is a shortened version of the NCI’s cognitively-based Diet History Questionnaire (DHQ) that has been found to be as good as or better than the Block and the Willet food frequency questionnaires when compared to multiple 24-hour recalls (Subar et al., 2001). Instructions on completion of the questionnaire were provided to each firefighter (Appendix F). Each firefighter was given two unique IDs and passwords to complete the questionnaire on-line. Using the respondent ID of “WORK###”, the firefighters answered the questions about their past month diet while on-duty, and using their respondent ID of “HOME###”, questions were answered based on diet while off-duty. The DSQ allowed predictions of the consumption of grams of fiber per day, teaspoons of sugars per day, ounce equivalents of whole grains per day, cup equivalents of fruits and vegetables per day, and teaspoons of sugar-sweetened beverages per day.

Each fire entity was asked to provide records on the total number of emergency-response dispatch calls for 2013 for each participating station. The “busyness” of the firefighters at each station was determined by the number of calls run.

Statistical Analysis

All statistical analyses were performed using Statistical Package for Social Science Software (SPSS) (IBM SPSS version 22, Somers, NY). Responses to the Dietary Screener Questionnaire (DSQ) were evaluated using Statistical Analysis System (SAS) (version 5.1, Cary, NC) and the scoring algorithms that were developed for each component of the DSQ. Results were then exported to SPSS. Statistical significance was set at p values < 0.05. Mean descriptive characteristics were presented as means, standard deviations, ranges, frequencies, and valid percentages. Pearson’s Bivariate correlation analyses were performed to determine association between health behaviors and CVD risk factors (1^{st} hypothesis), call volume and CVD risk factors and health behaviors (2^{nd} hypothesis), and motivation responses and health behaviors (3^{rd} hypothesis). Paired student’s “t” tests were utilized to compare results between on-duty and off-duty, and unpaired student’s “t” tests compared results between groups based on the median age of 41 years, sex, and obesity status (BMI≥30 kg/m^2 vs. BMI<30 kg/m^2).

CHAPTER IV

RESULTS

The final analysis included 82 professional firefighters representing eight fire departments and 20 fire stations in Colorado. The majority of the firefighters were male (92.5%). They represented various positions: 51.3% were firefighters, 14.6% were engineers, 13.4% were lieutenants, 14.6% were captains, and 6.1% fit into other categories. Table 1 shows the descriptive characteristics of these firefighters.

Table 1: Descriptive characteristics of firefighters

	N	Mean	Std Dev	Range
Age (years)	80	41.0	8.7	23-59
Time at current station (years)	74	5.7	6.6	0.1-34
Self-reported BMI (kg/m^2)	80	26.7	3.8	18.9-43.1

Due to the limited number of subjects, individuals were not completely excluded for missing data; however, subjects were only included in certain analyses if the required data was available. Of the 82 firefighters, 42 (95.2% males) had undergone an evaluation as part of the HDPP within the past year so the results of their blood analysis and fitness testing were included in the analysis. Tables 2 and 3 show the mean, standard deviation, range and frequency of clinical characteristics in the participants.

Table 2: Clinical characteristics of firefighters (n=42)

	Mean	Std. Dev.	Minimum	Maximum
Age (years)	41.0	9.7	23	59
Self-reported BMI (kg/m^2)	26.4	3.6	19.5	35.9
Measured BMI (kg/m^2)	26.8	3.4	20.3	33.8
Body fat percentage	21.5	6.1	7.53	32.2
Waist circumference (in)	36.1	3.6	28.4	44.8
Cardiorespiratory fitness (METS)	13.6	2.0	9.9	19.4
Systolic blood pressure (mmHg)	121.7	11.1	100	142
Diastolic blood pressure (mmHg)	76.4	9.8	58	110
Total cholesterol (mg/dL)	179.9	33.8	104	265
HDL (mg/dL)	46.5	9.19	27	67
Triglycerides (mg/dL)	109.5	69.8	39	394

Glucose (mg/dL)	89.1	7.9	76	113
C-reactive protein (mg/L)	1.47	1.8	<0.2	8.33
Coronary risk score	6.6	4.4	1	20

Table 3: Frequencies of clinical characteristics of the study population

	Frequency	Percent
Cardiorespiratory Fitness		
<12 METS	8	19.0
12-14 METS	17	40.5
>14 METS	17	40.5
Systolic Blood Pressure		
≥140 mmHg	4	9.5
130-139 mmHg	9	21.4
120-129 mmHg	11	26.2
<120 mmHg	18	42.8
Diastolic Blood Pressure		
≥ 90 mmHg	3	7.1
85-89 mmHg	3	7.1
80-84 mmHg	12	28.6
<80 mmHg	24	57.1
Coronary Risk		
Moderate (13-21)	4	9.5
Low (5-12)	24	57.1
Very low (0-4)	14	33.3
Glucose		
≥ 100 mg/dL	2	4.8
< 100 mg/dL	40	95.2
Cholesterol		
≥200 mg/dL	10	23.8
< 200 mg/dL	32	76.2
HDL-C		
< 40 mg/dL	10	23.8
≥ 40 mg/dL	32	76.2
Triglycerides		
≥ 150 mg/dL	8	19.0
< 150 mg/dL	34	81.0
C-reactive protein		
> 3 mg/L	5	11.9
1-3 mg/L	11	26.2
< 1 mg/L	26	61.9
Body Mass Index		
≥ 30 kg/m^2	10	23.8
25-29.9 kg/m^2	20	47.6
< 25 kg/m^2	12	28.6
Body fat percentage		
>25%	13	31.0
22-25%	6	14.2
≤ 22%	23	54.8
Waist circumference		
> 102 cm	5	11.9
95-102 cm	11	26.2
<95 cm	26	61.9
Metabolic syndrome*	1	2.4

*Results only include participants not having risk factors controlled through drug treatment as information on medication was not collected.

Hypothesis 1: Poor health behaviors (diet and physical activity) are positively correlated to increases in CVD risk factors.

Of the 42 individuals who completed a fitness evaluation in the past year, 30 (93.3% males, mean age 41.8 years) provided a complete diet record based on two shift days and two off days (see Table 4). The on-duty diet showed an increased consumption for each component of the diet, but differences were not significant.

Table 4: Average daily consumption based on diet logs (N=30)

	Work mean (SD)	Work range	Home mean (SD)	Home range
Calories (kcal)	2617.3 (764.8)	1345.7-4429.0	2463.5 (841.0)	1244.4-5001.7
Protein (g)	116.0 (43.3)	50.9-257.7	112.8 (41.2)	55.5-219.3
Protein g/kg body weight	1.39 (.57)	.66-3.20	1.32 (.44)	.68-2.73
Carbohydrates (g)	307.0 (120.0)	146.0-620.6	275.8 (126.0)	96.4-672.3
Fat (g)	111.6 (49.0)	28.1-208.7	97.3 (36.0)	32.3-160.9
Sodium (mg)	3895.0 (1490.5)	348.4-6954.5	3712.6 (1506.0)	844.5-7403.7
Fiber (g)	28.0 (10.9)	9.2-64.9	24.0 (11.5)	8.2-50.7
Fiber g/1,000 kcals	10.91 (3.19)	5.65-17.61	10.05 (4.30)	3.46-21.69
Sugar (g)	108.8 (48.8)	30.1-223.1	99.5 (52.2)	31.0-230.7

Correlations between these diet reports and CVD risk factors were analyzed (See Table 5). Protein consumption (grams per kilogram of body weight) showed a significant negative correlation with body fat percentage and waist circumference and a positive correlation with HDL ($p<.05$). Sodium intake showed a significant positive correlation with systolic blood pressure ($p<.05$).

Table 5: Correlations between diet and CVD risk factors (N=30)

	Calories	Protein[a]	Carbs	Fat	Sodium	Fiber[b]	Sugar
BMI	-.016	-.263	-.161	.161	.105	.209	-.335
% body fat	-.191	-.397*	-.087	-.195	-.131	.134	-.212
Waist circumference	-.023	-.368*	-.092	.024	.026	.021	-.183
Cholesterol	.212	-.191	.282	.068	.117	-.250	.207
HDL	.129	.364*	-.128	.261	-.001	-.341	-.022
CRF	.057	.231	-.078	.194	-.117	.172	-.049
SBP	.115	.062	-.028	.275	.363*	-.110	-.144
DBP	.189	-.043	.096	.261	.155	.077	.079
Coronary Risk	-.035	-.312	.008	-.124	.004	-.037	-.017
Glucose	-.229	-.128	-.174	-.223	-.259	-.068	-.239
TG	.096	-.208	.163	-.072	.098	-.095	.084
CRP	-.215	-.266	-.139	-.236	-.274	.163	-.116

[a] Protein in grams/kg of body weight [b] Fiber in grams/1,000 kcals
* p<.05

The percent of calories being consumed per macronutrient was computed for each individual using the Atwater Factors, estimating 9 kcal/g of fat and 4 kcal/g of carbohydrates and protein (Otten, Hellwig & Meyers, 2006). On-duty and off-duty average percentages along with the home/work combined average and range for percent of kilocalories consumed of protein, carbohydrates and fat are shown in Table 6. While there were some differences noted between the on-duty and off-duty balance of macronutrients (as shown in Figure 1), the differences were not significant.

Table 6: Mean (SD) of percent of calories consumed per macronutrient (N=30)

	On-duty	Off-duty	p-value	Averaged	Range
Protein (%)	18.0 (4.6)	19.1 (6.3)	.370	18.5 (4.5)	10.1-30.6
Carbohydrates (%)	47.9 (16.6)	44.2 (8.7)	.234	46.0 (10.2)	20.0-78.6
Fat (%)	37.5 (9.3)	35.6 (7.8)	.370	36.5 (6.3)	24.1-50.3

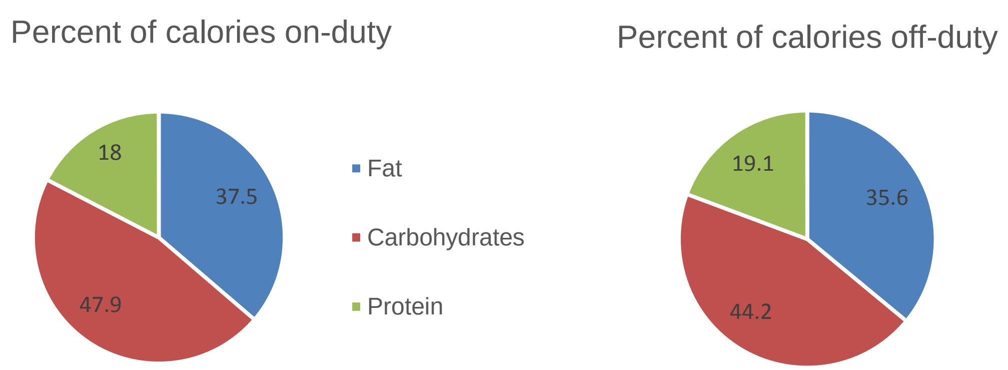

Figure 1: Percent of calories consumed per macronutrient while on-duty and off-duty (N=30)

Correlation between the percent of daily calories from each macronutrient and CVD risk factors was analyzed (See Table 7). An increase in carbohydrates was significantly correlated with a decrease in HDL ($p<.05$).

Table 7: Correlation between percent of macronutrient and CVD risk factors (n=30)

	Protein	Fat	Carbohydrates
SBP	-.034	.289	-.110
DBP	-.141	.135	-.063
Cholesterol	-.260	-.095	.189
HDL-C	.087	.323	-.368*
TG	-.040	-.222	.123

CRP	-.054	-.216	.070
BMI	.231	.352	-.260
% body fat	.026	-.079	.086
Waist circumference	.185	.104	-.159

* p<.05

Every component of diet showed a mean absolute increase for the on-duty diet record over that reported while off-duty. Therefore, further analysis was performed on the percentage increase of each diet component for each individual in the total sample and for BMI subsamples (see Table 8). Individuals categorized as obese had reported consuming significantly *lower* amounts of calories (p=.031), protein (p=.015), and fiber (p=.021) while on-duty than off-duty.

Table 8: Mean (SD) percent increase in diet while on-duty

	Overall	BMI ≥30	BMI <30	p value
Calories (%)	12.35 (32.84)	-8.77 (32.25)	20.02 (30.19)	.031
Protein (%)	8.39 (36.47)	-17.80 (24.89)	17.91 (35.69)	.015
Carbohydrates (%)	22.32 (45.69)	-2.54 (39.98)	31.36 (45.04)	.071
Fat (%)	26.58 (62.49)	5.11 (53.21)	34.39 (64.88)	.264
Sodium (%)	27.98 (81.92)	-4.95 (85.30)	39.95 (79.23)	.189
Fiber (%)	32.28 (52.83)	-3.76 (46.86)	45.39 (49.47)	.021
Sugar (%)	18.83 (43.55)	14.17 (32.49)	20.53 (47.49)	.730

* N=30 for the overall sample; n=8 participants with BMI of 30 kg/m^2 or higher, n=22 participants with BMI lower than 30 kg/m^2

In addition, 46 firefighters completed the on-line Dietary Screener Questionnaire (93.5% males, mean age 41.4 years). The data analysis assumes participants are at home twice as many days per month as they are at work, being that a typical work schedule is ten 24-hour days per month; the results are weighted accordingly. Table 9 shows the results of the dietary screener analysis for mean diet on-duty, off-duty, and a combined average of on- and off-duty for each dietary component. Correlation was found between reported consumption of fruits/vegetables/legumes (FVL) and whole grains (p<.01) and between added sugar and added sugar from sugar-sweetened beverages (p<.001) (data not shown).

Table 9: Average daily consumption on-duty and off-duty based on the Dietary Screener Questionnaire (N=46)

	On-duty Mean(SD)	On-duty Range	Off-duty Mean(SD)	Off-duty Range	Combined Mean (SD)
Whole grain (ounce equivalents)	3.86 (4.10)	0.07-20.01	1.31 (1.43)	0.07-6.78	2.16 (2.17)
Fruits/Vegetables/Legumes (minus fries) (cups)	4.92 (1.49)	2.11-8.67	3.58 (1.18)	1.46-7.00	4.03 (1.20)
Added sugar (tsp)	23.01 (10.7)	0.75-43.37	14.56 (7.92)	0.75-38.04	17.38 (8.29)
Added sugar from sugar-sweetened beverages (tsp)	10.38 (9.28)	0.00-34.78	5.52 (6.00)	0.00-26.71	7.14 (6.73)

Table 10 shows correlations between the diet components and risk factors for cardiovascular disease. Significant correlation was found between increased body fat percentage and added sugar and added sugar from sugar-sweetened beverages (p<.05). Added sugar was also positively correlated with coronary risk and triglycerides (p<.05). The home/work combined diet was then further analyzed by subgroups of BMI and age (Tables 11). Obese individuals (BMI ≥ 30 kg/m^2) consumed significantly more added sugar and added sugar from sugar-sweetened beverages (p=.02 and p=.001).

Table 10: Correlations between diet components and CVD risk factors (N=18)

	FVL	Whole Grains	SSB	Added sugar
BMI	0.21	0.38	0.18	0.12
% body fat	-0.19	0.28	0.54*	0.47*
Waist circumference	0.26	0.33	0.22	0.24
Cholesterol	0.37	-0.09	0.22	0.21
HDL	-0.17	-0.48*	-0.30	-0.45
Cardiorespiratory fitness	-0.22	0.28	-0.30	-0.33
SBP	-0.15	-0.36	0.18	0.13
DBP	-0.07	-0.24	-0.28	-0.20
Coronary risk	0.17	0.16	0.46	0.48*
Glucose	-0.05	0.11	0.01	-0.01
TG	0.17	0.12	0.37	0.51*
CRP	0.36	0.19	0.04	0.23

FVL = fruits/vegetables/legumes SSB = added sugar from sugar-sweetened beverages
* p < .05

Table 11: Average daily consumption for subsamples

	BMI ≥30*	BMI <30*	p value	≥41 yrs*	<41 yrs*	p value
Whole grain (ounce equivalents)	1.74 (1.39)	2.30 (2.36)	.61	2.57 (2.60)	1.68 (1.43)	.166
Fruits/Vegetables/Legumes (minus fries) (cups)	3.67 (1.45)	4.12 (1.24)	.46	4.40 (1.35)	3.58 (.83)	.021
Added sugar (tsp)	24.37 (10.0)	15.61 (6.70)	.02	16.50 (7.58)	18.42 (9.15)	.441
Added sugar from sugar-sweetened beverages (tsp)	15.04 (8.48)	5.56 (5.11)	.001	6.08 (4.90)	8.41 (8.37)	.246

* n=5 participants with BMI of 30 kg/m^2 or higher, n=33 participants with BMI lower than 30 kg/m^2, n=25 participants ≥41 years of age, n=21 participants <41 years of age

Participants responded whether they meet the AHA guideline of at least 150-minutes of moderate physical activity per week on the scale of 7 (strongly agree) to 1 (strongly disagree). The mean score was 5.49 (1.61). Sixteen percent of participants responded that they do not meet the recommendations for physical activity, 15% neither agreed nor disagreed, 26% somewhat agreed that they meet the recommendations, and 43% strongly agreed that they meet the physical activity guidelines. Table 12 shows correlation between the score on meeting physical activity guidelines and CVD risk factors for all participants who underwent a fitness evaluation. Significant negative correlation was shown for systolic blood pressure (p=.040).

Table 12: Correlation between meeting physical activity guidelines and CVD risk factors (N=42)

	Correlation	p value
BMI	.117	.462
% body fat	.021	.893
Waist circumference	-.005	.975
Cholesterol	.267	.083
HDL	.198	.204
Cardiorespiratory fitness (METS)	.085	.593
SBP	-.319	.040
DBP	-.154	.330
Coronary risk	-.014	.931
Glucose	.084	.593
TG	.059	.709
CRP	.065	.680

Hypothesis 2: The volume of emergency-response dispatch calls received are correlated with firefighters' health behaviors and CVD risk.

Data was also collected on the volume of emergency dispatch calls per year at each station. Participating stations were evenly distributed into classifications by call volume. Level 1 stations received less than 900 calls per year, level 2 received 900-2,000 calls per year, and level 3 received more than 2,000 calls per year. Table 13 shows the number of participants represented at each of these levels and the mean and range of number of calls received by their station for 2013.

Table 13: Call volume categories

	Participants	Mean (SD)	Range
Level 1	20	718.9 (93.4)	510-872
Level 2	22	1393.5 (204.5)	931-1710
Level 3	20	3073.1 (1172.6)	2226-5008

Correlation between call volume and CVD risk factors was also assessed (see Table 14). The results suggest that at stations where call volume was increased, there was a decrease in the percent of body fat on average among participants ($p<.05$). Figure 2 shows the average for each risk factor by level of call volume.

Table 14: Correlation between call volume and CVD risk factors (N=32)

	Call Volume	p-value
BMI	-.264	.145
% body fat	-.456	.009
Waist circumference	-.302	.093
Cholesterol	-.176	.328
HDL	.060	.742
LDL	-.104	.566
Cardiorespiratory fitness	-.113	.537
SBP	.069	.706
DBP	-.053	.771
Coronary risk	-.098	.594
Glucose	-.075	.678
TG	-.267	.133
CRP	-.046	.800

* $p < .05$

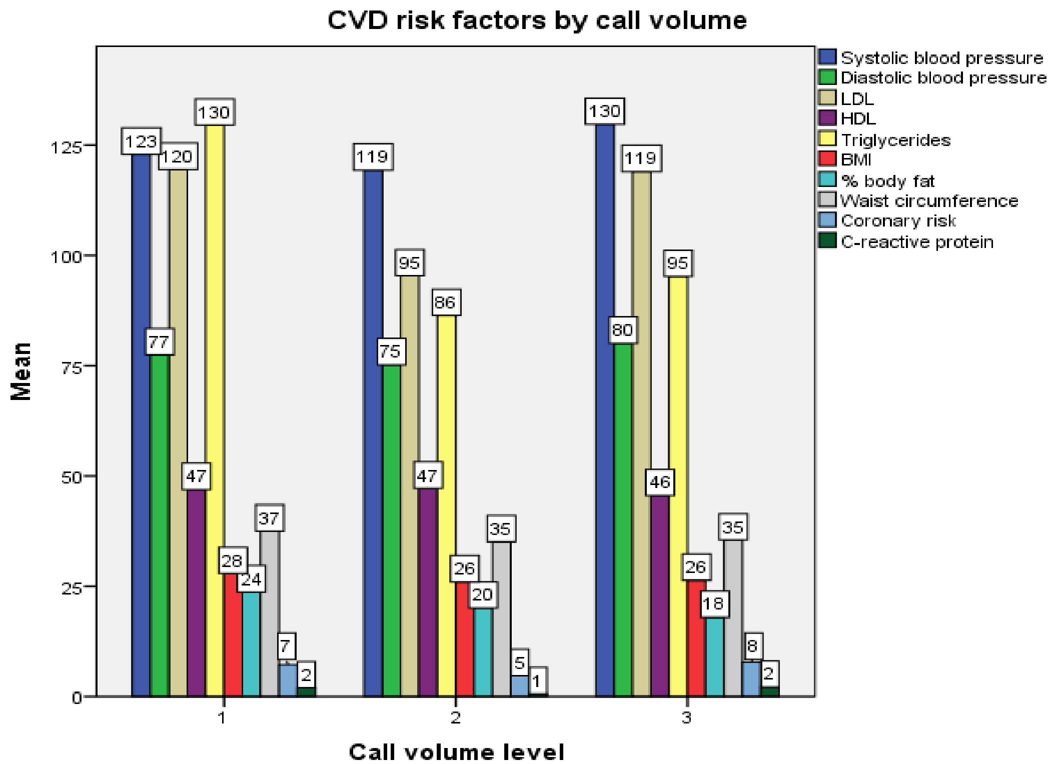

Figure 2: CVD risk factors by call volume*
* N=14 participants in level 1, N=13 participants in level 2, N=6 participants in level 3

Correlation between call volume and the percent increase in on-duty dietary components was analyzed (see Table 15). Significant positive correlation was found between call volume and increase in calories consumption on-duty (r=0.43). There was also a slight increase in on-duty consumption of carbohydrates as call volume increased (r=0.38). On-duty diet was also analyzed per call volume category (see Figure 3).

Table 15: Correlation between call volume and percent increase in on-duty diet from each component (N=24)

	Calories	Protein	Carbs	Fat	Sodium	Fiber	Sugar
Call Volume	0.43*	0.03	0.38	0.20	0.10	0.00	0.05

* p < .05

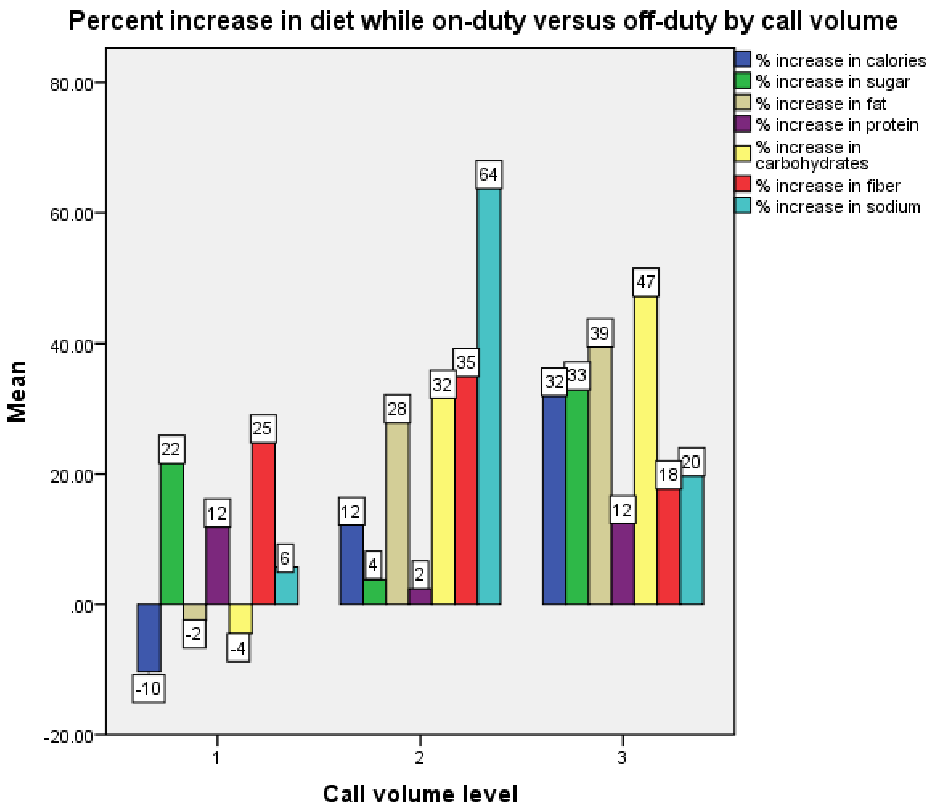

Figure 3: Percent increase in diet on-duty versus off-duty by call volume*
* N=9 participants in call volume level 1, N=10 participants in call volume level 2, N=5 participants in call volume level 3

Call volume was also analyzed for correlation with the on-duty diet data for each component from the Dietary Screener Questionnaire (Table 16). No significant correlation was found, although there was an inverse relationship between amounts of sugar-sweetened beverages (r=0.15) and increased amounts of fruits and vegetables (r=0.16) being consumed as call volume increased. Figure 6 compares the level of call volume to the on-duty dietary components.

Table 16: Correlation (p value) between call volume and on-duty diet for each component (N=31)

	FVL	Whole Grain	SSB	Added sugar
Call Volume	0.16 (.405)	0.01 (.957)	-0.15 (.411)	-0.11 (.568)

FVL = fruits/vegetables/legumes
SSB = added sugar from sugar-sweetened beverages

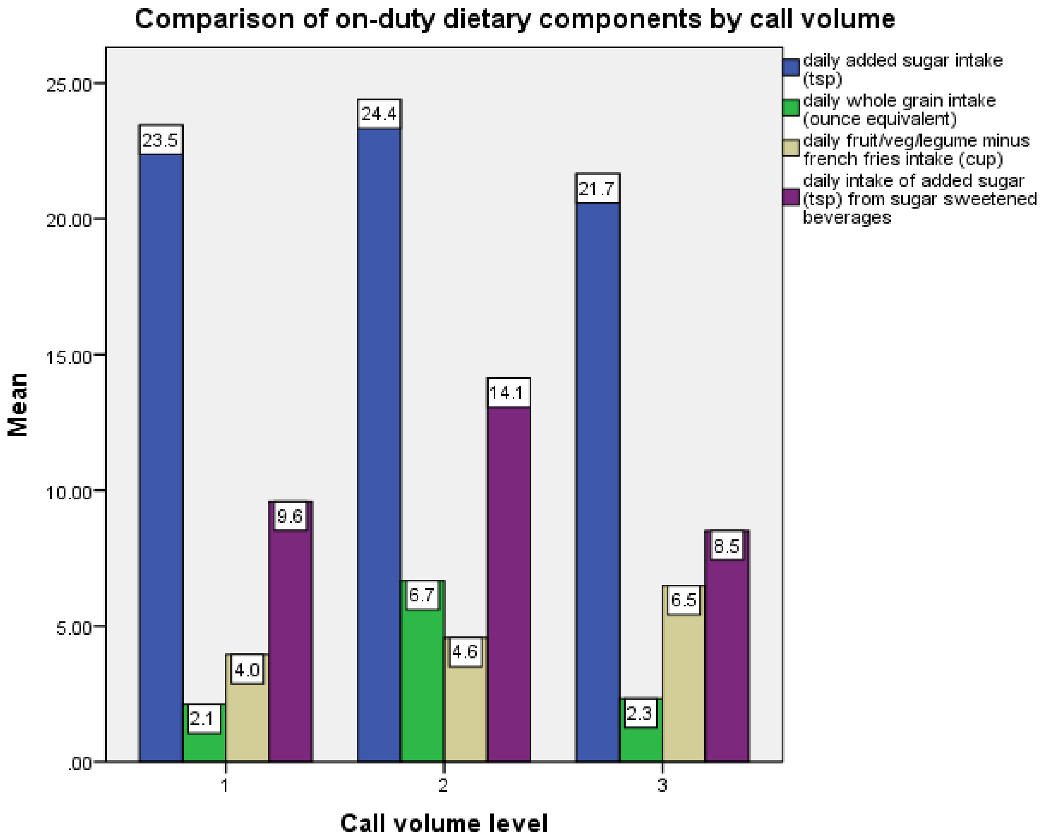

Figure 4: Comparison of on-duty diet by call volume*
* N=8 participants in call volume level 1, N=13 participants in call volume level 2, N=10 participants in call volume level 3

In addition to meeting the physical activity recommendations, participants were also asked about their on-duty exercise habits with higher numbers indicating greater agreement and values greater than 4 indicating some agreement (7=strongly agree, 1=strongly disagree). These responses are reflected in Table 17. These physical activity behaviors were also analyzed by call volume. On-duty exercise and meeting the recommendations were not significantly correlated with call volume as shown in Table 18 and Figure 5.

Table 17: Physical activity responses*

	Overall**	BMI ≥30**	BMI <30**	p value
I exercise more on-duty than off-duty.	3.95 (1.80)	4.62 (1.94)	3.75 (1.75)	.116
During every shift, I use the time given to exercise.	5.40 (1.50)	4.92 (1.71)	5.48 (1.48)	.226
I get at least 150 minutes of moderate to vigorous aerobic activity every week.	5.49 (1.61)	4.92 (1.75)	5.59 (1.61)	.181

* On scale of 1 (strongly disagree) to 7 (strongly agree)
** n=82 for the overall sample; n=13 participants with BMI of 30 kg/m^2 or higher, n=66 participants with BMI lower than 30 kg/m^2

Table 18: Correlation between call volume and physical activity behaviors (n=62)

	Correlation	p value
More on-duty	-.104	.423
Use shift time	.048	.708
Meet guidelines	.133	.304

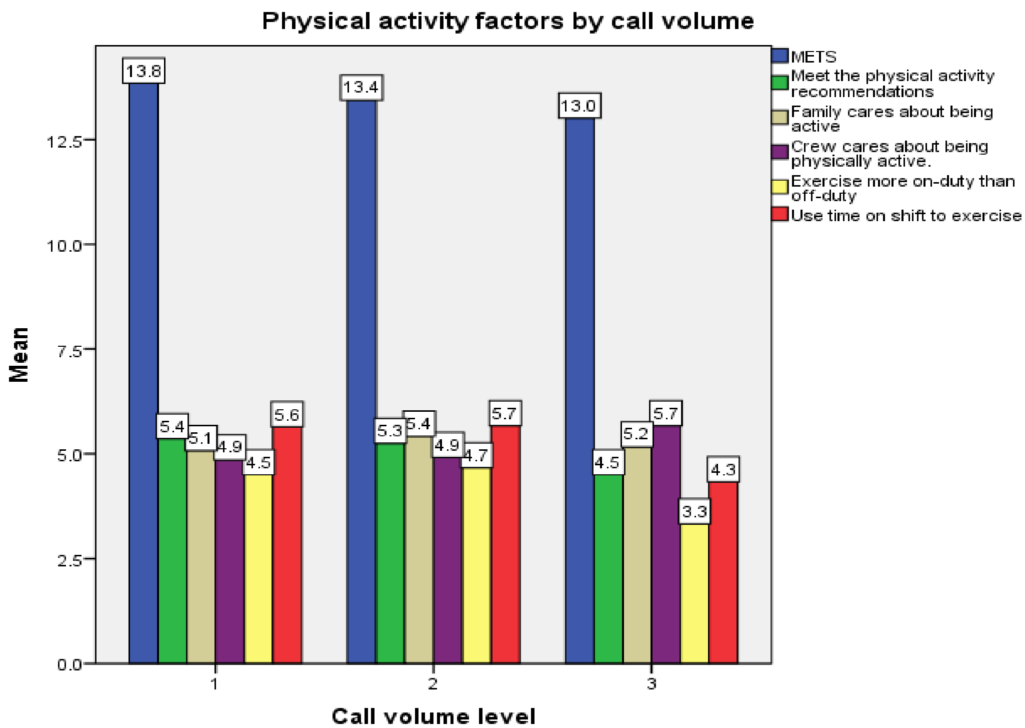

Figure 5: Physical activity factors by call volume*
* For METS: N=14 participants from level 1, N=12 participants from level 2, N=6 participants from level 3; for other variables: N=20 from level 1, N=22 from level 2, N=20 from level 3

Hypothesis 3: Social norms and the fire station environment are correlated with the firefighters' health behaviors, and these vary by obesity status.

All participants were asked to complete the Motivations for Health Behaviors Questionnaire. Table 19 shows their average responses about factors that trigger their eating in order from most often to least often. In addition, subgroups of sex, age and BMI are included for further analysis of differences between groups. Women were less likely than men to report eating habits influenced by social norms (p=.002). Younger participants (<41 years) were more likely to report pleasure and affect regulation influencing their eating habits (p=.019 and p=.014, respectively). Obese participants (BMI≥30 kg/m^2) were less likely to report health concerns influencing their eating habits.

Table 19: Mean (SD) responses to eating triggers*

	Overall**	Men**	Women**	p value	≥41 yrs**	<41 yrs**	p value	BMI ≥30**	BMI <30**	p value
Liking	5.55 (1.04)	5.54 (1.05)	5.83 (1.13)	.512	5.58 (1.11)	5.60 (.99)	.908	5.77 (1.05)	5.55 (1.05)	.499
Need & Hunger	5.12 (0.90)	5.09 (0.92)	5.39 (0.22)	.435	4.96 (.86)	5.27 (.94)	.135	4.87 (0.82)	5.16 (0.92)	.305
Convenience	4.74 (1.21)	4.73 (1.20)	4.61 (1.51)	.814	4.59 (1.26)	4.90 (1.16)	.266	5.03 (1.16)	4.69 (1.23)	.361
Health	4.63 (1.26)	4.60 (1.27)	5.04 (1.24)	.412	4.84 (1.21)	4.35 (1.26)	.086	3.83 (1.12)	4.75 (1.23)	.014
Habits	4.47 (1.26)	4.51 (1.26)	3.92 (1.32)	.273	4.33 (1.25)	4.69 (1.23)	.192	4.73 (1.22)	4.46 (1.26)	.481
Weight Control	3.43 (1.37)	3.46 (1.38)	3.22 (1.46)	.690	3.50 (1.35)	3.34 (1.35)	.605	3.62 (1.01)	3.38 (1.41)	.574
Price	3.35 (1.37)	3.36 (1.35)	2.83 (1.75)	.370	3.17 (1.31)	3.53 (1.44)	.253	3.69 (1.74)	3.28 (1.30)	.331
Social Norms	3.32 (1.06)	3.40 (1.03)	2.02 (0.59)	.002	3.18 (1.01)	3.45 (1.13)	.275	3.42 (1.14)	3.30 (1.07)	.718
Sociability	3.02 (1.28)	3.03 (1.26)	2.83 (1.72)	.717	3.06 (1.36)	2.95 (1.25)	.700	2.96 (1.28)	3.02 (1.32)	.893
Pleasure	2.72 (0.96)	2.72 (0.96)	2.78 (1.00)	.888	2.48 (.87)	2.99 (1.00)	.019	2.74 (1.12)	2.73 (0.94)	.970
Affect Regulation	2.15 (0.88)	2.14 (0.90)	2.23 (0.64)	.811	1.91 (.66)	2.40 (1.03)	.014	2.46 (1.08)	2.09 (0.84)	.175

* On scale of 1 (strongly disagree) to 7 (strongly agree)

** N=82 for the overall sample; n=76 men, n=6 women; n=39 participants younger than 41 years, n=40 aged 41 or older; n=39 participants with BMI of 30 kg/m^2 or higher, n=66 participants with BMI lower than 30 kg/m^2

Participants also responded to various statements about the work environment and the influences these factors may have on their diet, with higher numbers indicating greater agreement and values greater than 4 indicating some agreement (7=strongly agree, 1=strongly disagree). These statements with the mean responses overall and by BMI subgroups are shown in Table 20. On average, participants agreed with the statements: at work they usually eat the same food as their coworkers; their crew cares about eating healthy; community members often provide unhealthy snacks; they are willing to spend more money on food in order to eat healthy; they usually plan ahead what they will eat; and a crew member often brings unhealthy snacks to share. Individuals who were obese (BMI≥30 kg/m^2) were more likely to report having eating competitions at work (p=.005) and feeling upset, discouraged or emotionally drained while at work (p=.002), and less likely to report that their crew eats healthy (p=.035).

Table 20: Mean responses on workplace variables and their influences on diet*

	Overall**	BMI ≥30**	BMI <30**	p value
Community members often provide desserts or unhealthy snacks.	4.79 (1.43)	4.83 (1.27)	4.75 (1.47)	.861
Someone from the crew often brings an unhealthy snack to share.	4.36 (1.44)	4.46 (1.56)	4.33 (1.45)	.776
I eat better (more healthy) at work than at home.	3.63 (1.52)	3.77 (1.83)	3.52 (1.41)	.573
I eat larger portion sizes of food at work than at home.	3.98 (1.56)	4.23 (1.64)	3.98 (1.54)	.605
I eat “fast food” more while on-duty than off-duty.	2.34 (1.57)	2.15 (1.63)	2.41 (1.59)	.599
Sometimes we have eating competitions at work.	2.01 (1.59)	3.15 (2.38)	1.79 (1.33)	.005
The others in my crew eat healthy.	4.72 (1.39)	3.92 (1.62)	4.82 (1.29)	.035
My crew and I are willing to spend more money on food in order to eat healthy.	4.81 (1.68)	4.46 (1.61)	4.83 (1.32)	.374
At work we usually plan ahead what we will eat.	4.37 (1.68)	4.31 (0.55)	4.33 (1.66)	.961
At work, I usually eat the same food as my coworkers	5.48 (1.50)	6.00 (0.91)	5.32 (1.58)	.137
A firefighter that doesn’t eat what the rest of the crew is eating is kind of an outcast.	3.18 (1.76)	3.46 (1.76)	3.11 (1.80)	.515
I am more often upset, discouraged or emotionally drained while on-duty than off duty.	2.06 (1.42)	3.15 (2.15)	1.83 (1.16)	.002
I am more often bored or restless on-duty than off-duty.	2.65 (1.69)	3.31 (2.21)	2.55 (1.59)	.144
Many in my crew care about healthy eating.	5.23 (1.45)	4.62 (1.71)	5.29 (1.38)	.127

* On scale of 1 (strongly disagree) to 7 (strongly agree)

** N=82 for the overall sample; n=13 participants with BMI ≥ 30 kg/m^2, n=66 participants with BMI<30

Additional questions in this questionnaire were based on personal and home-based variables that may affect diet (see Table 21). On average, participants agreed that their family members care about healthy eating. Participants who were obese were significantly lower in their belief that their family members care about healthy eating ($p=.003$), more likely to report having a hard time resisting free snacks ($p=.036$), and more likely to have a desire to eat when feeling upset, discouraged or emotionally drained ($p=.040$).

Table 21: Mean responses on personal and home-based variables and their influences on diet*

	Overall**	BMI ≥30**	BMI <30**	p value
I eat more than usual when I see others eating.	3.30 (1.39)	3.69 (1.65)	3.27 (1.35)	.328
I snack more off-duty than on-duty.	3.52 (1.64)	3.31 (2.18)	3.53 (1.56)	.662
I have a hard time resisting free snacks.	3.78 (1.60)	4.62 (1.56)	3.59 (1.59)	.036
I have a desire to eat when I am upset, discouraged, or emotionally drained.	2.01 (1.14)	2.62 (1.19)	1.89 (1.13)	.040
I have a desire to eat when I am bored or restless.	2.94 (1.66)	3.77 (1.59)	2.82 (1.66)	.062
My family members care about healthy eating.	5.33 (1.33)	4.62 (1.26)	5.48 (1.33)	.033

* On scale of 1 (strongly disagree) to 7 (strongly agree)
**N=82 for the overall sample; n=13 participants with BMI of 30 kg/m^2 or higher, n=66 participants with BMI lower than 30 kg/m^2

Eating triggers and statements about factors related to work and home environments were analyzed for correlation with results from the 4-day diet records (see Table 22). The eating motivation of Convenience was significantly positively correlated with sodium intake ($p<.01$). Individuals who reported a crew member bringing unhealthy snacks more often also consumed more calories ($p<.01$), fat ($p<.05$) and sodium ($p<.05$) while on duty. Reporting that community members bring treats was correlated with increased calories ($p<.05$) and showed a slight association with increased fat intake.

Table 22: Correlation between on-duty diet and motivations (N=30)

	Calories	Protein[a]	Carbs	Fat	Sodium	Fiber[b]
Liking	.034	.151	-.001	.054	.171	-.252
Need & Hunger	.060	.096	.089	-.029	.043	.049
Convenience	.202	.061	.189	.148	.526**	-.487**
Health	.473**	.399*	.301	.269	.191	.152
Habits	-.120	-.187	-.011	-.099	.030	-.232
Weight Control	-.074	-.457*	.145	-.027	-.363*	.136
Price	-.227	-.143	-.348	-.111	-.094	-.198
Social Norms	.152	-.036	-.051	.175	-.003	.232
Sociability	.319	-.019	.257	.154	.325	-.151
Pleasure	-.119	-.040	-.231	.016	-.124	.174
Affect Regulation	-.118	-.118	-.225	-.010	-.068	-.133
I eat better (more healthy) at work	.074	.187	-.009	.059	.288	-.261
I eat larger portion sizes at work.	-.268	-.380*	-.131	-.071	-.110	-.097
I eat more “fast food” on-duty.	.160	-.084	.087	.231	-.274	.184
I eat larger meals at work because I know I might be too busy to eat the rest of the day.	-.122	-.319	-.160	.154	-.039	-.014
Community members often provide desserts or unhealthy snacks.	.430*	.256	.297	.346	.205	.012
Someone from the crew often brings an unhealthy snack to share.	.541**	.258	.319	.401*	.406*	-.253
Sometimes we have eating competitions at work.	-.144	-.146	-.228	-.075	-.069	-.054
The others in my crew eat healthy.	.079	.445*	-.155	-.030	.249	-.330
My crew and I are willing to spend more money on food in order to eat healthy.	-.261	.165	-.292	-.295	.006	-.056
At work we usually plan ahead what we will eat.	-.082	-.125	.122	-.074	-.142	.195
At work, I usually eat the same food as my coworkers	-.182	-.043	.071	-.301	-.050	-.002
A firefighter that doesn’t eat what the rest of the crew is eating is kind of an outcast.	.151	.028	-.055	.237	-.134	.269
I am more often upset, discouraged or emotionally drained while on-duty than off duty.	-.023	-.087	-.177	.088	.104	-.200
I am more often bored or restless on-duty than off-duty.	-.226	-.181	-.435*	.044	-.096	-.267
Many in my crew care about healthy eating.	-.190	.216	-.401*	-.174	.017	-.065
I eat more than usual when I see others eating.	.049	-.242	.030	.110	-.016	-.156
I have a hard time resisting free snacks.	-.086	-.247	-.230	.030	-.204	-.156
I have a desire to eat when I am upset, discouraged, or emotionally drained.	-.289	-.289	-.307	-.131	-.445*	.302
I have a desire to eat when I am bored.	-.238	-.259	-.370*	-.056	-.159	-.215
My family members care about healthy eating.	.333	.246	.041	.425*	.048	.011

[a] Protein in grams/kg of body weight [b] Fiber in grams/1,000 kcals

* p<.05

Correlation was further analyzed between the home/work combined diet components from the DSQ and responses to statements about eating triggers and workplace, personal, and home environment (see Table 23). The eating motivation of Habits was found to be negatively correlated with fruits/vegetables/legumes ($p<.01$), whole grains ($p<.05$), and fiber ($p<.01$). Added sugar was found to be positively correlated with the eating motivations of Convenience ($p<.01$) and Affect Regulation ($p<.05$) and negatively correlated with the motivation of Health ($p<.01$). Individuals who reported eating larger portion sizes of food at work also reported consuming more added sugar and added sugar from sugar-sweetened beverages ($p<.01$). Significantly less added sugar ($p<.05$) and added sugar from sugar-sweetened beverages ($p<.01$) was consumed by individuals who reported that their family cares about healthy eating. Individuals who were more likely to report eating the same food as their coworkers consumed slightly more added sugar ($r=0.29$).

Table 23: Correlations between eating motivations and dietary components (N=38)

	FVL	Whole Grain	SSB	Added sugar
Liking	-0.09	-0.23	0.19	0.21
Need & Hunger	-0.18	-0.07	0.08	0.15
Convenience	-0.27	0.01	0.31	0.42**
Health	0.27	0.17	-0.42**	-0.43**
Habits	-0.44**	-0.38*	0.03	-0.07
Weight Control	-0.12	0.12	0.14	-0.01
Price	-0.21	-0.11	0.11	0.18
Social Norms	0.16	0.04	0.21	0.21
Sociability	0.29	0.30	0.12	0.20
Pleasure	-0.14	-0.11	0.15	0.18
Affect Regulation	-0.11	-0.11	0.35*	0.38*
Community members often provide desserts or unhealthy snacks.	-0.02	-0.27	0.00	-0.02
Someone from the crew often brings an unhealthy snack to share.	0.05	-0.41*	-0.07	-0.13
I eat better (more healthy) at work than at home.	0.02	0.19	0.25	0.24
I eat larger portion sizes of food at work than at home.	0.00	0.09	0.45**	0.48**

I eat “fast food” more while on-duty than off-duty.	0.04	-0.15	-0.06	-0.07
I eat larger meals while on-duty because I know I might be too busy to eat the rest of the day.	0.02	0.05	0.23	0.34*
Sometimes we have eating competitions at work.	0.07	-0.11	0.01	0.04
The others in my crew eat healthy.	-0.05	-0.08	-0.14	-0.08
My crew and I are willing to spend more money on food in order to eat healthy.	0.05	-0.07	-0.07	-0.01
At work we usually plan ahead what we will eat.	0.01	0.05	0.11	0.10
At work, I usually eat the same food as my coworkers	-0.20	-0.11	0.23	0.29
A firefighter that doesn’t eat what the rest of the crew is eating is kind of an outcast.	0.18	0.05	0.08	0.12
I am more often upset, discouraged or emotionally drained while on-duty than off duty.	0.25	0.10	0.19	0.21
I am more often bored or restless on-duty than off-duty.	0.10	0.00	0.21	0.25
Many in my crew care about healthy eating.	0.06	-0.01	-0.15	-0.16
My family members care about healthy eating.	-0.09	-0.21	-0.44**	-0.34*
I eat more than usual when I see others eating.	-0.13	0.04	0.31	0.27
I snack more off-duty than on-duty.	-0.21	0.17	0.08	0.23
I have a hard time resisting free snacks.	-0.12	-0.03	0.25	0.43**
I have a desire to eat when I am upset, discouraged, or emotionally drained.	-0.03	-0.02	0.03	-0.01
I have a desire to eat when I am bored or restless.	-0.06	0.05	0.18	0.31

FVL = fruits/vegetables/legumes
SSB = added sugar from sugar-sweetened beverages
* p < .05 ** p < .01

The Motivations for Health Behaviors questionnaire also addressed the value the family members and crew place on being physically active. Average responses and responses by BMI subsamples are shown in Table 24. On average, participants reported that their family members and crew care about being physically active. There were no significant differences between the obese and non-obese subsamples, but there was near significance for obese participants reporting lower on their family members caring about being physically active (p=.056). Table 25 displays the correlations found between these influences, exercise habits and cardiorespiratory fitness (CRF). Firefighters who reported using time on the shift to exercise were significantly more likely to meet the AHA recommendations (p<.01), but those who reported exercising more on-duty than off-duty were significantly less likely to meet the recommendations (p<.01). There was also a positive correlation between meeting the guidelines and reporting that their family members care about physical activity (p<.05). Firefighters who reported being more likely to use time on their shift to exercise were significantly more likely to report that their crew (p<.01) and family (p<.05) care about being physically active.

Table 24: Mean responses on caring about physical activity*

	Overall**	BMI ≥30**	BMI <30**	p value
My family members care about being physically active.	5.30 (1.41)	4.62 (1.39)	5.44 (1.41)	.056
Many in my crew care about being physically active.	5.42 (1.43)	5.15 (1.52)	5.42 (1.42)	.552

* On scale of 1 (strongly disagree) to 7 (strongly agree)
** n=82 for the overall sample; n=13 participants with BMI of 30 kg/m^2 or higher, n=66 participants with BMI lower than 30 kg/m^2

Table 25: Correlation between physical activity responses and cardiorespiratory fitness (CRF) (N=82 participants; N=42 for correlations with CRF)

	CRF	Family	Crew	More on-duty	Shift time	Meet guidelines
CRF		.169	-.190	.050	.186	.085
Family[a]			.231*	-.021	.270*	.240*
Crew[b]				-.059	.302**	.172
More on-duty[c]					.203	-.321**
Shift time[d]						.464**
Meet guidelines						

[a] My family members care about being physically active.
[b] Many in my crew care about being physically active.
[c] I exercise more on-duty than off-duty.
[d] During every shift, I use the time given to exercise.
[e] I get at least 150 minutes of moderate to vigorous aerobic activity every week.
[*] p < .05 [**] p < .01 [***] p < .001

CHAPTER V

DISCUSSION

Prevalence of CVD Risk Factors

Five participants out of 42 evaluated displayed all of the characteristics of optimal cardiovascular health (systolic blood pressure below 120 mmHg, diastolic blood pressure below 80 mmHg, total cholesterol under 200 mg/dL, fasting plasma glucose under 100 mg/dL, and body mass index (BMI) below 25 kg/m^2) as described by Lloyd-Jones et al. (2010). Further, our study found 88% of firefighters tested displayed at least one risk factor for cardiovascular disease.

The prevalence of overweight and obesity combined was consistent with previously published studies among firefighters and similar between self-reported data and measurements taken during fitness evaluations. About 71% of firefighters evaluated would be considered overweight/obese based on BMI, with about 24% of them classified as obese. These percentages are a little lower than what other nationwide studies have found (Baur et al., 2011; Carey et al, 2011; Durand et al., 2011). However, the obesity prevalence in this study is higher than reported previously for Colorado firefighters (Donovan et al., 2009). The results from this study show a lower prevalence of overweight and obesity among these firefighters than the national average for men in the general population (73% and 35%, respectively); however, the prevalence of obesity in the state of Colorado is lower than the national average, reported at 20.5%, based on BMI (CDC, 2013). Compared to the state prevalence, obesity was more prevalent in this sample of Colorado firefighters. Data from this study suggest that the overweight/obesity rates of firefighters are similar to the general

American public, which is also suffering from high rates of overweight/obesity, inactivity and the resulting comorbidities. This is concerning considering that the job of a firefighter requires significant exertion and their coworkers and community depend on them to be healthy and fit. This indicates that more studies are needed to determine what types of interventions would be most successful in addressing weight gain and obesity in the fire service.

Hydrodensitometry revealed about 31% of firefighters were considered obese (BF% >25%) and an additional 14% of firefighters to be overweight (BF% 22-25%). Consistent with the present findings, Poston et al. (2011) reported that obesity in the fire service was even more prevalent when assessing body fat percentage than by BMI and that prevalence reports of obesity among firefighters is not a result of misclassifying muscular firefighters as obese by using BMI. According to waist circumference measurements, 12% were at high risk (>102 cm) and another 26% were at an elevated risk of CVD (95-102 cm).

Hypertension was also found among participants in this study. The average blood pressure was 122/76 mmHg. Hypertension was found in 9.5% of the participants and another 21.4% were prehypertensive. While these results are concerning, they are considerably lower than what has been reported in other studies on firefighters and among American adults (Carey et al., 2011; Donovan et al., 2009; Go et al., 2013). However, this study did not collect information on medication so it is unknown how many participants may have been taking medication to control their blood pressure.

About 24% of this group had high cholesterol, 24% had low HDL, and 19% had hypertriglyceridemia. Though concerning, these results are all somewhat lower than what has been reported on firefighters in other published studies (Baur et al., 2012; Donovan et al., 2009). In addition, about 5% of participants had elevated blood glucose levels. Again, it is unknown whether participants were taking medication that would affect their lipid profile or blood glucose levels.

Some firefighters displayed increased CVD risk based on their levels of C-reactive protein. About 26% were found to be at average risk (1.0-3.0 mg/L) and an additional 12% were found to be at high risk (>3.0 mg/L).

Fortunately, none of the firefighters evaluated had Cooper Clinic coronary risk scores that would indicate that they were at high risk. However, 9.5% were evaluated to be at moderate coronary risk. In addition, only one firefighter in this study would be considered to have metabolic syndrome based on a clustering of risk factors. It is possible that other individuals would have been classified as having metabolic syndrome if data on medications had been collected. Including data on medication use, Donovan et al. (2009) found that 15% of firefighters in a larger sample from Colorado met the National Cholesterol Education Program diagnostic criteria for metabolic syndrome.

Among the 42 firefighters evaluated, 19% of firefighters did not meet the NFPA's minimum cardiorespiratory fitness (CRF) standard of 12 METS. Larger studies of career firefighters have shown higher prevalence of low CRF. Baur et al. (2011) reported 44% and Donovan et al. (2009) reported 25%.

Hypothesis 1: Poor health behaviors (diet and physical activity) are positively correlated to increases in CVD risk factors.

Diet analysis revealed that on average the 30 firefighters evaluated were consuming a fairly typical Western diet based on calculations of the percent of calories being consumed per macronutrient (Miller et al., 2011). However, the Acceptable Macronutrient Distribution Ranges (AMDRs), or range of intakes that is associated with reduced risk of chronic disease while providing adequate intakes of essential nutrients, suggest that 45-65% of the total energy intake should come from carbohydrates, 20-35% from fats, 10-35% from protein (Otten, Hellwig & Meyers, 2006). Based on this guideline, firefighters are consuming fat in excess. A diet approach such as DASH (Dietary Approaches to Stop Hypertension) that is high in fiber and lower in fat could have beneficial effects on total cholesterol, LDL and HDL. DASH includes 8-10 daily servings of fruits and vegetables, 2-3 servings per day of low-fat dairy products, includes whole grains, legumes, fish and poultry, and limits added sugars and fats.

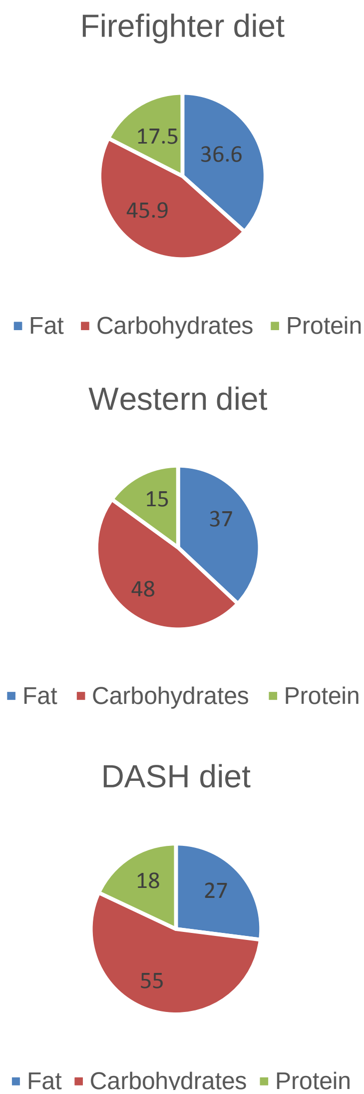

Figure 6: Distribution of Macronutrients

However, replacing fat with processed carbohydrates having a high glycemic index is not recommended. Among these firefighters, a significant inverse correlation was observed between carbohydrates and HDL (r=-.368). Most likely related to this, a decrease in the percent of calories from fat was slightly associated with a decrease in HDL and an increase in triglycerides. Consistent with the present findings, Miller et al. (2011) reported that for each 5% decrease in total fat consumption, HDL was estimated to decrease by 2.2% and triglyceride level to increase 6%. Substituting carbohydrates for fats has been found in several studies to increase levels of fasting TG and reduce HDL, especially in diets low in fiber (Miller et al., 2011). The Adult Treatment Panel IV lists causes of elevated triglycerides to include very low-fat diets and high intake of refined carbohydrates, in addition to weight gain and obesity and recommends carbohydrate intake should be limited to 60% of total calories with lower intakes considered for individuals with elevated TG or low HDL cholesterol (Stone et al., 2013). Although many studies have shown that high carbohydrate diets increase TG levels, some studies have shown no effect; this may be due to higher fiber and/or protein intake (Miller et al., 2011).

Although the on-duty diet also seems to be higher in fiber than the off-duty diet for most individuals, neither diet shows adequate consumption of fiber according to the Dietary Reference Intake (DRI) values. The Institute of Medicine considers 14 grams per 1,000 kcals to be the adequate intake of fiber to provide protection against heart disease (Otten et al., 2006). According to this guideline and based on the average calories consumed on-duty, the diet should include at least 36.6 grams of fiber, but what was reported was 28 grams on average. Firefighters reported consuming about 10.9 grams of fiber per 1,000 kilocalories (kcals) while on-duty and 10.1 g/1,000 kcals while off-duty, with the combined average about 25% below the adequate intake value. This indicates that both the on-duty and off-duty diets are low in fiber. Fiber, carbohydrates that are not digested and absorbed in the small intestines, has many beneficial physiological effects that contribute to reducing the risk of coronary heart disease and hypertension. Fiber promotes satiety and laxation, attenuates blood glucose levels and the insulin response, and interferes with the absorption of dietary fat and cholesterol and with enterohepatic recirculation of cholesterol and bile acids thus reducing serum cholesterol levels (Otten et al., 2006). Studies indicate an inverse relationship between serum TG and fiber intake. Miller et al. (2007) reported that for a similar levels of carbohydrates, increasing consumption of fiber resulted in reductions in triglycerides, thus showing triglyceride-lowering effect for dietary fiber. Fruits, vegetables, legumes and whole grains are common sources of fiber. Firefighters should be encouraged to increase consumption of foods rich in fiber both on-duty and off-duty.

Analysis of the diet records suggests firefighters are consuming adequate protein both on- and off-duty. The Recommended Dietary Allowance (RDA) for protein is 0.80 grams per kilogram of body weight per day (Otten et al., 2006). The at-work average is 1.39 g/kg and at-home is 1.32 g/kg.

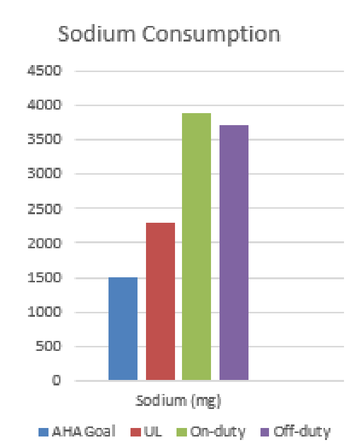

Figure 7: Sodium Consumption

The AHA recommends limiting sodium consumption to less than 1500 mg per day (Lloyd-Jones et al., 2010). This is considered one of the five dietary goals to reduce risk of CVD and obesity. The DRI indicates 1500 mg of sodium as the adequate intake (AI) and 2300 as the tolerable upper intake level (UL). High intake of sodium is correlated with an increase in blood pressures, which also increases the risk of heart disease and stroke. Most of the sodium intake comes from sodium chloride (salt), primarily from processed foods, such as lunch meat, hot dogs, chips, canned vegetables, and condiments. Research shows that about 77% of sodium chloride intake is from processed foods, 12% is naturally present in foods, 6% is added while eating, and 5% is added while cooking (Otten et al., 2006). According to the diet records, on average firefighters consume 3895 mg per shift day and 3713 mg per off-duty day. This is 154% more than the AHA goal and 65% more than the tolerable upper intake level (UL). None of the firefighters reported meeting this AHA goal by consuming less than 1500 mg of sodium per day. Only 10% reported consuming less than 2300 mg, and 90% reported consuming more than the UL of 2300 mg, and sodium intake was significantly positively correlated with systolic blood pressure ($p<.05$).

Diet records indicated that non-obese firefighters eat more while on-duty than they do while off-duty, and obese firefighters eat more while off-duty. However, although obese firefighter reported consuming less calories, protein, carbohydrates and fiber on-duty compared to off-duty, they also reported consuming more sugar and fat. Non-obese firefighters reported consuming more of every dietary component while on-duty, and an increase in calories was most strongly correlated with an increase in fat ($p<.001$) and increase in sugar ($p<.01$). These results combined indicate that the on-duty diet may be high in fat and sugar, and higher than either group consumes while off-duty. In addition, average sodium consumption while on-duty was even greater than off-duty. These findings are consistent with the feedback from focus group that report firehouse recipes high in fat, processed foods, and sugars (Poston et al., 2012).

In order to have diet data on more participants and to be able to further assess how well firefighters are meeting the AHA dietary goals, a short food-frequency questionnaire was offered to all participants. A self-administered, web-based questionnaire was selected because there is increased privacy, data can be collected in a neutral environment at any time, questioning is standardized, and data processing is simplified. The Dietary Screener Questionnaire was chosen because it has been used by the National Health and Nutrition Examination Survey (NHANES) 2009-2010, and it would present low participant burden since it can be completed in less than ten minutes. The AHA dietary goals are based on a 2000 kcal diet (Lloyd-Jones et al., 2010), but diet records from the subsample indicated about a 2500 kcal diet so responses for each goal should be expected to be a little higher, but no adjustments to the goals were made for the sake of this study. The DSQ included legumes in the category with fruits and vegetables, but legumes did not seem to contribute significantly so they are not believed to make the value of the fruit and vegetable component much of an overestimate. Per day, the AHA recommends at least 4.5 cups of fruits and vegetables, at least 3 ounces of whole grains, and on average no more than 64.3 kcals (5.1 oz.) of sugar-sweetened beverages (or about 16.1 grams or 4 tsp of added sugar from sugar-sweetened beverages) (Lloyd-Jones et al., 2010). According to the DSQ, the on-duty averages were 4.92 cups of fruits/vegetables/legumes (FVL), 3.86 ounces of whole grains, and 10.38 tsp of added sugar from sugar-sweetened beverages. This suggests that on average the on-duty diet meets the goals for fruits and vegetables and whole grains. However, the amount of added sugar far exceeds the AHA recommendation. The off-duty diet is lower for each component, as also observed in the 4-day diet records from the subsample. Average off-duty consumption was 3.58 cups of FVL, 1.31 ounces of whole grains, and 5.52 tsp of added sugar from sugar-sweetened beverages.

Assumptions were made that firefighters reported diet based on ten 24-hour work days per month. It is possible that they had worked over time, and if so the on-duty diet would show a larger portion of their diet than expected by the assumption and related calculations. Therefore it is useful to consider the combined mean diet. The combined on-duty/off-duty diet estimates 4.0 cups of FVL, 2.2 ounces of whole grains, and 7.1 tsp of added sugar from sugar-sweetened beverages per day. According to these estimates, on average firefighters are below the goal on fruits and vegetables and whole grains, and they are getting nearly double the recommended limit of sugar-sweetened beverages. However, age appears to be a contributing factor. Firefighters under age 41 consumed significantly less fruits and vegetables, and although not significant also reported consuming less whole grains and slightly more sugar-sweetened beverages.

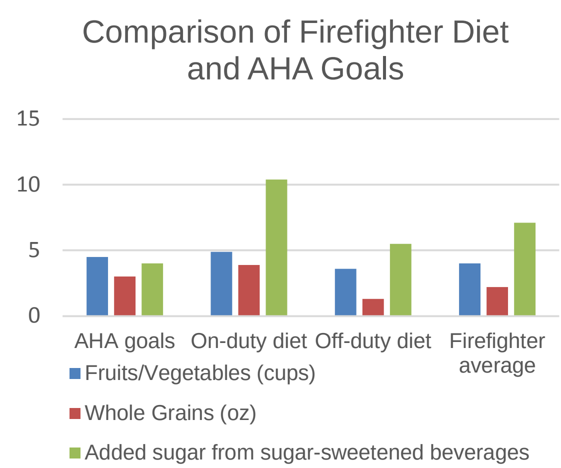

Figure 8: Comparison with AHA Goals

Based on data from 18 participants who completed both the diet screener and the HDPP evaluation, some correlations between added sugar and health outcomes were observed. An increase in fat mass was positively correlated with an increase in sugar-sweetened beverages and added sugar ($p<.05$). An increase in triglycerides and in overall coronary risk score was positively correlated with an increase in added sugar ($p<.05$). In addition, obese firefighters ($BMI \geq 30 kg/m^2$) consumed significantly more added sugar ($p=.02$) and added sugar from sugar-sweetened beverages ($p=.001$). This indicates that the increase in consumption of added sugar and sugar-sweetened beverages is placing firefighters at increased risk for cardiovascular disease.

About 26% of participating firefighters reported daily consumption of at least 4.5 cups of FVL, 28% reported at least 3 ounces of whole grains, none for sodium, and 35% reported consuming less than 4 tsp of added sugar from sugar-sweetened beverages based on the combined on- and off-duty responses. Data has shown that among American adults, only about 12% meet the fruits and vegetables goal, 7% meet the goal for whole grains, less than 1% for sodium, and 52% for sugar-sweetened beverages (Go et al., 2013). There is a lot of concern about the diet of the average Americans, and efforts abound to educate and encourage better eating habits. The results from the current study suggest that while on-duty, firefighters are doing better than the general public on eating fruits and vegetables and whole grains, but are doing even worse on reducing sodium and sugar-sweetened beverages. By increasing the number of firefighters meeting the AHA dietary goals, there is strong evidence that that prevalence of obesity and cardiovascular events may be reduced in the fire service (Lloyd-Jones et al., 2010).

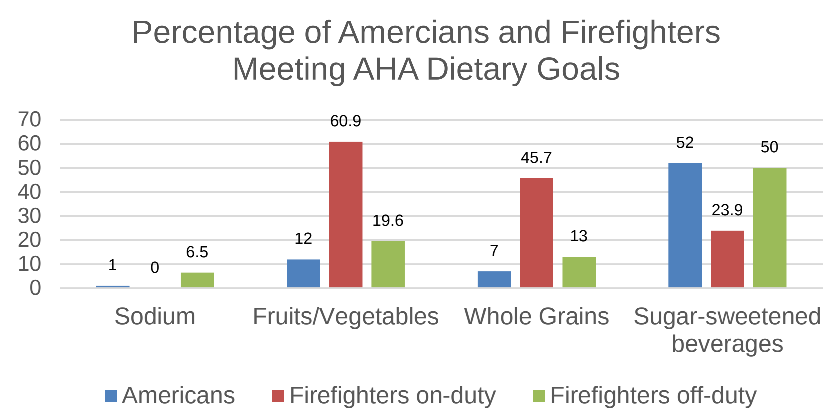

Figure 9: Americans and Firefighters Meeting AHA Goals

Of the total sample (N=82), 16% of participants responded that they do not meet the AHA physical activity recommendations, and 43% strongly agreed that they do meet these recommendations. These results are much more favorable than those reported by Baur et al., 2011 indicating that less than 25% of firefighter reported meeting the recommendations. Being less likely to meet the guidelines was significantly correlated with an increase in systolic blood pressure ($p=.04$), but no other correlations were observed between the reported level of physical activity and CVD risk factors.

Hypothesis 2: The volume of emergency-response dispatch calls received are correlated with firefighters' health behaviors and CVD risk.

For participating stations, call volume ranged from 510 to 5,008 emergency dispatch calls per year, with the overall average being 1,638 calls. It has been hypothesized that low call volume may lead to a more sedentary work shift and result in increased obesity and that high call volume may also result in increased obesity due to the added stress and poor health habits related to the busyness (Choi et al., 2011); however, to date, no published study has assessed the correlation between call volume and CVD risk factors.

Call volume was found to be negatively correlated with percent of body fat measured among participants ($p<.05$), and participants working at busier stations tended to have lower BMI, waist circumference, triglyceride and cholesterol levels reported.

Call volume may affect health behaviors so a factor worth considering for firefighters is whether call volume is influencing their eating habits and level of physical activity. Results from this study indicate that call volume is positively correlated with an on-duty increase in calories ($p<.05$). On average, stations with the lowest call volume showed that while on-duty firefighters were consuming less calories than while off-duty. There was also a slight association between an on-duty increase in carbohydrates and working at a station with higher call volume. There were no other correlations between call volume and on-duty diet based on responses from participants in this study. In addition, no correlations were observed between call volume and meeting the recommended amount of physical activity or exercising while on-duty.

Hypothesis 3: Social norms and the fire station environment are correlated with the firefighters' health behaviors, and these vary by obesity status.

Interventions can best be targeted at improving diet when there is better understanding of the factors that contribute to the dietary choices. Eighty-two firefighters rated the relative importance of various eating motives for food choice. They indicated that the top five types of motives that most often trigger food choice are Liking, Need & Hunger, Convenience, Health and Habits. In contrast, Sociability, Pleasure and Affect Regulation were seldom rated as a trigger for eating by the overall group and by all subpopulations. To consider how these factors were associated with on-duty eating habits, correlations between statements about eating motivations and the diet components were analyzed. Eating triggers of Liking, Need & Hunger, and Pleasure did not have any significant correlations with any of the diet components analyzed. Firefighters indicating Health (variable including to lower risk of heart disease, to maintain a healthy/balanced diet, and to stay in shape) as a more common trigger consumed significantly less added sugar and sugar-sweetened beverages, more fiber, and more total calories ($p<.01$), and they also tended to report greater intake of protein and carbohydrates. Participants who rated Weight Control (the sixth highest trigger, a combined variable including eating to lose weight, because the food is low in calories and because the food is low in fat) as a more common trigger consumed significantly less sodium and protein while on-duty ($p<.05$), but there were no other significant diet differences that correlated with ratings of weight control. Together this data suggest that some of the eating behaviors are related to the value an individual places on health and weight management; however, for individuals trying to control their weight more guidance may be warranted. Rating the eating trigger of Habits higher was significantly correlated with lower intake of fruits/vegetables ($p<.01$) and whole grains ($p<.05$), but was slightly associated with lower intakes of added sugar while on-duty. Habit responses were based on being accustomed to the food and growing up with it. The challenge for these individuals is to develop new, healthier habits.

For this group of firefighters, the eating motivation of Sociability was the third to last trigger and Social Norms was the fourth to last trigger rated; however, in a large general population, Social Norms was the lowest rated trigger on a very similar survey (Renner et al., 2012). This suggests that although firefighters rated it as only an occasional trigger, social norms do impact their eating habits somewhat more than a general population. The male firefighters were significantly more likely to rate Social Norms as a trigger for eating than female firefighters ($p=.002$). In addition, firefighters agreed that they usually eat the same food as their coworkers. However, on average they slightly disagreed that a firefighter that does not eat what the rest of the crew is eating may be considered an outcast and strongly disagreed that they have eating competitions at work. There are some differences noted in the responses from firefighters who were classified as obese. Firefighters with BMI ≥ 30 kg/m^2 were significantly more likely to agree that there were eating competitions at work (p=.005) and were less likely to believe that their crew eats healthy (p=.035). In correlating responses to eating motivations with diet reports, being more likely to indicate having eating competitions at work was not correlated with increased or decreased reported food consumption, and neither was being more likely to report that others in the crew eat healthy, eating the same food as their coworkers, or believing that a firefighter that doesn't eat the same as the crew is an outcast. Eating triggers of Social Norms and Sociability were not significantly correlated with any of the eating components, but there was a slight increase in calories and sodium with higher ratings for the Sociability variable. However, higher agreement on the statement that many crewmembers care about healthy eating was significantly correlated with consuming fewer carbohydrates on-duty (p<.05), and increased agreement with eating the same as the crew showed a slight association with consuming more added sugar and sugar-sweetened beverages and less fruits/vegetables but also less fat. These results provide some support for the hypothesis that there is social cohesion in the fire station which affects diet as suggested in studies based on focus groups (Haddock et al., 2011; Poston et al., 2012). The influence of social norms and social cohesion on firefighters appears to be stronger in male firefighters than in females, and some of those social norms may be correlated with obesity.

Various aspects of the firehouse have been considered to have an influence on health behaviors. One aspect based on focus groups is the availability of unhealthy snacks (Haddock et al., 2011). The average response of firefighters was that they somewhat agreed that community members often provide desserts and that someone from the crew often brings an unhealthy snack. Responding that community members often provide desserts and unhealthy snacks was correlated with an increase in total calories ($p<.05$) and was associated with a slight increase in fat consumption while on-duty. There was a significant increase in on-duty calories ($p<.01$), fat ($p<.05$) and sodium ($p<.05$) and a decrease in whole grains ($p<.05$) that correlated with an increase in agreement that someone from the crew brings an unhealthy snack to share. This data indicates that crew members and community members providing unhealthy snacks may be significantly contributing to a less healthy diet. Community members and the crew could be encouraged to bring healthier, lower-fat snacks, and the snacks may need to be consumed more in moderation and without compromising healthier choices, such as whole grains.

The availability of treats presents an external stimulus to eat, and external stimuli coupled with emotional factors has been noted to contribute to excessive eating (van Strien, et al., 1986). However, contrary to previous reports of high levels of psychological and emotional stress (Frattaroli, et al., 2012), firefighters reported strongly disagreeing that they feel more upset, discouraged or emotionally drained while on-duty than off-duty and Affect Regulation was rated as the lowest trigger for eating. This is supported by the fact that focus group studies did not report Affect Regulation impacting the dietary habits among firefighters (Frattaroli et al., 2012; Haddock et al., 2011). Obese firefighters, on the other hand, reported being more likely to have a desire to eat when upset, discouraged, or emotionally drained, and more likely to feel this way while at work. In addition, there was a significant positive correlation between ratings of

Affect Regulation (combined variable of eating triggered by feeling stressed, sad, frustrated, or bored and to cheer up) and an increase in on-duty consumption of added sugar and sugar-sweetened beverages ($p<.05$) and slight increase in added sugar for stronger agreement with feeling bored/restless while on-duty, so for some firefighters emotions and/or boredom seem to be triggering some increases in on-duty sugar consumption.

On average, firefighters reported not having a hard time resisting free snacks. However, Convenience was the third rated trigger for eating, and the availability of snacks does offer a convenient eating opportunity. Obese firefighters, on the other hand, responded that Convenience was more often the trigger than Need & Hunger, Habits, or Health and reported having a significantly harder time resisting free snacks. The eating trigger of Convenience was positively correlated with an increase in added sugar and sodium in the on-duty diet ($p<.01$), and indicating having a harder time resisting free snacks was positively correlated with an increase in added sugar ($p<.01$). On average, firefighters slightly agreed that they plan ahead what they will eat, but there were no significant correlations between being more likely to express planning ahead and amount food intake in any category.

While Convenience was rated high, Price was not rated as triggering eating behavior nearly as often (although significantly more so for younger firefighters). On average, firefighters slightly agreed that their crew is willing to spend more money on food in order to eat healthy. Only 14.5% of firefighters responded that their crew is not willing to spend more for health food, while 30.5% of firefighters strongly agreed (rating of 6 or 7) that their crew is willing to spend more money to eat healthy. Stronger agreement with the crew being willing to spend more money on food to eat healthy was slightly associated with decreased consumption of fat and carbohydrates on-duty. This seems to suggest that for this group of firefighters, in contrast to responses from focus-group-based studies (Dobson et al., 2013; Haddock et al., 2011), they are willing to compromise cost for health.

The Fire Service Joint Labor Management Wellness Fitness Initiative recommends fire departments allocate 60 to 90 minutes per work shift for exercise (International Association of Fire Fighters, 2008). Not all stations are following this recommendation, but most are allocating some time for exercise. About 66% of firefighters responded that they use the time given to exercise, and about 33% responded that they exercise more while on-duty than off-duty. This on-duty exercise time seems to be very important. Using the on-duty exercise time was positively correlated with meeting the AHA recommendations ($p<.001$) and there was a small association between using the shift time to exercise and increased CRF levels. However, responding that they exercise more on-duty was inversely correlated with meeting the AHA recommendations ($p=.004$), and obese firefighters were more likely to say that they are exercising more on-duty than off-duty and were also somewhat less likely to report using the on-duty exercise time. This suggests that while allocating time during the shift for exercise helps firefighters meet the guidelines, encouraging the use of that time is crucial, and off-duty exercise also needs to be advocated.

In attempts to further reveal and support the suggested significance of the work environment on health behaviors, data on the family and home environment was also acquired. This factor, which has not received much attention in published studies, also seems to have a strong correlation with firefighters' health behaviors. Obese firefighters were less likely than non-obese firefighters to agree that their family members care about healthy eating and being physically active. The differences in responses between obese and non-obese firefighters were not as pronounced based on the value their *crew* places on healthy eating and exercise. This suggests that the family members' values on exercise are more correlated with an individual's health than the crew's values. Responding that family members care about healthy eating was correlated with decreased consumption of added sugar (p=.039) and sugar sweetened beverages (p=.006); however this correlation was not observed related to the crew caring about healthy eating. In addition, obese firefighters were somewhat more likely to respond that they exercise more on-duty than off-duty. Thus, their off-duty time includes less physical activity. This suggests that for obese firefighters the work environment may in some ways be promoting better health than their home environment. On the other hand, for non-obese firefighters the off-duty environment appears to be more supportive of healthy diet and exercise. For both groups though, the off-duty environment seems to be significantly correlated with their health behaviors.

Another possible variable that is affecting CVD risk among firefighters is work schedule. Firefighters typically work 24 hour shifts. Shift work is considered any job schedule that has employees working hours other than standard hours, and chronic shift work is correlated to increased BMI and a higher risk for developing metabolic syndrome, a clustering of several disorders that are central in the pathogenesis of CHD (Barclay et al., 2012). Shift work results in alterations of the secretion of endocrine factors, such as melatonin, growth hormone, prolactin, leptin and glucocorticoids, which affect metabolic function. The circadian clock is believed to play a major role in metabolic regulation, and shift work disrupts it. In their study, Barclay et al. (2012) noted that mice showed changes in hepatic energy utilization, impaired glucose tolerance, decreased leptin, and a potential for leptin resistance. Interruptions in the circadian clock would likely promote carbohydrate craving, reductions in leptin's appetite suppression effect, and increased food intake in humans during normal resting hours (Barclay et al., 2012). Shift workers of all professions have been found to have high levels of triglycerides, free-fatty acids and glucose and low levels of HDL (Soteriades, et al., 2011). In addition, more stress, lower positive mood scores, and greater sleepiness has been reported as effects of shift work (Paley & Tepas, 1994). Sleepiness and sleep disturbance is positively correlated with weight gain (Poston et al., 2012). However, this study was not able to assess for alterations in endocrine factors and did not include data on sleep and mood. Future studies may consider including this data in order to further evaluate the increased risk for CVD events in the fire service.

Limitations

There are several limitations in this study that need to be addressed. The primary limitation of this study is the cross-sectional design. Temporality and causality cannot be inferred by the data reported. Furthermore, the firefighter population was not compared to a similar control population. Internal validity may be weak due to confounding variables that affect individual health behaviors that this cross-sectional, descriptive epidemiological study cannot control. Another limitation is the small sample size and that all of the data was not available for all of the subjects. In addition, the data were not always collected at the same time point, however we did put a one year limit between responses for the same individual. This could have resulted in some misclassification bias. Participation in this study was completely voluntary and without any incentive so that may have contributed to participation bias. It is possible that those who participated had a lower number of CVD risk factors in comparison to data reported in larger studies and may also affect data on health behaviors and motivations. All information on diet was self-reported, so inaccuracies may have occurred, and social-desirability bias may have affected reporting. While the DHQ has been fully validated, the DSQ used in this study has only been partially validated, and the calculations were modified for this study to represent one-third of the month on-duty and two-thirds of the month off-duty. This may have resulted in some miscalculations. In addition, responses about eating triggers and other factors contributing to eating and exercising habits were all self-reported and subjective, and individuals may have different perspectives on ratings associated with usually to seldom and strongly agree to strongly disagree, and social-desirability bias may have affected these responses as well. Although the eating triggers questionnaire was based on a validated test, it was adapted and shortened for the study population and the additional questions were not screened for reliability or validity.

CHAPTER VI

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

While the cardiac events are all too common in the fire service, the risk factors are well known, detectable, and controllable. Firefighters are displaying a concerning proportion of these risk factors, and evidence suggests that diet and exercise are contributing to increases in risk, supporting the first hypothesis. Unhealthy eating habits were found to include high consumption of fat, sugar, and sodium and not consuming adequate fruits and vegetables, whole grains, and fiber. Some of the CVD risk factors directly correlated with these eating behaviors include increased fat mass and obesity, increased triglycerides, increased systolic blood pressure, decreased HDL, and increased overall coronary risk score. In addition, the on-duty diet was found to indicate slightly greater food intake than the off-duty diet for most individuals, suggesting overeating while on-duty may be likely. Low levels of cardiorespiratory fitness and reported physical activity were evident for some firefighters, and systolic blood pressure was inversely related to level of physical activity.

When examining the reasons for the diet and exercise habits, the volume of dispatch calls run by that station appeared to have only a modest association with the CVD risk factors and health behaviors; thus, not providing substantial evidence to support the second hypothesis at this time. Busier stations had firefighters with lower fat mass and tended to display lower BMI, triglycerides, and coronary risk. Stations with higher call volume also indicated consuming more calories, but no other correlations between call volume and eating or exercising habits were noted in this study.

The firefighters indicated that they do usually eat the same foods as their coworkers, and being more likely to eat the same as their crew showed a tendency to consume more added sugar and sugar-sweetened beverages and less fruits/vegetables and fat. Also believing that the crew care more about health showed correlation with lower consumption of carbohydrates. However, firefighters reported the eating trigger of social norms and sociability as less common triggers than liking, need and hunger, convenience, health, habits, weight control, and price. This study offers some support to the hypothesis that social norms influence eating habits but that its effect may not be as strong as believed.

This study offers support for the hypothesis that the firehouse environment includes unhealthy snacks provided by crewmembers and the community, and these snacks contribute to a less healthy diet. Availability and convenience was reported to be associated with diet, but among these participants price did not have a strong correlation with diet. Support for the belief that firefighters are more stressed and emotionally drained while at work was not provided by this study, but individuals who did indicate affect regulation as an eating trigger reported consuming more added sugar while on-duty. Reporting being conscientious about making eating choices based on health was associated with better eating habits, but responding that habit guided eating more often showed more unhealthy diet choices. In addition, the results from this study indicate that factors related to the family and home environment are often strongly associated with diet and exercise both positively and negatively.

Conclusion

From the results of the present study, some conclusions can be drawn. Eating habits are contributing to the risk of CVD among firefighters, and call volume does not appear to be strongly associated with the health behaviors or CVD risk. Social norms and group cohesion were associated with eating behaviors, seemingly more negatively than positively. Availability of unhealthy snacks at the firehouse was also associated with unhealthier eating habits. Affective motivations and price did not seem to have a strong association, but health-consciousness, habits, and family influences did seem to be correlated with diet and exercise behaviors.

Future Recommendations

Due to the cross-sectional nature of this study, we cannot determine if the diet and exercise were affecting the CVD risk factors or if knowledge of one's level of health was influencing the health behaviors. In addition, we were not able to control for multiple potential confounding variables. Therefore, a longitudinal study could better examine the changes in motivational factors, diet and CVD risk over time and take into consideration confounders. A larger and more heterogeneous sample would permit stronger evidence of correlations between variables that affect health among firefighters. More variables, including endocrine factors, could be analyzed. The food frequency questionnaire could be developed to specifically elicit on-duty versus off-duty diet records based on the number of actual days worked, and responses to the motivations for health behaviors could be provided by firefighters in less subjective manners.

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APPENDIX A

INFORMED CONSENT TO BE IN HDPP RESEARCH DATABASE

HEART DISEASE PREVENTION PROGRAM
RESEARCH DATABASE

PURPOSE OF THE RESEARCH DATABASE: The purpose of the Heart Disease Prevention Program (HDPP) is to develop a research database to be used to study interactions between physical/biological characteristics and cardiovascular disease risk. This is a “population study”, not unlike major studies like the Framingham Heart Study or the Nurses Health Study that are often in the news. With your consent, the data obtained from your visit to the Human Performance Clinical/Research Laboratory will be coded (for confidentiality) and entered into a large computer database. You may participate in the HDPP without giving consent for the use of your data for research purposes.

RESEARCH DATA TO BE USED: The following tests are included in the HDPP. We are asking for your consent to use the data obtained from these tests to develop a research database.

1. Health History Questionnaire
2. Underwater weighing for body composition
3. DEXA scan
4. Maximal treadmill test data
5. Resting ECG and blood pressure
6. Body height and weight, and body size.
7. Blood chemistry
8. Pulmonary function
9. Strength and flexibility

CONFIDENTIALITY:
Your data will be coded and kept in a locked file cabinet on the CSU campus. The data will also be coded and entered into a computer database. Your name will not appear in the computer database. A copy of the uncoded data may be sent to your personal physician or insurance company only upon your written request. However, you will not be identified in relation to your data for research purposes at any point. In addition, you should be advised that any time a researcher wishes to study the HDPP database to address a specific research question, we will seek approval of the Colorado State University to access the database to address that specific research question.

PARTICIPATION:
Your participation in this research database is voluntary. **If you decide to participate in the database, you are simply consenting to allow the use of the data obtained during your participation in the HDPP for the development of a research database**. Your signature acknowledges that you have read the information stated and willingly sign this consent form.

I agree to allow the use of my HDPP test data in the research database YES ☐ NO ☐

I agree to allow the HDPP research team to contact me in the future if I qualify for other research projects. By agreeing to allow the research team to contact me, I am NOT obligated to participate in any research study.
YES ☐ NO ☐

________________________ __________ ________________________
Participant Name (PRINT) DATE Participant Signature

Tiffany Lipsey ________ ______________________________
Investigator/co-investigator DATE Sign

APPENDIX B

SUBJECT RECRUITMENT

Email Recruitment

Re: Firefighter Health Study

Dear _____________,

I would like to invite you to participate in a study being conducted by the Health and Exercise Science Department at CSU. This study is about various environmental, social and personal factors that may affect health behaviors and cardiovascular disease risk among firefighters.

The estimated time commitment is 20-30 minutes. If you would like to take part in this study, then please:

1. Review and sign the attached consent form.
2. Complete and return the attached questionnaire on motivations for health behaviors.
3. Complete two Dietary Screener Questionnaires on-line.

To return completed Consent Form and Health Behaviors Questionnaire, either scan and email back to bduss25@gmail.com or fax to 970-491-7677 or send to:
Beth Dussinger
Department of Health and Exercise Science
1582 Campus Delivery
Fort Collins, CO 80523-1582

Participation is completely voluntary. All information will be kept confidential. If you have any questions about the study, please contact Beth Dussinger at bduss25@gmail.com or call 970-227-3644.

Thank you for your time and consideration. I look forward to hearing from you.

Beth Dussinger
Graduate Student, Health and Exercise Science
Colorado State University

The content of this email message has been approved by a CSU Institutional Review Board (IRB). IRBs are charged with protecting the rights and welfare of people who take part in research studies.

Recruitment flyer at fire station:

Firefighter Health Study

Do you want to help further research on factors that influence the health of firefighters?

If so, please consider participating in this health and exercise science research study.

The purpose of this study is to examine specific health behaviors and some of the environmental, social and personal motivations for these behaviors. This study is looking at various factors that may contribute to increased and decreased levels of cardiovascular disease risk among firefighters.

To participate, please:

- Take an envelope.
- Review and sign the consent form.
- Complete the questionnaire on health behaviors (<10 min.).
- Complete 2 on-line Dietary Screener Questionnaires (<20 min.).
- Please return by _______________, 2014
  - Scan and email to bduss25@gmail.com
  - *Or* fax to 970-491-7677
  - *Or* mail to:
    Beth Dussinger
    Department of Health and Exercise Science
    1582 Campus Delivery
    Fort Collins, CO 80523-1582

This study is being conducted by the Health and Exercise Science Department at CSU. All information will be kept confidential.

Please contact Beth Dussinger at bduss25@gmail.com or 970-227-3644 if you have any questions.

APPENDIX C

INFORMED CONSENT TO PARTICIPATE IN RESEARCH PROJECT

COLORADO STATE UNIVERSITY
INFORMED CONSENT TO PARTICIPATE IN A RESEARCH PROJECT

TITLE OF STUDY: Predictors of Health Behaviors and Cardiovascular Disease Risk Factors for Professional Firefighters

PRINCIPAL INVESTIGATOR: Dr. Tracy Nelson, PhD, Department of Health and Exercise Science; tracy.nelson-ceschin@colostate.edu and Beth Dussinger, Department of Health and Exercise Science; bduss25@gmail.com

CONTACT PERSON FOR QUESTIONS: Beth Dussinger; bduss25@gmail.com; 970-227-3644.

WHAT IS THE PURPOSE OF THIS STUDY? The purpose of this study is to examine specific health behaviors and some of the environmental, social and personal motivations for these behaviors. This study is looking at various factors that may contribute to increased and decreased levels of cardiovascular disease risk among firefighters.

WHY AM I BEING INVITED TO TAKE PART IN THIS RESEARCH? You are being invited to participate in this research because you are a full-time, professional firefighter.

WHO IS DOING THE STUDY? This study will be conducted by Beth Dussinger, a Master's student in the Health and Exercise Science Department.

WHAT WILL I BE ASKED TO DO AND HOW LONG WILL IT TAKE ME? If you agree to participate in this study, you will be asked to:

- Complete a web-based Dietary Screener Questionnaire twice, once based on past month food consumption while on-duty and once based on past month food consumption while off-duty. Each time, the questionnaire may take up to 10 minutes to complete. You will be able to logout and log back in to complete the questionnaires in multiple sittings.
- Complete a questionnaire entitled "Motivations for Health Behaviors". This questionnaire can be completed in less than 10 minutes.

The total time commitment will be approximately 20-30 minutes.

WHAT IS THE ANTICIPATED BENEFIT OF THIS STUDY? Information collected in this study may contribute to better understanding of factors that affect cardiovascular health in firefighters and practical ways that cardiovascular disease risk can be reduced.

WHAT OTHER INFORMATION WILL BE USED? The researcher will be collecting information on the emergency dispatch calls at your fire station. If you had an evaluation with the Heart Disease Prevention Program at CSU and gave consent to the use of your data for future research, this data may also be used for this study.

WHAT ARE THE POSSIBLE RISKS AND DISCOMFORTS? There are no known research risks for these questionnaires.

WILL I BENEFIT FROM TAKING PART IN THIS STUDY? There is no known personal benefit for participating in this study.

DO I HAVE TO TAKE PART IN THE STUDY? Your participation in this research is voluntary. If you decide to participate in this study, you may withdraw your consent and stop participating at any time without penalty.

WHAT WILL IT COST ME TO PARTICIPATE? There is no cost to participate in this study.

WHO WILL SEE THE INFORMATION THAT I GIVE? We will keep private all research records that identify you. You will not be identified in relation to your data for research purposes. You will be assigned a code number that will not include identifiable information such as your initials. Your information will be combined with information from other people taking part in the study. When we write about the study to share it with other researchers, we will write about the combined information we have gathered. You will not be identified in these written materials. We may publish the results of this study; however, we will keep your name and other identifying information private. We will make every effort to prevent anyone who is not on the research team from knowing that you gave us information, or what that information is. For example, your name will be kept separate from your research records and these two things will be stored in different places under lock and key.

WILL I RECEIVE ANY COMPENSATION FOR TAKING PART IN THIS STUDY? You will not receive compensation for taking part in this study.

WHAT HAPPENS IF I AM INJURED BECAUSE OF THE RESEARCH? The Colorado Governmental Immunity Act determines and may limit Colorado State University's legal responsibility if an injury happens because of this study. Claims against the University must be filed within 180 days of the injury.

WHAT IF I HAVE QUESTIONS? You may direct any questions about the study to Beth Dussinger at 970-227-3644 or bduss25@gmail.com.

Your signature acknowledges that you have read the information stated and willingly sign this consent form. Your signature also acknowledges that you have received, on the date signed, a copy of this document containing 2 pages.

______________________	___________	__________________
Participant Name (PRINT)	DATE	Participant Signature
______________________	___________	__________________
Investigator/co-investigator	DATE	Investigator Signature

APPENDIX D

COOPER CLINIC CORONARY RISK SCORE

CORONARY RISK PROFILE

NAME: | **MALES:** <30 YEARS OF AGE

Percentile Rankings	Balke Treadmill Time (min)	Total Cholestrol/ HDL Ratio	Triglyceride (mg. %)	Glucose (mg.%)	% Body Fat	RESTING BLOOD PRESSURE SYSTOLIC (MM HG)	DIASTOLIC (MM HG)
YOUR VALUES							
99	30.21	2.2	31.0	71.7	2.2	90.0	56.0
97	28.00	2.5	40.0	77.0	4.2	98.0	60.0
95	26.23	2.6	45.0	79.7	5.4	100.0	62.0
90	25.00	2.9	51.0	83.0	7.6	105.0	66.0
85	23.00	3.0	56.0	86.0	8.7	110.0	68.0
80	22.25	3.2	61.0	87.0	9.8	110.0	70.0
75	22.00	3.4	65.0	89.0	11.3	112.0	70.0
70	21.00	3.5	70.0	90.0	12.2	115.0	72.0
65	20.22	3.7	75.0	91.0	13.1	118.0	74.0
60	[2] 20.00	3.8	80.0	93.0	14.1	118.0	76.0
55	19.25	4.0	85.0	94.0	15.0	120.0	78.0
50	19.00	4.1	91.0	95.0	16.0	120.0	78.0
45	18.00	4.2	97.0	96.0	16.9	120.0	80.0
40	18.00	4.4	104.0	98.0	17.6	122.0	80.0
35	17.00	[1] 4.5	114.1	100.0	18.3	124.0	80.0
	[4]		[1]		[1]		
30	16.25	4.7	123.0	100.0	19.7	127.0	80.0
						[1]	
25	15.40	4.9	133.0	102.0	20.9	130.0	82.0
		[2]					
20	15.00	5.1	148.0	104.0	22.1	130.0	84.0
		[3]			[2]		[1]
15	14.00	5.6	170.0	106.0	23.8	134.0	88.0
	[5]						
10	13.00	[4] 6.0	196.0	110.0	25.9	[2] 140.0	[2] 90.0
5	11.00	[6] 7.0	[2] 263.8	114.2	[3] 29.6	142.0	94.0
3	10.00	7.3	304.9	118.0	32.8	148.1	96.0
		[7]		[1]		[3]	
1	7.52	8.9	437.2	123.5	38.9	155.0	100.0
		[10]		[3]		[4]	[4]
n	1,372	386	1,073	1,074	939	1,397	1,397

Personal History of Heart attack or bypass

- 0 ☐ none
- 2 ☐ over 5 years ago
- 4 ☐ 2-5 years ago
- 5 ☐ 1-<2 years ago
- 8 ☐ 0-<1 years ago

Family History of Heart Attack

- 0 ☐ None
- 2 ☐ Yes, over 50 years
- 4 ☐ Yes, 50 years or under

- 6 ☐ Known coronary heart disease w/o heart attack or bypass

Smoking Habits

- 0 ☐ none
- 0 ☐ Past 1 year or more
- 1 ☐ Past only less than 1 year
- 1 ☐ Pipe/Cigar
- 2 ☐ 1-10 Daily
- 3 ☐ 11-20 Daily
- 4 ☐ 21-30 Daily
- 5 ☐ 31-40 Daily
- 6 ☐ More than 40 daily

Tension-Anxiety

- 0 ☐ No Tension, very relaxed
- 0 ☐ Slight Tension
- 1 ☐ Moderate Tension
- 2 ☐ High Tension
- 3 ☐ Very Tense, "High Strung"

- 3 ☐ Diabetes

Age Factor

- 0 ☐ under 30 yrs age
- 1 ☐ 30-39 years of age
- 2 ☐ 40-49 years of age
- 3 ☐ 50-59 years of age
- 4 ☐ 60 + years of age

Resting ECG		Exercise ECG	
0 ☐	Normal	☐	0
1 ☐	Equivocal	☐	4
3 ☐	Abnormal	☐	8

Total coronary risk

- ☐ very low (0 - 4)
- ☐ low (5-12)
- ☐ moderate(13-21)
- ☐ high (22-31)
- ☐ very high (32 +)

Adapted from Cooper Clinic

APPENDIX E

MOTIVATIONS FOR HEALTH BEHAVIORS QUESTIONNAIRE

Motivations for Health Behaviors Questionnaire

Please mark one box in each row indicating about how often your eating is motivated (at least in part) by that statement.

I eat what I eat…	**Usually**		**Occasionally**			**Seldom**	
	7	6	5	4	3	2	1
…because I feel like eating it.	☐	☐	☐	☐	☐	☐	☐
…because it tastes good.	☐	☐	☐	☐	☐	☐	☐
…because I am accustomed to eating it.	☐	☐	☐	☐	☐	☐	☐
…because I grew up with it.	☐	☐	☐	☐	☐	☐	☐
…because I need energy.	☐	☐	☐	☐	☐	☐	☐
…because I'm hungry.	☐	☐	☐	☐	☐	☐	☐
…because it is pleasantly filling.	☐	☐	☐	☐	☐	☐	☐
…because it is healthy.	☐	☐	☐	☐	☐	☐	☐
…to maintain a balanced diet.	☐	☐	☐	☐	☐	☐	☐
…because it keeps me in shape.	☐	☐	☐	☐	☐	☐	☐
…because it is quick and easy to prepare.	☐	☐	☐	☐	☐	☐	☐
…because it is readily available.	☐	☐	☐	☐	☐	☐	☐
…because it is the most convenient.	☐	☐	☐	☐	☐	☐	☐
…in order to reward myself.	☐	☐	☐	☐	☐	☐	☐
…because it puts me in a good mood.	☐	☐	☐	☐	☐	☐	☐
…because I deserve it.	☐	☐	☐	☐	☐	☐	☐
…so that I can spend time with others.	☐	☐	☐	☐	☐	☐	☐
…to be social.	☐	☐	☐	☐	☐	☐	☐
…because it is inexpensive or on sale.	☐	☐	☐	☐	☐	☐	☐
…because it is a good value for money.	☐	☐	☐	☐	☐	☐	☐
…because it is free.	☐	☐	☐	☐	☐	☐	☐
…because I feel stressed.	☐	☐	☐	☐	☐	☐	☐
…as a distraction.	☐	☐	☐	☐	☐	☐	☐
…because it cheers me up.	☐	☐	☐	☐	☐	☐	☐
…because I feel sad or frustrated.	☐	☐	☐	☐	☐	☐	☐
…because I am bored.	☐	☐	☐	☐	☐	☐	☐
…because it would be impolite not to.	☐	☐	☐	☐	☐	☐	☐
…because my coworkers eat it.	☐	☐	☐	☐	☐	☐	☐
…because my family eats it.	☐	☐	☐	☐	☐	☐	☐
…because I am supposed to eat it.	☐	☐	☐	☐	☐	☐	☐
…because I want to lose weight.	☐	☐	☐	☐	☐	☐	☐
…because it is low in calories.	☐	☐	☐	☐	☐	☐	☐
…because it is low in fat.	☐	☐	☐	☐	☐	☐	☐
…to lower my risk of heart disease.	☐	☐	☐	☐	☐	☐	☐

Please rate how strongly you agree or disagree with each of the following statements by marking the appropriate box.

	Strongly Agree				**Strongly Disagree**		
	7	6	5	4	3	2	1
I eat more than usual when I see others eating.	☐	☐	☐	☐	☐	☐	☐
I snack more off-duty than on-duty.	☐	☐	☐	☐	☐	☐	☐
Community members often provide desserts or unhealthy snacks.	☐	☐	☐	☐	☐	☐	☐
Someone from the crew (or the overtime person) often brings an unhealthy treat to share.	☐	☐	☐	☐	☐	☐	☐
I have a hard time resisting free snacks.	☐	☐	☐	☐	☐	☐	☐
I eat better (more healthy) at work than at home.	☐	☐	☐	☐	☐	☐	☐
I eat larger portion sizes of food at work than at home.	☐	☐	☐	☐	☐	☐	☐
I eat “fast food” more while on-duty than off-duty.	☐	☐	☐	☐	☐	☐	☐
I eat larger meals while on duty because I know I might be too busy to eat the rest of the day.	☐	☐	☐	☐	☐	☐	☐
Sometimes we have eating competitions at work.	☐	☐	☐	☐	☐	☐	☐
The others in my crew eat healthy.	☐	☐	☐	☐	☐	☐	☐
My crew and I are willing to spend more money on food in order to eat healthy.	☐	☐	☐	☐	☐	☐	☐
At work, we usually plan ahead what we will eat. (We have a meal plan(s) before we go to the store.)	☐	☐	☐	☐	☐	☐	☐
At work, I usually eat the same food as my coworkers.	☐	☐	☐	☐	☐	☐	☐
A firefighter that doesn’t eat what the rest of the crew is eating is kind of an outcast.	☐	☐	☐	☐	☐	☐	☐
I follow a specific diet practice/regimen as much as possible. (Paleo, gluten-free, etc.)	☐	☐	☐	☐	☐	☐	☐
I have a desire to eat when I am upset, discouraged, or emotionally drained.	☐	☐	☐	☐	☐	☐	☐
I am more often upset, discouraged or emotionally drained while on-duty than off-duty.	☐	☐	☐	☐	☐	☐	☐
I have a desire to eat when I am bored or restless.	☐	☐	☐	☐	☐	☐	☐
I am more often bored or restless on-duty than off-duty.	☐	☐	☐	☐	☐	☐	☐
My family members care about healthy eating.	☐	☐	☐	☐	☐	☐	☐
My family members care about being physically active.	☐	☐	☐	☐	☐	☐	☐
Many in my crew care about healthy eating.	☐	☐	☐	☐	☐	☐	☐
Many in my crew care about being physically active.	☐	☐	☐	☐	☐	☐	☐
I exercise more on-duty than off-duty.	☐	☐	☐	☐	☐	☐	☐
During every shift, I use the time given to exercise.	☐	☐	☐	☐	☐	☐	☐
I get at least 150 minutes of moderate to vigorous aerobic activity every week.	☐	☐	☐	☐	☐	☐	☐

Please report: Your weight: ______ pounds   Your height:_________   Your age: ________

Over the past year, I have ☐ gained weight   ☐ lost weight   ☐ stayed about the same.
(Mark one.)

Current department: ___________________________________

Current station: __________________________________   Shift: _________________
☐ Single company   ☐ Double company

Length of time there: _________

Other stations you have been at over the past 5 years: ______________________________

____

____

Are you a ☐ captain   ☐ firefighter   ☐ other: ________________________?

Name ___________________________________ Date ___________________________

APPENDIX F

DIETARY SCREENER QUESTIONNAIRE

Dietary Screener Questionnaire

To complete your Dietary Screener Questionnaire, please go to: https://appliedresearch.cancer.gov/dsq-respondent.html**.**

The Study Code is FFHEALTH.

Please complete both questionnaires to provide information on your diet both on-duty and off-duty. If you are not able to complete your questionnaires in one setting, you can log back in at a later time. The questionnaire may take up to about 10 minutes to complete each time

To begin your questionnaire based solely on food consumption while on-duty over the past month, please use this login and password:

Respondent ID: ____________
Password: ____________

To begin your questionnaire based solely on food consumption while off-duty over the past month, please use this login and password:

Respondent ID: ___________
Password: ___________

Thank you for your time in participating in this research.

If you have any questions or concerns, please contact Beth Dussinger at bduss25@gmail.com or 970-227-3644.