

THESIS

DEPRESSIVE SYMPTOMS AND METABOLIC SYNDROME RISK FACTORS IN MALE
AND FEMALE COLORADAN FIREFIGHTERS

Submitted by

Corrine H. Voss

Department of Health and Exercise Science

In partial fulfillment of the requirements

For the Degree of Master of Science

Colorado State University

Fort Collins, Colorado

Spring 2017

Master's Committee:

Advisor: Dale DeVoe

Tiffany Lipsey
Kimberly Henry

Copyright by Corrine H Voss 2017

All Rights Reserved

ABSTRACT

DEPRESSIVE SYMPTOMS AND METABOLIC SYNDROME RISK FACTORS IN MALE AND FEMALE COLORADAN FIREFIGHTERS

Posttraumatic stress disorder (PTSD), sleeping disorders, and obesity are emerging traits among emergency workers. According to the National Fire Protection Association, as many as 37% of firefighters exhibit PTSD symptoms. Depression, distressed sleep, and PTSD are only a few symptoms associated with the rise in suicide rates among firefighters in recent years. Firefighters are also four times more likely to encounter a cardiovascular episode than the general public. Cardiovascular disease is responsible for 45% of firefighter deaths each year. Most cardiovascular disease is caused by factors that can be monitored, measured and modified. The clustering of several cardiovascular disease risk factors (abdominal obesity, hypertriglyceridemia, low HDL cholesterol, elevated blood pressure, and hyperglycemia) is termed the metabolic syndrome (MetS). MetS includes at least three of the following five characteristics: abdominal obesity (waist circumference >102 cm in men or >88 cm in women), elevated plasma triglycerides (≥ 150 mg/dL), decreased HDL cholesterol (<40 mg/dL in men or <50 mg/dL in women), elevated blood pressure (≥ 130 mmHg systolic or ≥ 85 mm Hg diastolic), and impaired fasting blood glucose (≥ 110 mg/dL).

Depressive symptoms have been linked to several MetS risk factors including insulin resistance, high blood pressure and abdominal adiposity. Research suggests MetS and heart disease are caused by chronic stress and depression paired to poor health habits. Little is known, however, regarding depression and MetS among firefighters. Therefore, the purpose of this study

was to examine depressive symptoms (CES-D questionnaire) and MetS risk factors among FTP firefighters through the following questions; *what are depressive symptoms and MetS risk factor profiles among female firefighters compared to male? Is there an association between depressive symptoms and MetS risk factors at time one? Are depressive symptoms related to the change in MetS risk factors from time one to time two?* Data was utilized from the Firefighter Testing Program (FTP), which *seeks to assess known risk factors for cardiovascular disease, reduce the likelihood of developing heart and vascular disease and utilize cardiovascular risk factor status in developing individualized strategies for lifestyle changes* at Colorado State University.

Main findings were (1) no statistical difference between female and male CES-D depressive symptom scores, (2) no association between MetS risk factors and depressive symptoms, and (3) too small of a sample size to determine any longitudinal changes in MetS risk factors. Confounder variables within the study could be increased awareness of mental health among firefighters, low female sample sizes, acute firehouse incidents, the “healthy worker effect,” increased resilience levels, or time allotted to pursuing physical fitness during shift hours. Further study with other variable relationships, larger sample sizes and following critical firehouse events should be conducted to further expand the literature. Departmental enforcement of both fitness and mental health standards would be an essential step to insure firefighter effectiveness, safety and wellbeing.

ACKNOWLEDGEMENTS

The completion of this thesis represents the culmination of much support and encouragement from those around me. First I'm most thankful to Jesus Christ, His grace and love abounding astonishes me every day. I'd also like to thank my wonderful husband Matt for all of his support and love during my studies and writing. My family Peter, Margery and Sydney Walters and the Voss family have also been extremely supportive. To all of the professor role models in my life, Dr. Peter Walters, Dr. Hank Voss, Dr. Matthew Renfrew, Dr. Bill Heth, Dr. Gerry Root and Dr. Erik Hayes, thank you for believing in me and encouraging me to pursue higher education. I admire your teaching, interactions with students and ardent perusal for knowledge. I hope that one day I might be a professor similar to you.

TABLE OF CONTENTS

ABSTRACT	ii
ACKNOWLEDGEMENTS	iv
 I.INTRODUCTION.....	 1
Current Firefighter Health Status	1
<i>Psychological health</i>	1
<i>Physiological health</i>	4
<i>Duty standards</i>	6
The Metabolic Syndrome	6
<i>Definition</i>	6
<i>Prevalence</i>	7
Mental Health	8
<i>Depression</i>	8
<i>Resilience</i>	10
<i>Sex differences</i>	12
The Metabolic Syndrome and Biological Pathways	12
<i>Suggested pathways</i>	12
<i>Stress</i>	13
<i>Cortisol and other hormones</i>	14
<i>Other components of the biological pathways</i>	16
Overall Purpose	17
Hypotheses	17
Specific Aims	17
Expected Outcomes	18
 II.METHODS	 19
Study Design	19
Subject Selection	19

Procedures	22
<i>Depression</i>	22
<i>Metabolic Syndrome risk factors</i>	22
Waist circumference	22
Blood pressure	22
Blood chemistry: triglycerides, HDL cholesterol, glucose	23
Statistical Analysis	23
 III.RESULTS	 25
<i>Hypothesis 1: Female firefighters will exhibit more depressive symptoms and less metabolic syndrome risk factors compared to male.</i>	
<i>Hypothesis 2: There will be an association between depressive symptoms and metabolic syndrome risk factors at time one.</i>	
<i>Hypothesis 3: There will be a negative change in metabolic syndrome risk factors from time one to time two among firefighters with elevated depressive symptoms (16 or more symptoms)</i>	
 IV.DISCUSSION	 34
The Metabolic Syndrome and Depression	34
Implications Within Fire Agencies	37
Delimitations, Limitations, and Assumptions	38
 V.SUMMARY, CONCLUSIONS, AND FUTURE RECOMMENDATIONS	 40
Summary	40
Conclusions	40
Future Recommendations	41
 REFERENCES	 43
 APPENDICES	 61
A. Heart Disease Prevention Program Informed Consent	61

B. IRB approval	63
C. Center for Epidemiological Studies Depression Questionnaire (CES-D)	64
D. Scoring template	66
E. Circumference protocol.....	67
F. Blood pressure detailed protocol	68
G. Blood chemistry results example	69

Introduction

Psychological Health

Research suggests emergency responders have increased exposure to emotional demands, affecting their mental health and sleep quality (Kallestad et al., 2012). Fire service personnel are expected by society to bravely serve in crisis situations and unfortunately, firefighter mental health is often overlooked. Firefighters and EMS personnel are frequently exposed to critical events and often have no outlet for debriefing or consultation (Choi et al., 2011). Others choose not to utilize the employee assistance programs offered (Gist, 2007; McMahon, 2010).

Firefighters are trained to save burning buildings, however dealing with drowning, mental illness, suicide, etc. requires an entirely separate skill set (Dorfman & Walker, 2007).

Firefighters rarely grasp the magnitude of crisis before answering a call and are required to act quickly and professionally.

Hegg-Deloye's review of the literature (2014) found trends toward post-traumatic stress disorder (PTSD), sleeping disorders, and obesity among emergency workers. According to the National Fire Protection Association, as many as 37% of firefighters exhibit (PTSD) symptoms. In a large scale (8,487 firefighters) computerized screening study, 76% reported at least one symptom of PTSD and 12% elevated risk for PTSD (Corrigan et al., 2009). In France, compared to the general population, there is an elevated prevalence of PTSD among both professional and volunteer firefighters (4%) (Bordron et al., 2013). The effects of PTSD include elevated dissociation and detachment from society (DeLorme, 2015).

Not only is PTSD a side effect of the emotional demands of emergency workers, symptoms could give rise to more serious outcomes such as suicide. Savia (2008) found North Carolinian firefighter death by suicide three times more likely than line of duty deaths from

1984-1999. The Firefighter Behavioral Health Alliance (FFBHA) identified 360 suicides among firefighters between 2000 and 2013 with increasing number of deaths in more recent years (Dill, 2015). In response to these data, in the summer of 2014, the International Association of Fire Fighters (IAFF) and the International Association of Fire Chiefs (IAFC) issued more specific recommendations regarding behavioral health for firefighters, including the addition of holistic wellness initiatives, education regarding warning signs of behavioral stress and depression, and outlets for struggling firefighters (Morrison & Leto, 2013). In 2011, the National Fallen Firefighters Foundation (NFFF) held a meeting to discuss Depression and Suicide in the Fire Service (Nock, n.d.). The committee created an agenda to allocate resources to address behavioral health needs of firefighters and their families. In 2013, “Stress First Aid” was introduced into the fire services, a service originally developed by the U.S. Navy.

Other firefighter mental health proposals include Initiative 13 among the “16 Firefighter Life Safety Initiatives” stating, “Firefighters and their families must have access to counseling and psychological support.” The National Fire Protection Association (NFPA) 1500 Standard on Health and Safety requires mental health assistance programs be made available. Initiative 13 is one of 16-firefighter life safety initiatives within the *Everyone Goes Home* organization founded by the National Fallen Firefighters Foundation in 2004. The goal of this program is to decrease the number of preventable line-of-duty injuries and deaths among firefighters. Within Initiative 13, the Protocol for Exposure to Occupational Stress is identified. This model emphasizes individualized reactions to frequent potentially traumatic events (PTEs) on the job. The Trauma Screen Questionnaire is recommended as a tool to identify those in need of behavioral assistance. Firehouses are beginning the shift from utilizing employee assistance programs (EAP) to

specifically behavioral health assistance programs (BHAP), creating resources and exposure for the underpublicized problem (Holland, 2013).

Within the field of mental health, depression has been recognized as a significant risk factor for type II diabetes and CVD (Everson-Rose & Lewis, 2005; Kubzansky et.al, 1998; Musselman et al., 2003). Some studies hypothesize that these psychological factors could be associated with increased risk for disease through the development of the metabolic syndrome (discussed shortly) (Räikkönen et al., 2004; Nelson, Palmer, & Pedersen, 2004). Other data suggests the metabolic syndrome effects risk of disease via psychological factors (Todaro et al., 2005).

Depression, distressed sleep, and PTSD are only a few symptoms attributed to the rise in suicide rates among firefighters in recent years; sleep deprivation may also play a role. Carey et al. (2011) found depression among 11% of firefighters and poor mental health, as assessed by the Psychosocial Well-Being Index, among 21%. Depression is found to be associated with firefighter sleep disorders (Lim et al., 2014). Furthermore, it is suggested that psychological distress, psychosomatic disturbances and suicidal ideation may be associated with firefighter sleep disturbance (Vargas de Barros et al., 2013).

Several protective factors or *safeguards that enhances a person's ability to resist stressful life events, risks, or hazards and promote adaptation and competence* (Kia-Keating, 2011) exist among firefighters with depression. These factors include mindfulness, perceived social support, resilience (Lee et al., 2014), emotional intelligence, and proactive coping (Wagner & Martin, 2012). Several coping methods or therapies have been presented among traumatized firefighter populations. Narrative Exposure Therapy (Alghamdi, Hunt, & Thomas, 2015), Firefighter

Coping Self- Efficacy (FFCSE) (Lambert et al., 2012) and coping humor (Sliter, Kale, & Yuan, 2014) all may alter PTSD or depressive symptoms among firefighters.

There are other factors influencing PTSD / depression positively or negatively, including *being female, critical incident exposure, critical incident stress debriefing attendance, occupational support, occupation satisfaction, occupational effort, problem-focused coping, and emotion-focused coping* (Sattler, Boyd, & Kirsch, 2014). Meyer et al. (2012) further added to the list of factors; occupational stress and interaction between perceived social support and self-blame. Years on the job also appears to influence depression levels, as more experienced firefighters indicate lower levels of social support and self efficacy compared to new recruits (Regehr et al., 2003).

Depression and mental health among firefighters is multifaceted and not entirely understood. Several research studies and psychological texts have brought limited exposure to underlying causes and treatments. Firefighter depression risk factors as well as protective factors are slowly emerging, but have yet to be entirely identified and explored. Future research is needed to explicate the risk for depression among firefighters and assess several variables, including metabolic syndrome risk factors, which may contribute to firefighter mental health.

Physiological Health

The United States depends on the services of fire and rescue teams to respond in crisis events. Physical and mental health of fire services personnel plays a critical role in effective responses. Significant elevations in heart rate, core temperature, and respiratory exertions (rushing in response to a call or upon a traumatic sight) are only a few of the physiological adaptations firefighters encounter on the job (Petruzzello et al., 2014).

Physical fitness is associated with better performance among firefighters (Elsner & Kolkhorst, 2008; Michaelides et al., 2008; Rhea, Alvar, & Gray, 2004). Unfortunately, data suggests firefighters may fail to meet physical and/ or mental health standards. Poston et al. (2011) found 80% of firefighters in the Missouri Valley obese or overweight by foot-to-foot bioelectrical impedance and BMI. Other studies have found data ranging from 73% to 88% prevalence of overweight and obese by BMI, bioelectrical impedance, and waist circumference in fire service workers (Donovan, 2008; Kales, 2007; Clark, 2002; Mancuso, 2003; Sotariades et al., 2008; Tsismenakis, 2009). These studies suggest firefighter personnel may have a higher prevalence of obese and overweight individuals than the United States population (approximately two thirds of 3.25 million) (Ogden et al., 2006). Obese firefighters are not only at elevated risk for cardiovascular disease (CVD), they may be almost three times more likely to accrue a musculoskeletal injury over time (Jahnke et al., 2013).

Regrettably, only 30% of US fire departments are implementing fitness and wellness programs within shift hours (Storer et al., 2014). This may be due, in part to unpredictable working conditions, not knowing how, when or where services are most needed. This may also be due to budget restraints.

Lifestyle factors, such as exercise, smoking, and alcohol consumption, may also play a role in predicting health outcomes among firefighters (Murphy et al., 2002). Several epidemiological studies among the general population suggest sedentary work, shift work tasks, long work hours, low job control, high job demands, high job strain, and low social support on the job may contribute to rising obesity levels within the American work force (Brunner et al., 2002; Ishizaki et al., 2008; Block et al., 2009; Lakdawalla et al., 2007; Shileds, 2002; Yamada et al., 2002; van Amelsvoort, 1999; Scheer et al., 2009; Morikawa et al., 2007; Ostry et al., 2006;

Mummery, et al., 2005; Ishizaki et al., 2004). Choi et al. (2011) identified specifically within the fire service, longer and more numerous shifts, low support for exercise (organizational, supervisorial, and coworker), and exposure to critical events (job strain) exist. These may lead to infrequent exercising at work, exhaustion, psychological distress, PTSD, stress related overeating, and obesity (Choi et al., 2011).

Duty Standards

According to the National Fire Protection Agency, firefighter personnel are required to meet minimum fitness standards of up to 12 metabolic equivalents (METS) (NFPA, 2013; Van Zandit, 2011). One MET is defined as the amount of oxygen consumed while sitting at rest (approximately 3.5 mL/kg/min) (Jetté, Sidney, & Blümchen, 2009). Baur et al. (2012) detected firefighters in the lowest fitness category ($\text{METS} \leq 10$) had nearly 10 fold greater prevalence of the metabolic syndrome compared to those in with $\text{METS} > 14$. The metabolic syndrome (MetS) is inversely related to cardiorespiratory fitness and directly related to cardiovascular disease (CVD) (Baur et al., 2012; Martin et al., 2011). In other words, fitness is inversely related to MetS, specifically among the firefighter population (Chung, 2015). MetS, its symptoms, prevalence, and individual components requires further investigation.

The Metabolic Syndrome

Definition

Various comorbidities have been identified in relation to obesity including cardiovascular disease and MetS. CVD is the leading cause of firefighter death (in the line of duty), approximately 45% (Baur et al., 2011; Carey et al., 2011; CVDC, 2015). Firefighters are four

times more likely to encounter a cardiovascular episode than the general public (Carey et al., 2011). The clustering of several CVD risk factors (abdominal obesity, hypertriglyceridemia, low high density lipoprotein (HDL) cholesterol, elevated blood pressure, and hyperglycemia) or MetS is linked to heart disease, morbidity and mortality (Glassi, Reynolds, & He, 2006; Alberti & Zimmet, 1998). The World Health Organization (WHO), International Diabetes Foundation (IDF) as well as the United States National Cholesterol Education Program Adult Treatment Panel III (ATP III) offer MetS characteristics (Alberti & Zimmet, 1998; Grundy et al., 2005; Alberti et al., 2005). Compiled characteristics include at least three of the following five characteristics: abdominal obesity (waist circumference >102 cm in men or >88 cm in women), elevated plasma triglycerides (≥ 150 mg/dL), decreased HDL cholesterol (<40 mg/dL in men or <50 mg/dL in women), elevated blood pressure (≥ 130 mm Hg systolic or ≥ 85 mm Hg diastolic), and impaired fasting blood glucose (≥ 110 mg/dL) (ATP III, 2005; Grundy et al., 2005).

Prevalence

The prevalence of MetS increases from 7% in 20-29 year olds to 42% in adults 60 years of age and older (Ford et al, 2002). Stroke, CVD and myocardial infarctions have two to three times greater prevalence in subjects with MetS than those who do not (Lakka et al., 2002; McNeill et al., 2005). Magyari et al. (2008) found 28% of firefighters of several Midwestern states met the criteria for MetS (n= 169, age= 20-59). In another study, Donovan et al. (2008) found 15% of northern Colorado firefighters meeting criteria for MetS (n= 214, age= 39). Although these values are similar to American adults nation wide, the physical demands of firefighting may increase risk for heart attack and sudden death.

There are some confounding data regarding physical health status of firefighter personnel. There is a selection bias for employment, typically attracting the young and physically fit. Vena and Fiedler (1987) termed this phenomenon the “healthy worker effect” where employers are more physically fit than the unemployed (in the specified occupation). Unemployed individuals may be too physically ill to work thus, may skew Vena and Fiedler’s observation regarding a reduced risk for coronary heart disease (CHD) in firefighters compared to the general population (Hennekens & Buring, 1987).

Mental Health

Depression

Depression is defined as *the diagnosis of minor or major depressive disorder or depressive symptoms* (Goldbacher & Matthews, 2007). Overall, data supports depression impacting MetS, especially among women. Räikkönen, Matthews, and Kuller (2002) found Beck Depression Inventory depressive symptoms (Kühner et al., 2007) predicted longitudinal risk for developing MetS (7.4 years later) in middle-aged women. The follow up study demonstrated depressive symptom scores predicted increased risk for development and greater cumulative prevalence of MetS risk factors among the women, but not men (Räikkönen, Matthews, & Kuller, 2007).

Apart from longitudinal studies, several cross sectional studies have investigated the association of both major depression (Kinder et al., 2004; Heiskanen et al., 2006) and depressive symptoms (McCaffery et al., 2003; Skilton et al., 2007) with MetS among men and women. Herva et al. (2006 b) found no association between MetS and depression; results may be attributed to the lack of separating men and women into independent groups.

Among more specific factors within MetS, blood glucose and abdominal adiposity play significant roles. Insulin resistance could be caused by abdominal adiposity, reflected by blood glucose levels (a MetS risk factor). Research data overall suggests a positive association between major depression, insulin resistance and abdominal adiposity. Among older and middle aged men, depressive symptoms may be associated with elevated insulin and glucose levels (Ahlberg et al., 2002; Räikkönen, Keltikangas-Järvinen, & Hautanen, 1994) and insulin resistance during midlife (Timonen et al., 2006). This is not the case among younger men (Suarez, 2006). Among women, a positive association between insulin resistance and depressive symptoms has been observed (Suarez, 2006). Baseline depression scores predicted increased insulin resistance and depressive symptoms in women (associated with elevated waist circumferences and low physical activity levels) (Everson-Rose et al., 2004). Multiple cross sectional reviews have found both men and women with clinical depression possessing elevated insulin resistance impairment (Kahl et al., 2005; Amsterdam, Schweizer, & Winokur, 1987; Amsterdam & Maislin, 1991; Koslow et al., 1982; Weber et al., 2000). One study did not find the same relationship among women (Amsterdam & Maislin, 1991).

Depressive symptoms tend to have an association with abdominal adiposity among women. In one longitudinal study, depressive symptoms predicted greater waist to hip ratio among middle-aged women, not men (Nelson et al., 1999). Räikkönen et al. (1999) found depressive symptoms were related to greater waist circumference in postmenopausal women cross-sectionally. A variety of cross sectional studies among men and women have shown a positive association between depressive symptoms and waist to hip ratio (Herva et al., 2006 a; Ahlberg et al., 2002; Haukkala & Uutela, 2000; Wing et al., 1991). Two studies with limited variability in waist to hip ratios presented contradicting data for women. Findings should be

carefully interpreted due to underrepresentation of range in waist to hip ratio (Herva et al., 2006 a; Cota et al., 2001).

Weber-Hamann et al. (2006) found a greater increase in abdominal adipose tissue over time among men and women diagnosed with a major depressive episode compared to controls. However during follow-up, no significantly greater abdominal adipose tissue than controls was noted. Depressed young adults within cross sectional studies exhibit greater levels of abdominal adiposity (Miller et al., 2003; Eskandari et al., 2005; Kahl et al., 2005). Two studies did not find differences in abdominal adiposity in depressed older women (Hach et al., 2006; Weber-Hamann et al., 2002).

It is important to note some studies have found a bidirectional relationship between depression and metabolic disorders (Evans et al., 2005; Katon, 2003). In other words, MetS appears to be a contributor to depression and depression seems to contribute to MetS risk factors. For purposes of this study, the Center for Epidemiological Studies Depression Scale (CES-D) (Radloff, 1977) is utilized for measurements of depressive symptoms (over 16 symptoms classifies “depressive”) among firefighters.

Resilience

Resilience may play a role in firefighter depression and PTSD; firefighters with high resilience are protected from both direct and indirect impacts of traumatic stress compared to lower resilience firefighters (Lee, 2014). Although data suggests firefighters have elevated risk for depression and other mental health problems, some studies suggest they possess elevated resilience levels (Meyer et al., 2012). Resilience is defined as *positive adaptation or the ability to maintain or regain mental health, despite experiencing adversity* (Herrman et al., 2011). This

results from having encountered serious life situations and having coped successfully (Rutter, 1993; Rutter et al., 1995). Resilience appears both a genetic and environmental protective factor; healthy individuals appear to express more resilience than ones with mood disorders (G Camardese, Serrani, Szczepanczyk, Walstra, & Janiri, 2014).

Little research has been done directly investigating resilience, however the topic is slowly emerging among the literature. The United States Army is taking steps toward comprehensive soldier fitness, in instilling the *Master Resilience Training Initiative* (Peeters, Jonge, & Taris, 2013) to encourage resilience development for stressors of combat. Among firefighters, Regehr (2009) found factors opposing resilience (insecurity, lack of personal control, and alienation) all contributed to elevated experience of depression and PTSD after distressing events. Other studies allude to positive impacts of instigating resilience training and decreasing firehouse occupational stressors (Meyer et al., 2012; Sattler et al., 2014). Lee et al. (2014) examined resilience among Korean firefighters and found PTSD symptoms were moderated by individual resilience. Firefighters with high resilience were protected from both direct and indirect impacts of traumatic stress compared to lower resilience firefighters.

In a study of Chilean firefighters, intense emotional demands and social support from one's firehouse chief affected firefighter resilience (Bernabé & Botia, 2015). A strong social network is a resilience promoting factor among first responders, significantly benefiting mental health (Prati & Peitranтони, 2010). This network extends to time off the job, as Kent (2013) identified the value of fostering familial and couple resilience within firefighter extended family.

Sex Differences

Some differences in MetS risk factor association with depression have been observed across the sexes. It may be likely that depression is a better predictor in females for MetS risk factors (Kinder et al., 2004) while aggression and hostility may be better predictors among young males (Ravaja, Keltikangas-Järvinen, & Keskivaara, 1996). Other studies have shown no differences in major depression (Heiskanen et al., 2006) and MetS factors among middle-aged persons. Results could imply with age, waning sex hormones may play a role in the sex differences observed among men and women (Vitaliano et al., 2002).

The Metabolic Syndrome and Biological Pathways

Suggested Pathways

Several factors have been presented for mediating pathways between depression and MetS risk factors. Depression is related to insulin resistance, high blood pressure and abdominal adiposity. Vitaliano et al. (2002) suggested MetS and heart disease are caused by chronic stress and depression followed by poor health habits. Other research has unveiled biological pathways such as the dysregulation of the hypothalamic pituitary adrenal axes (HPA) and sympathetic adrenal medulla (SAM) as further impacting health (Rosmond, 2005). Deuschle et al. (1998) and Holsboer (2001) found an association between high cortisol levels and depression. These variables were also associated with HPA dysregulation and chronic stress. Elevated cortisol levels are also related to specific MetS risk factors such as abdominal adiposity and glucose intolerance (Björntorp & Rosmond, 1999). These systems and regulatory mechanisms will be discussed in the following sections to greater detail.

Stress

Stress is another plausible biological mechanisms that may affect MetS. A stress is *the biological and psychological response when encountered with . . . a threat or situation* (McLeod, 2010). The stressor is the event causing the stress response (i.e. conflict at work, presentation, exam . . .). A sudden stressor causes the following physiological responses: increase heart rate and breathing, slowing of digestion, and release of glucose from the liver. If a situation is thought to be stressful, the hypothalamus activates the adrenal medulla and pituitary gland, depending on the duration and magnitude of the stressor (Tortora, 2009).

The sympathetic adrenal medulla (SAM) regulating the fight or flight response, is activated during short-term stressors whereas the HPA is activated in response to long-term stressors. In the SAM pathway, once the hypothalamus activates the adrenal medulla, adrenaline is released, increasing sympathetic activity and decreasing parasympathetic activity. This continues until termination of the perceived stressor, and the parasympathetic system helps bring the body back to homeostasis (McLeod, 2010).

Long-term stressors involving the HPA system begin with hypothalamus stimulation of the pituitary gland. This gland releases adrenocorticotrophic hormone (ACTH), stimulating the adrenal glands to release cortisol. Cortisol aids in maintaining physiological blood sugar levels during the stressor (Currie & Symington, 1955). Several other brain stem noradrenergic neurons and parasympathetic systems also play roles in mediating the stress response (Smith & Vale, 2006).

Multiple studies have shown evidences of hyperactive HPA activity in depressed patients with HPA and SAM dysregulation (Plotsky, Owens, & Nemeroff, 1998; Rosmond & Björntorp, 1998). Research suggests these pathways play a role in the development of MetS (Vicennati &

Pasquali, 2000; Giorgino, Laviola, & Eriksson, 2005; Brunner et al., 2002). Hyper-insulinemia and insulin resistance as well as abdominal fat distribution are characterized by alterations in the HPA activity (Vicennati & Pasquali, 2000). More specifically, depressed individuals (with potentially hyperactive HPAs) possess greater mean abdominal adiposity, triglycerides, and fasting glucose (Rosmond & Björntorp, 1998).

Cortisol and Other Hormones

Levels of cortisol may explain the relationship between depression and abdominal adiposity (Weber-Hamann et al., 2006; Weber-Hamann et al., 2002). Volgelzangs et al. (2007) found the odds of having MetS were higher among high cortisol, depressed individuals than those with low cortisol levels and no depression. In other words, when both high cortisol levels and depression are present, the likelihood of MetS is increased. These findings were consistent with other studies (McCaffery et al., 2003; Räikkönen, Matthews, & Kuller, 2002), identifying associations between depressive symptoms and metabolic risk among adult male twins as well as middle aged women. Volgelzangs et al. (2007) found this relationship also extends to the elderly population. Specifically among firefighters and police trainees, Pineles et al. (2013) found waking cortisol levels may predict negative emotional responses to potentially traumatic events.

Some research has explored the role of cortisol in the link of depression and MetS as a whole. Weber-Hamann et al. (2002) found hypercortisolemic depression is associated with increased abdominal adiposity among older women compared to normocortisolemic-depressed women over a four-year time (Weber-Hamann et al., 2006). Other data failed to find a relationship between urinary cortisol and metabolic parameters (Otte et al., 2004). It is important to note this study did not investigate depression/ cortisol interactions or MetS as a whole.

It may be suggested that there is a link between cortisol levels, MetS and depression, suggesting associations may be stronger for hypercortisolemic depressed individuals with MetS.

The biological mechanisms underlying the relationship between hypercortisolemic depression and MetS must be identified. Björntorp (2001) explained how cortisol binds to glucocorticoid receptors, which are especially dense in abdominal adipose. Upon binding, cortisol activates lipoprotein lipase, which inhibits lipid mobilization, leading to an accumulation of triglycerides in the abdominal area. Björntorp (2001) also suggests effects are even more pronounced when combined with sex steroid inhibition. This coincides with Barrett-Connor, Von Mühlen, and Kritz-Silverstein (1999), who found an association of low sex steroid hormone levels and depression. Findings may explain the biological mechanisms by which high levels of cortisol and depressive symptoms and low levels of sex steroid hormone may increase the prevalence of MetS.

Hypercortisolemic depression is associated with a prevalence of MetS through several specific means. Age related hormone regulation may be a contributor. In several studies, late-life depression may be associated with high or low levels of cortisol (Morrison et al., 2000; Oldehinkel et al., 2001; Penninx et al., 2001); whereas other studies have evidence for hypocortisolemic depression association with physical frailty, fatigue and pain (Fries et al., 2005; Gur et al., 2004; Penninx et al., 2001). Hypercortisolemic depression has been linked with more severe depressive symptoms (Nelson & Davis, 1997; Penninx et al., 2001). Interestingly, Gold and Crousos (2002) found melancholic depression (a particularly severe form) is associated with hyperactive HPA and atypical depression (less severe) could be associated with hypoactive HPA activity. In summary, hypo and hyper activity of the HPA may identify specific depressive subtypes. Hyperactive HPA may be the subtype of depression most closely related to MetS.

Other Components of the Biological Pathways

Research examining individual risk factors of MetS and depression is limited.

Vogelzangs et al. (2007) found abdominal adiposity, low HDL cholesterol and antihypertensive medication higher among depressed participants; this study also found no association between depression/ cortisol and hypertension. Similar to findings by Shen et al. (2003), blood pressure was shown to be a less powerful contributor to MetS as opposed to other components.

Another potential component of the biological pathway regarding MetS factors and depression is hormone serotonin. Serotonin is related to mood, appetite, sleep, activity, and cognitive dysfunction, all symptoms of depression (Meltzer, 1989). Serotonergic dysfunction (Horáček et al., 1999) and blood inflammatory markers (Everson-Rose & Lewis, 2005) may also play a role in the development of MetS, psychological factors, and/ or heart defects (Muldoon et al., 2004; 2006).

Finally, behavioral mediators, diet, smoking, physical activity and sleep also influence MetS (Goldbacher & Matthews, 2007). Psychological distress may lead to decline in healthy behaviors associated with increased insulin resistance and abdominal adiposity (Samaras & Campbell, 1997; Han et al., 1998; Marshall, Bessesen, & Hamman, 1997; Godsland et al., 1998; Mensink et al., 2003). MetS as a whole is associated with unhealthy behaviors (Park et al., 2003).

Further examining the relationship between psychological factors including depression and resilience, and MetS is important in creating psychological and physiological interventions to decrease risk for disease (including diabetes and coronary heart disease).

Overall Purpose

The overall purpose of this study is to examine depressive symptoms (CES-D questionnaire) and MetS risk factors (waist circumference, triglycerides, HDL cholesterol, blood pressure, and blood glucose) among Coloradan firefighters of the Firefighter Testing Program (FTP) at Colorado State University through the following questions:

What are depressive symptoms and metabolic syndrome risk factor profiles among female firefighters compared to male?

Is there an association between depressive symptoms and metabolic syndrome risk factors at time one?

Are depressive symptoms related to the change in metabolic syndrome risk factors from time one to time two?

Hypotheses

1. Female firefighters will exhibit more depressive symptoms and less metabolic syndrome risk factors compared to male.
2. There will be an association between depressive symptoms and metabolic syndrome risk factors at time one.
3. There will be a negative change in metabolic syndrome risk factors from time one to time two among firefighters with elevated depressive symptoms (16 or more symptoms).

Specific Aims

Specific Aim 1: Access and compile depressive symptom and resiliency questionnaire data.

Specific Aim 2: Present descriptive statistics regarding female firefighter depressive symptoms and metabolic syndrome risk factors compared to male.

***Specific Aim 3:** Identify relationships (or lack of relationships) between depressive symptoms and metabolic syndrome risk factors at time one.*

***Specific Aim 4:** Determine changes in metabolic syndrome risk factors from time one to time two.*

Expected Outcomes

The expected outcomes of this study are to expose the need for specific programs to equip firefighters in preventing decline in mental or physical health. Results are expected to have a positive impact by providing more information on longitudinal progression of physical fitness trends among firefighters. The long-term goal is to increase support and feasibility for instigating physical and mental health programs in fire agencies across Colorado such as the FTP.

Methods

Study Design

The Firefighter Testing Program (FTP) offers both physical and mental assessments to Colorado firefighters. The present study represents a secondary data analysis, previously collected by the FTP. All data collected were coded and entered into a database to examine interactions between physical/biological characteristics and the risk for cardiovascular disease (HPCRL, 2015). All firefighters completed informed consent (Appendix A) to allow data collected to be utilized for research at Colorado State University. Professional firefighter subjects are voluntary, no compensation is provided. The Human Subjects Committee and Institutional Review Board of Colorado State University granted approval for Firefighter Testing Program procedures (Appendix B).

Trained FTP laboratory technicians at Colorado State University administered assessments (all technicians are trained by professional research associates of the FTP). Technician preparation includes specific methodology for each testing procedure as well as allotted mandatory supervised practice time before testing firefighter personnel.

Subject Selection

The FTP serves twenty fire agencies in Northern Colorado (Figure 1); six fire agencies' data were utilized for this study. Census Bureau records (2010) indicate seven of the twenty fire agencies are located in townships of 7,000 or less, while only two districts contain over 100,000. Fire agencies run on average fifteen calls per day and combat 223 fires per year. Shift hours are typically forty-eight hours on, ninety-six off (48/ 96) (Figure 1). Each fire agencies is proximate to mountainous Coloradan regions, thus may be called to combat wildland fires or *brush, forest*

and grass fires in the backcountry (Cook, Sutton, & Useem, 2005). Towns farther from urban centers tended to lack mandatory workout regimens, whereas other fire agencies allot up to two hours of shift time for mandatory exercise. Organized fitness programs within the fire agencies are limited (Figure 1). Two fire agencies come every year for testing while the others rotate through testing based on initial risk assessment.

Fire Agency	Avg. calls/day	Avg. fires/year	Shift hours (hr on/hr off)	Mandatory workout regimens (y/n)	Organized fitness programs (y/n)	Time allotted per shift for exercise (hr)	Town Population	Professional FF	How often/who goes to HPCRL testing (every # yr/ who) *
A	50	375	24/ 24	y	n	1	150,000	158	3
B	2	600	48/ 96	n	n	1.25	<5000	60	1
C	4.5	20	48/ 96	n	n	0	19,000	45	3
D	2	95	48/ 96	n	n	1.5	6,250	16	3 age 18-29 2 age 30-39 1 age ≥ 40
E	5	80	48/ 96	n	n	1.5	20,000	31	1
F	2.5	500	48/ 96	n	n	1	5,000	10	3
G	3	80	48/ 96	n	n	1	8,000	10	3
H	3.5	3.5	48/ 96	y	y	1	150	19	1
I	1	200	48/ 96	n	n	1	4,000	36	1
J	3	7.5	48/ 96	y	y	2	6,000	11	3
K	42	310	48/ 96	n	y	1	200,000	270	0**
L	20	223	48/ 96	y	n	1	16,000	54	NA
M	13	600	48/ 96	y	y	.75	60,000	70	1

N	5	150	48/ 96	y	y	2	7,000	40	3
O	8	200	24/ 24	n	n	2	35,000	32	3
P	6.5	6	48/ 96	y	n	1.5	25,000- 200,000 ***	31	4
Q	100	1,100	24/ 24	n	n	1	67,000	88	2
R	3	7	48/ 96	n	n	1	5,000	12	3
S	6	30	48/ 96	y	y	1	7,000- 100,000***	50	3
T	2.5	40	48/ 96	y	n	1	4,500	43	3-4
Average	14.87	223.79				1.24	36,074	48.63	

Figure 1: Characteristics of FTP Firehouses

* *entire fire agency attends testing if no indication of who is selected is provided*

** *no longer undergoing testing with FTP*

*** *population dependent upon the time of year (ski season)*

Note: not all fire agencies or professional firefighters listed were utilized in final data analysis due to missing data

Statistical analysis was conducted for career (paid) firefighters from 2008 -2015. There were 564 men and 36 female firefighters, with a mean age of 37.2 years (range 25-63).

Firefighters with incomplete data sets were excluded from the study. Upon receiving test results, a trained laboratory technician reviewed results individually with firefighters. Technicians explain American College of Sports Medicine (ACSM) age predicted normal values for blood tests, maximal treadmill test, strength and flexibility assessment, etc. Following the evaluation, technicians offer general recommendations for areas of healthy lifestyle change. Technicians then assist firefighters in individualized goal setting.

Procedures

Depression

Prior to FTP testing, firefighters were electronically sent several documents including the *Behavioral Health Questionnaire* (Appendix C), a combination of thirteen separate psychological tests. For purposes of this study, the CES-D Depression Scale (Radloff, 1977) is utilized.

Firefighters select responses on the Likert scale (1: *not at all/ less than 1 day per week*, 5: *nearly every day over the past two weeks*) (Likert, 1932). Questionnaire data was gathered, scored (Appendix D) and entered into the FTP database by trained laboratory personnel.

Metabolic Syndrome Risk Factors

Waist Circumference

During preliminary assessments, circumference measurements were gathered to depict distribution patterns of adipose tissue. Waist circumference measurements were perpendicular to the long axis of the body, measured two times at each site to 0.635 cm using a *Creative Health Product* Gulick tape measure (Appendix E). The mean of the two measurements was calculated and recorded.

Blood Pressure

Blood pressure measurements were collected with a mercury sphygmomanometer (Rustagi & Singh, 2010) during preliminary supine, seated and standing positions as well as every three minutes during the graded exercise test (GXT). Post GXT, additional blood pressures were recorded (Appendix F). For purposes of this study, seated pre GXT blood pressure values

are utilized. Trained lab technicians collected measurements according to the *ACSM (Eighth Edition) National High Blood Pressure Education Program* (ACSM, 2013). Cuff sizes were selected according to firefighter arm circumference. Cuffs were placed approximately 2.54 cm above the antecubital space with the center over the medial surface of the arm.

Blood Chemistry; Triglycerides, HDL Cholesterol, Glucose

The University of Colorado Health Center conducted all blood chemistry analyses off-site. Triglycerides, HDL cholesterol, and glucose among other blood markers were assessed using a Beckman Coulter AU 680 Synchron Clinical System[®] (Beckman Coulter, Inc., Fullerton, CA). For triglyceride levels below 400 mg/dl, LDL cholesterol was calculated using the Friedewald equation (Friedewald, Levy, & Fredrickson, 1972):

$$LDL = TC - (HDL + (TG / 5))$$

Blood analyses results were faxed to the FTP upon completion. An example of blood work profile is found in Appendix G.

Statistical Analysis

Mean descriptive characteristics were assessed and presented as means and standard deviations for the following variables age, BMI, CES-D, and each of MetS risk factors. All analyses were performed using *R foundation for statistical computing* (2008, Vienna, Austria). Descriptive examination for CES-D and MetS cut points were determined by previously validated parameters. Established cutpoints allowed for grouping low and high depressive symptom and MetS and non- MetS individuals.

MetS prevalence was determined using combined characteristics from The World Health Organization (WHO), International Diabetes Foundation (IDF) as well as the United States National Cholesterol Education Program Adult Treatment Panel III (ATP III) (Alberti & Zimmet, 1998; Grundy et al., 2005; Alberti et al., 2005). Depressive symptoms were accessed through the Center for Epidemiological Studies Depression Scale (CES-D) (Radloff, 1977). Each were utilized individually to examine MetS and depressive symptoms among men and women (hypothesis 1).

To determine association between MetS risk factors and depressive symptoms at time one, the Pearson's chi squared test was utilized. Statistical significance was determined by two sided probability values < 0.05 (hypothesis 2). The Fisher's Exact Test for Count Data was employed to examine changes in MetS risk factors from time one to time two (hypothesis 3). This test however had a low power to detect differences due to small sample size.

Results

Hypothesis 1: Female firefighters will exhibit more depressive symptoms and less metabolic syndrome risk factors compared to male.

The final statistical analysis of the Coloradan firefighters consisted of 600 firefighters (the entire database consisted of 1731 firefighters, however due to missing data or demographical constraints, 1131 subjects were excluded). Mean clinical characteristics of both male and female firefighters are listed in Table 1. Although male and female population groups differ greatly in size, the similarity of age, BMI and CES-D score should be noted.

Table 1. Clinical characteristics of study population ($n = 600$)

	Male ($n = 564$)	Female ($n = 36$)
Age, years	37.2 ± 9.5	35.3 ± 8.1
BMI	27.4 ± 4.2	24.3 ± 3.4
CES-D, raw score (0-60)	5.9 ± 5.5	6.5 ± 5.2
Systolic blood pressure, mm Hg	126.9 ± 11.5	117.6 ± 11.0
Diastolic blood pressure, mm Hg	82.0 ± 9.6	76.7 ± 9.7
Triglycerides, mg/dl	112.5 ± 68.0	71.3 ± 34.1
Blood glucose, mg/dl	88.4 ± 8.0	83.2 ± 6.0
HDL cholesterol, mg/dl	45.5 ± 10.6	61.5 ± 15.3
Waist circumference, cm	90.2 ± 9.9	74.9 ± 9.4

MetS risk factor guidelines are listed in Table 2. Values that did not fall within range guidelines were considered risk factors within the data set. Note the differences in sex-based risk factor values for males and females for HDL cholesterol and waist circumferences.

Table 2. Metabolic syndrome risk factors (2015 NIH guidelines)

	Male	Female
Systolic blood pressure, mm Hg	≥ 130	≥ 130
Diastolic blood pressure, mm Hg	≥ 85	≥ 85
Triglycerides, mg/dl	≥ 150	≥ 150
Blood glucose, mg/dl	≥ 110	≥ 110
HDL cholesterol, mg/dl	≤ 40	≤ 50
Waist circumference, cm	≥ 102	≥ 88

Individual MetS values for males and females are listed in Table 3. Candidates for MetS exhibit three or more risk factors (denoted by shading). Interestingly, only eleven percent of females exhibited MetS characteristics (n=4) with no females exceeding 3 risk factors. Nineteen percent of males exhibited MS, while 30% and 27% had 0 and 1 risk factors respectively. Total MetS values are listed in Table 4.

Table 3. Individual risk factor numbers for study population (n = 600)

Risk Factors	0	1	2	3	4	5
Male (n = 564)	169	152	135	71	31	6
Female (n = 36)	17	11	4	4	0	0

* shading denotes metabolic syndrome candidates

Table 4. Total metabolic syndrome values for study population (n = 600)

	MetS	No MetS
Male (n = 564)	108	456
Female (n = 36)	4	32

* p value = 0.23

Table 3 data is presented in Figure 2 in bar graph form. Figure 3 expressed these values in relative terms, presenting the relative frequency or percentages of males and females exhibiting risk factors. Females appear to surpass male relative frequency with one risk factor only.

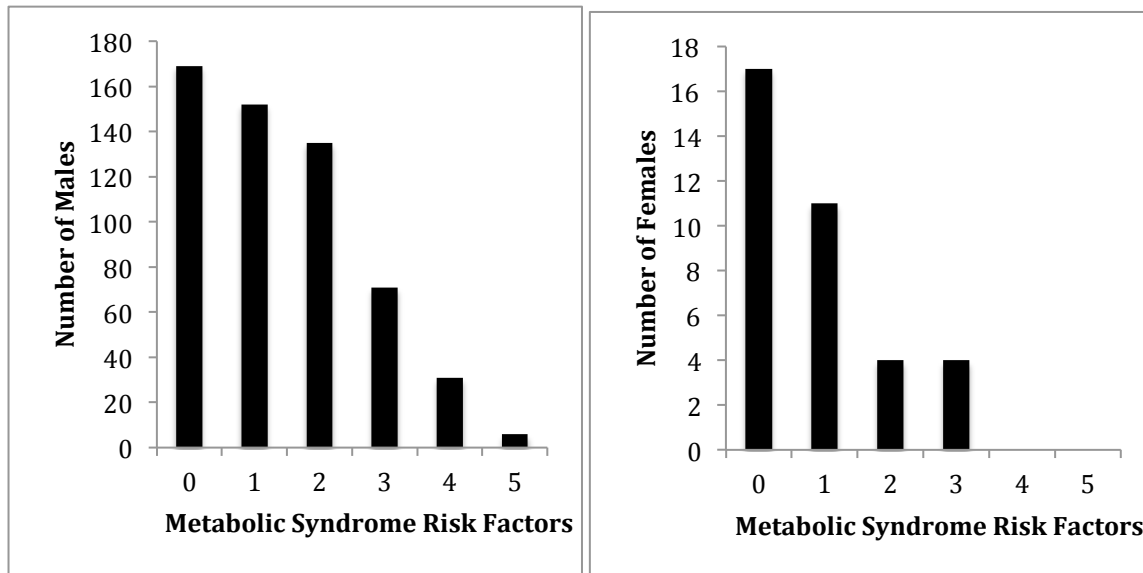


Figure 2. Absolute male and female metabolic syndrome risk factors at time one

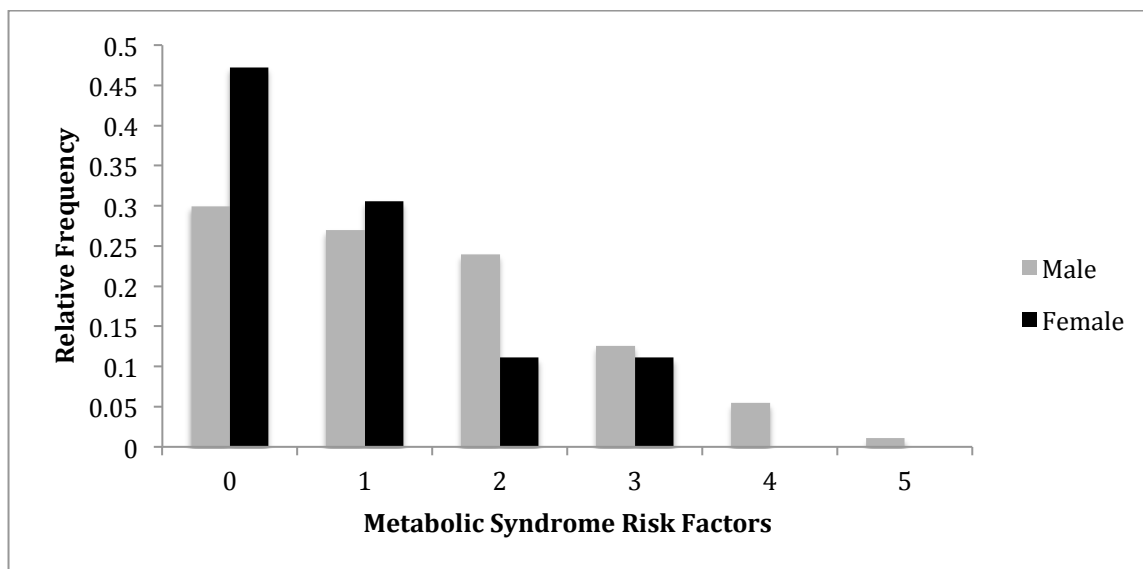


Figure 3. Relative male and female metabolic syndrome risk factors at time one

** relative values are calculated as percentages*

There is no statistical difference between female and male MetS risk factors.

Hypothesis 2: There will be an association between depressive symptoms and metabolic syndrome risk factors at time one.

Pearson's chi squared test was used to determine the association between MetS risk factors and depressive symptoms. Firefighters were split into high (score of ≥ 16) and low (score of < 15) depressive symptom groups defined by the CES-D, with 6.5% of firefighters in the high and 93.5% in the low group. Risk factor data presented in Table 5 is high and low depressive symptom group percentages. P values indicate no statistical significance ($p \leq 0.05$).

Table 5. Percentage of metabolic syndrome risk factors at time one for low depressive and depressive symptom individuals

	Systolic blood pressure	Diastolic blood pressure	Triglycerides	Blood glucose	HDL cholesterol	Waist circumference
Low depressive symptoms (0-15) (n = 561)	37.1	35.7	17.6	1.6	29.8	14.3
Depressive symptoms (≥ 16) (n = 39)	46.2	33.3	23.1	0	30.8	12.8
<i>Chi-squared test</i>	<i>1.280</i>	<i>0.086</i>	<i>0.728</i>	<i>0.635</i>	<i>0.017</i>	<i>0.062</i>
<i>p value</i>	<i>0.258</i>	<i>0.77</i>	<i>0.393</i>	<i>0.426</i>	<i>0.895</i>	<i>0.803</i>

** Pearson's chi squared test, df=1
note values do not equal 100% due to overlap in risk factors*

Tables 6a and 6b indicate MetS groups in relation to depressive symptoms. No statistical significance ($p \leq 0.05$) was found.

Table 6a. Prevalence of metabolic syndrome risk factors as a function of depressive symptoms at time one

Risk Factors	0	1	2	≥ 3
Low depressive symptoms (0-15) ($n = 561$)	174	153	132	102
Percentage (%)	31.0	27.3	23.5	18.2
Depressive symptoms (≥ 16) ($n = 39$)	12	10	7	10
Percentage (%)	30.8	25.6	17.9	25.6

* Pearson's chi squared test= 1.614, $df=3$, p value= 0.656

Table 6b. Prevalence of metabolic syndrome candidates as a function of depressive symptoms at time one

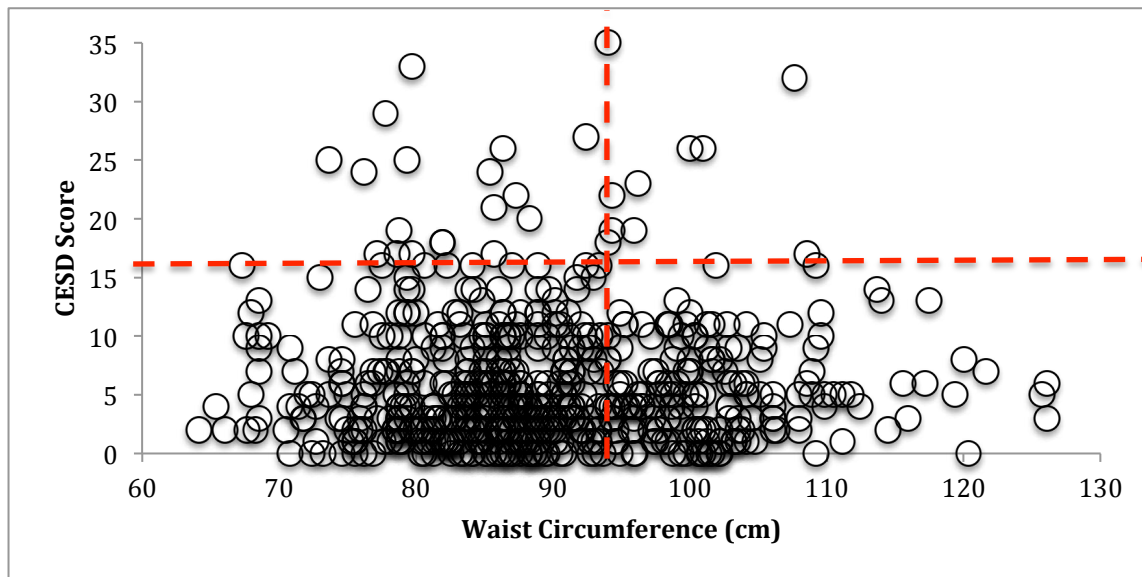
Risk Factors	<3	≥ 3
Low depressive symptoms (0-15) ($n = 561$)	459	102
Percentage (%)	81.8	18.2
Depressive symptoms (≥ 16) ($n = 39$)	29	10
Percentage (%)	74.4	25.6

* Pearson's chi squared test= 1.336, $df=1$, p value= 0.248

* shading denotes metabolic syndrome candidates

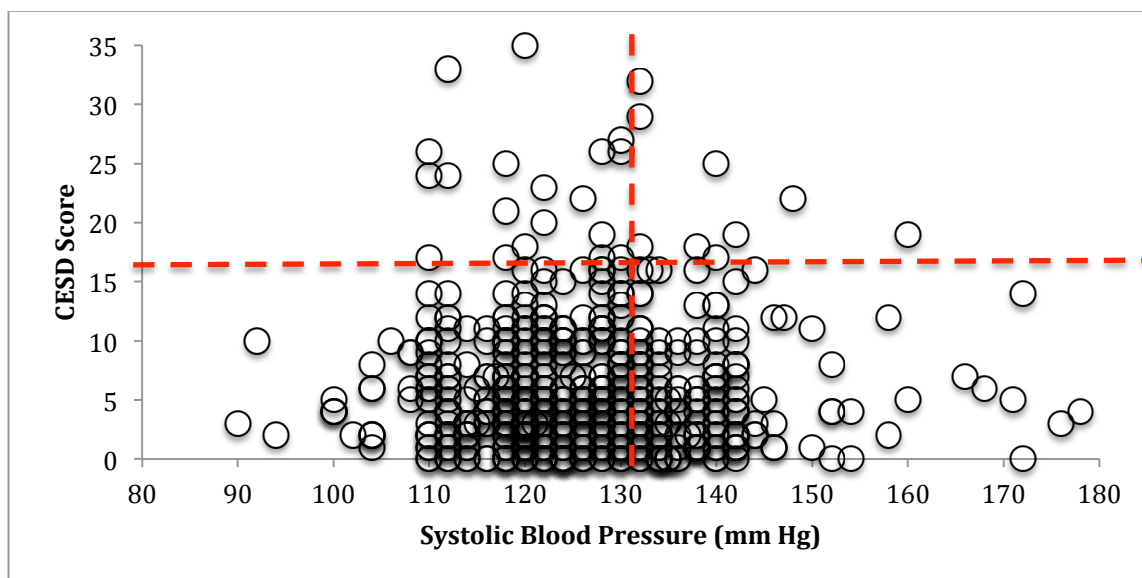
Data from Table 5 is presented in Figure 4a-f in graph form. Each graph indicates individual scores on the CES-D questionnaire as well as MetS risk factor raw values. Values above the horizontal dashed line indicate high depressive symptom individuals. Values to the right of the

vertical dashed line indicate individuals exhibiting the specific risk factor. Note that waist circumference (a) and HDL cholesterol (f) risk factor cut off values were averaged (data is a culmination of male and female data).



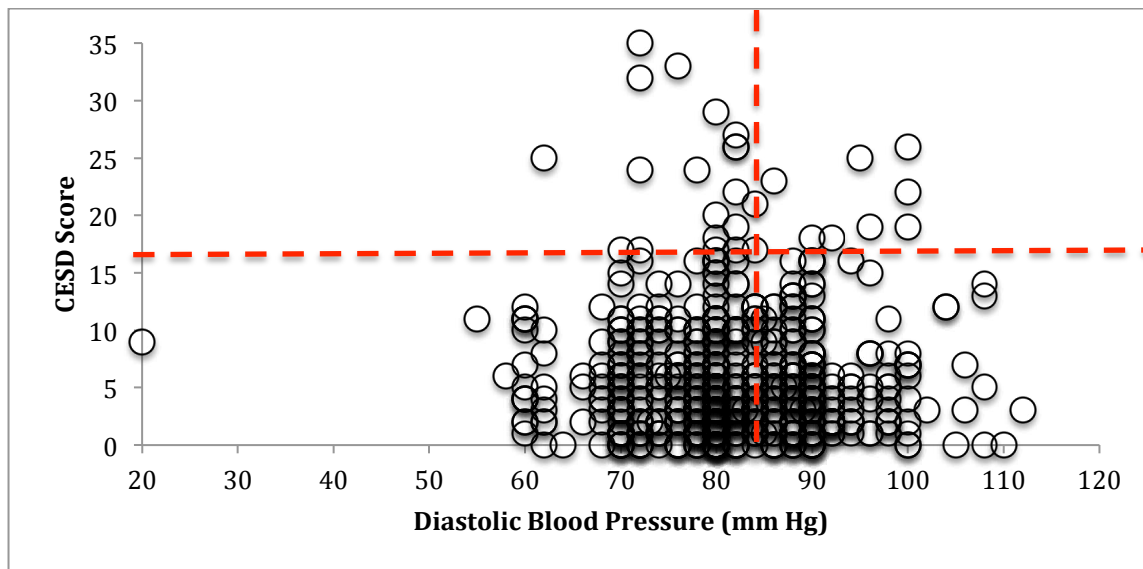
* correlation R value: 0.001

Figure 4a. Association between depressive symptoms total metabolic syndrome risk factors at time one



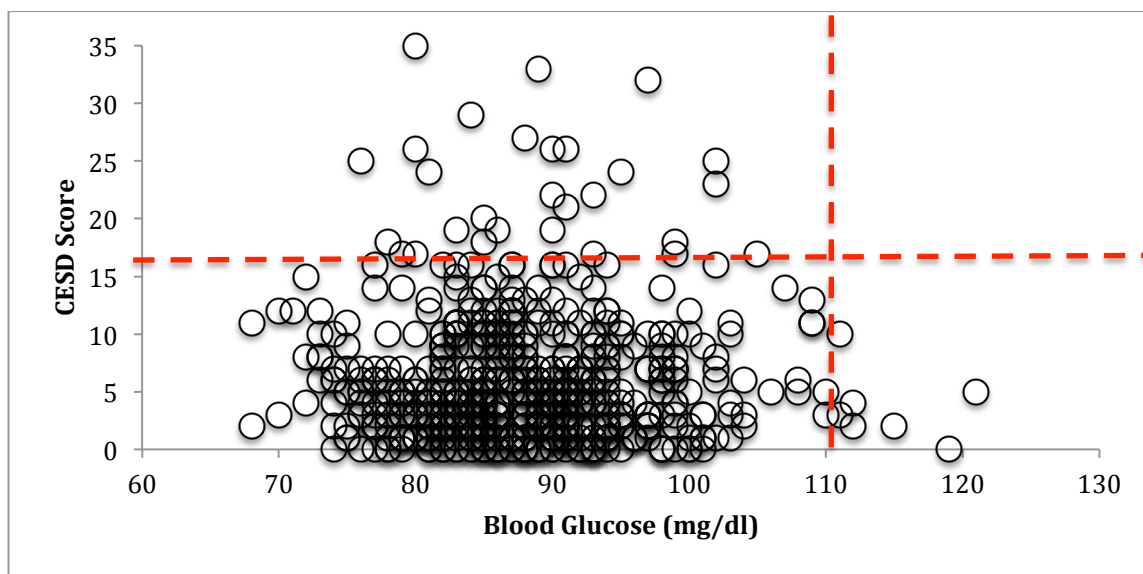
* correlation R value: - 0.004

Figure 4b.



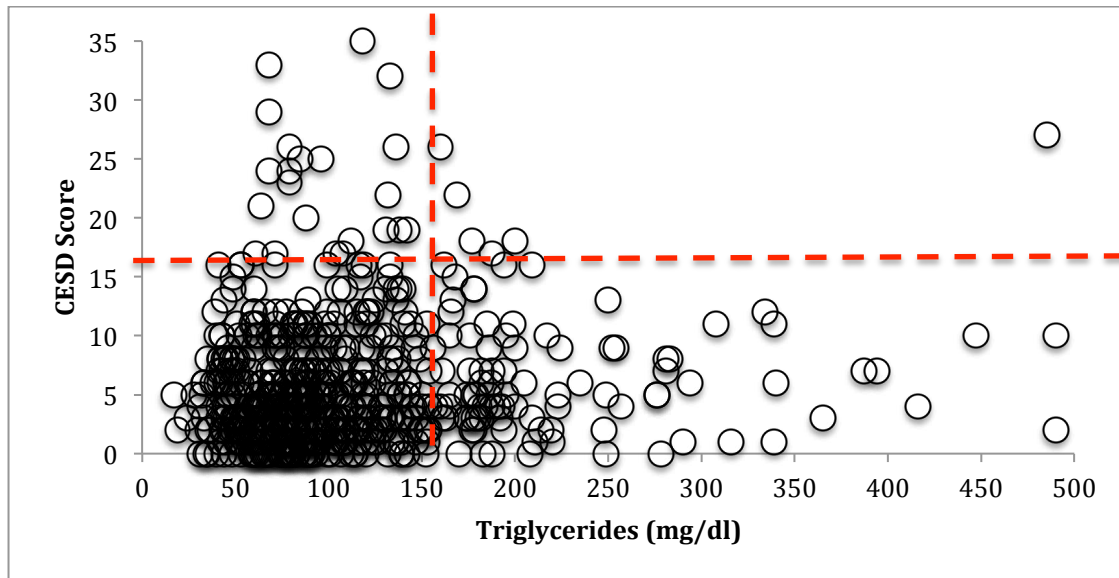
* correlation R value: - 0.014

Figure 4c.



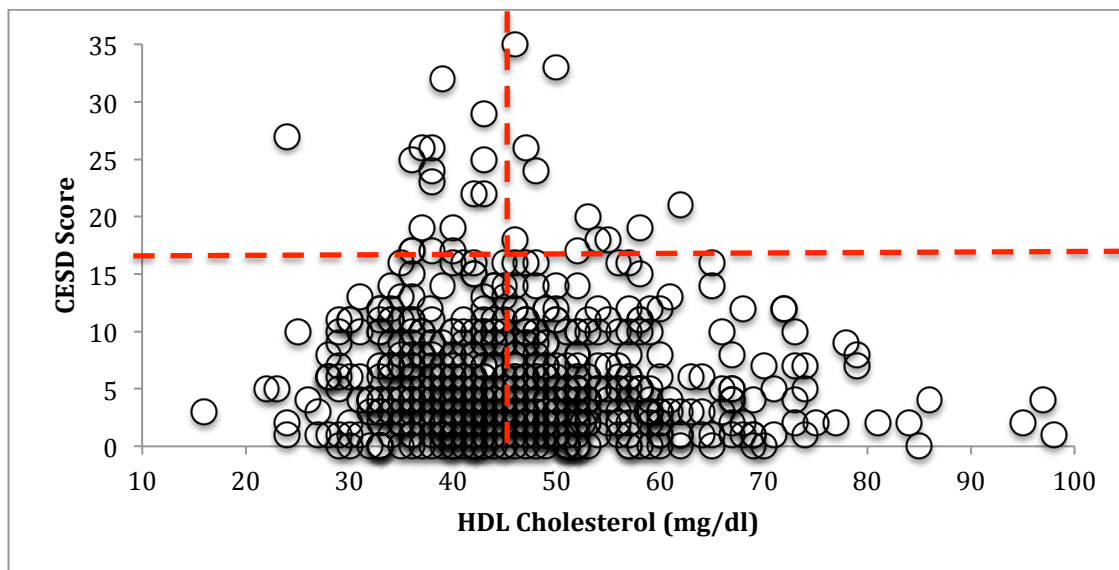
* correlation R value: - 0.007

Figure 4d.



* correlation R value: 0.103

Figure 4e.



* correlation R value: - 0.088

Figure 4f.

There are no significant associations between depressive symptoms and MetS risk factors of firefighters at time one.

Hypothesis 3: There will be a negative change in metabolic syndrome risk factors from time one to time two among firefighters with elevated depressive symptoms (16 or more symptoms).

With such a low sample size of high depressive symptom individuals returning to the FTP (n=7), there is very low power to detect any difference among MetS risk factor change from time one to time two (difference was calculated time 2 risk factor number – time 1 risk factor number). Raw scores are expressed in Table 7 below with negative change (less risk factors exhibited on second test date than first test date) labeled *Negative Δ* and positive change (more risk factors on the second test date) labeled *Positive Δ*. Average time between time one and time two was 1.8 years (657.4 days).

Table 7. Association between depressive symptoms change in metabolic syndrome risk factors from time one to time two

Change in Risk Factors (time 1- time 2)	Negative Δ	0 (no Δ)	Positive Δ
Low depressive symptoms (0-15) (n = 96)	24	37	35
Depressive symptoms (≥ 16) (n = 7)	3	1	3

* Fisher's Exact Test for Count Data p value= 0.379

* note small depressive sample size, minimizes power to detect difference
shading denotes healthful change (reduction in risk factors overtime)

Hypothesis 3 may not be determined due to small depressive symptom sample size in returning firefighters.

Discussion

Metabolic Syndrome and Depression

The main findings were (1) no statistical difference between female and male CES-D depressive symptom scores, (2) no associations between MetS risk factors and depressive symptoms and (3) too small of a sample size to determine any longitudinal changes in MetS risk factors. Results agree with findings regarding Coloradan firefighter environmental differences. From previous reports, only 30% of United States fire departments implement fitness and wellness programs into shift hours (Storer et al., 2014); all but one of the twenty fire agencies examined in this study provide time to firefighters to complete workouts. Donovan et al. (2008) found 15% of male Coloradan firefighters exhibit MetS characteristics as opposed to 28% in the Midwest (Magyari et al., 2008). Time pursuing fitness may blunt depressive effects within the population. In the context of the state Colorado, one of the fittest within the United States (Centers for Disease Control and Prevention (CDC), 2010), firefighters may exhibit healthier physical and therefore emotional characteristics (male BMI 27.4 ± 4.2 , female 24.3 ± 3.4 ; male CES-D 5.9 ± 5.5 and female 6.5 ± 5.2). Fire agencies in this study also pay for fitness evaluations and thus may place a higher priority on health.

Another environmental factor to consider is increased awareness over the past several years on the topic of emotional distress among firefighters. According to the Colorado Department of Public Health and Environment (2015), the Colorado suicide rate is 19.4 per 100,000 residents. However, the cumulative effects of Initiative 13 counseling support, NFPA mental health assistance programs, NFFF suicidal prevention meetings and IAFC behavioral health recommendations may positively effect firefighter depressive symptoms across the nation (Morrison & Leto, 2013). The shift from employee assistance programs to behavioral health

assistance among fire agencies may also impact depressive symptoms. Firefighters may now be choosing to utilize offered services due to increased awareness of the issue more now than ever (Gist, 2007; McMahon, 2010).

Findings also agree with firefighter studies regarding increased resilience levels (Meyer et al., 2012) and selection bias (Vena & Fiedler, 1987). Job appeal to both physically healthy and resilient individuals may confirm observations that MetS and depressive symptoms are not associated among Coloradan firefighters.

It is important to note that few females were among the study population. Accumulating evidence suggests depression is a better predictor in females for MetS risk factors (Kinder et al., 2004; Rääkkönen, Matthews, and Kuller, 2002). These findings agree with Herva et al. (2006) also finding no association between MetS and depression in a mixed gendered group of individuals. The age of our population (37.2 ± 9.5 years for males, 35.3 ± 8.1 for females; 18-64) may have also contributed to finding no association. Heiskanen et al. (2006) found no differences in major depression and MetS factors among middle-aged individuals (typically beginning at 45).

Results of no association between MetS and depressive symptoms among Coloradan firefighters may also be attributed to other confounding variables. Research has explored various mechanisms that could explain the lack of association. Serotonin, cortisol, stress, and sleep patterns play a role in depressive symptoms and physiological health. Gender, occupational support, occupation satisfaction, occupational effort, problem-focused coping, emotion-focused coping, and interaction between perceived social support and self-blame may also contribute to the lack of association (Sattler, Boyd, & Kirsch, 2014, Meyer et al., 2012). Social network especially has been shown to promote resilience among firefighters, benefiting mental health and

potentially effecting depressive symptom scores (Prati & Peitrantoni, 2010). Further studies should evaluate these factors to determine plausible effects on the present data.

Another factor to consider is the cross sectional nature of the data may not capture chronic depressive symptoms accurately. The bidirectional interaction between the two variables may not have an associative relationship, but require further investigation as to other possible interactions (Evans et al., 2005; Katon, 2003).

Although no definitive correlations were of statistical significance, several deductions may be made from the data. Male and female firefighters had similar BMI values, suggesting either lean women or heavier men among the subject pool (although both male and female averages fell within “healthy” BMI parameters) (Table 1). This may have implications regarding overall physiological health conditions of the firefighters, identifying optimal physique and to meet firefighter physical demands.

Males exhibited poorer MetS profiles for each risk factor than women (Table 1). Female firefighters may have superior physical health, but less emotional coping mechanisms than males. Further research within the physiological and psychological health of male and female firefighters is warranted.

None of MetS risk factor variables were associated with depression (hypothesis 2) (Table 5). Acute personal life events or within the firehouse may have affected reliability in CES-D questionnaire responses. Coloradan firefighters do appear to exhibit lower CES-D scores than other firefighters. In Korea, 19.2% and in Japan, 21.1% of firefighters exhibited “depressive symptoms,” compared to 6.5% found among Coloradan firefighters (Kim, Kim, & Ahn, 2010; Saijo, Ueno, & Hashimoto, 2008).

Regarding the third hypothesis, differences in the time span between the first and second testing date may have impacted results. Although nearly 2 years was the average time of return, some firefighters may have returned much later or sooner than the average (0.52 - 5.22 years). It is interesting to note that only 18% of “high depressive symptom” individuals returned for testing (7 out of 39) (Table 7). It is important to note, 17% of “low depressive symptom” individuals returned for testing (96 out of 561). Depressive symptoms may affect career longevity or commitment to long-term health. Again, further study is required to draw definitive conclusions.

Implications Within Fire Agencies

Data from this study confirms approximately 6.6% depression exists within the fire agencies among both male (36 of 39 individuals) and female (3 of 39 individuals) firefighters. The importance of identifying and addressing depressive symptoms is important to prevent further decline. Firefighters spend the majority of their workday serving others and caring for the physical and at times emotional needs of victims. They require time to heal and process after highly stressful situations. If firefighters could train young recruits to recognize depressive symptoms and care for themselves within accountability group settings, depressive symptoms could dramatically decrease. Training should occur from the initial entry into the fire agency, so skills may be developed throughout their career and disseminated to fellow crewmembers.

Specific physical assessments should be required among fire agencies with specific parameters and repercussions for individuals who fail to meet standards. Since physical fitness is required among firefighters to serve optimally, physical health is of paramount importance. The FTP specifically, should highly encourage fire agencies and individuals to return for follow

up testing regularly to monitor changes in health over time. Longitudinal data studies among firefighters would allow further recommendations and improvements to current system.

Delimitations, Limitations, and Assumptions

Several delimitations, limitations and assumptions are provided, but not limited those discussed here. The generalizability of study results is limited due to the specific population. Firefighters were predominantly Front Range regional Coloradan firefighters (Caucasian). Multiple studies have measured fitness and depression among various populations of firefighters (Antonellis & Thompson, 2009; Dill, 2015; Hegg-Deloye et al., 2014; Poston et al., 2011; Storer et al., 2014), however it is unknown how representative these data are of fire service personnel nationwide.

Outside factors such as lifestyle, physical activity, diet, smoking, sleep or social support systems may affect feelings of depression or resilience as well as MetS risk factors, thus limiting correlation observations between variables. Acute traumatic or stressful events may have impacted depressive symptom values, as mentioned before. Uncontrollable moderators (sex, race, socioeconomic status) may also play a role in both psychological and physiological outcomes.

Firefighters may possess three MetS risk factors, but risk factor values may be very near established parameters (ATP III, 2005; Grundy et al., 2005). Others may have extremely high values in one risk factor, and low values among the others. Further research is needed to distinguish and confirm appropriate ranges within MetS factors and the relationship of individual factors on the others. Differences between acute/symptomatic and chronic/clinical depression may also play a role in study results. Future studies could define and distinguish specific groupings among firefighters and observe the impact on MetS risk factors.

It was also assumed that firefighters provided accurate and complete questionnaire data and all tests and measurements were administered consistently and correctly across all firefighters.

Summary, Conclusions and Future Recommendations

Summary

Despite recent efforts to both educate and alter the patterns of mental health and physical well being among firefighters, depressive symptoms and MetS risk factors remain. In order to examine associations between MetS and depressive symptoms among Northern Coloradan firefighters, a study of 600 firefighters from twenty fire departments was conducted. Through the Firefighter Testing Program at Colorado State University, participants were tested for all five MetS risk factors through blood sampling, blood pressure and anthropometric measurements. Each firefighter also completed the Center for Epidemiological Studies Depression questionnaire to determine depressive symptoms.

This study adds several key elements to scientific literature regarding firefighter mental and physical health. Primarily, while previous research has examined the effects of depression on MetS risk factors, no studies has examined this relationship in the context of firefighters. Also, female firefighters are an underreported group. The present research study presents physical and mental characteristics for both male and female firefighters.

Findings from the study are presented in Figures 1-3 and Tables 1-8. There were no associations found between MetS and depressive symptoms among firefighters.

Conclusions

There are several practical conclusions from the present study. First, the presence and frequency of both MetS risk factors and depressive symptoms among firefighters warrants attention and treatment. Fire agencies should investigate and implement educational, emotional and physical programs or initiatives for personnel.

Female sample sizes somewhat limit conclusions. Despite tendencies observed in either sex, male and female wellness should be encouraged and monitored. Furthermore, future studies could investigate similar relationships between the variables in larger sample size populations (see future recommendations section).

Finally, duty standards for both physical and mental health should be both established and implemented in the fire agencies. Through widespread fire agency standard enforcement, firefighter effectiveness, safety, emotional and physical wellbeing may increase.

Future Recommendations

Results for female characteristics and MetS risk factors would be more compelling and definitive with a larger sample size; therefore a greater sample of female firefighters would be beneficial. Depressive symptoms could be examined longitudinally, across the career or firefighter rank changes (Cheryl Regehr et al., 2003). Stress, resilience, depressive symptoms and physiological condition could all be measured to determine the longitudinal mental and physical changes.

Further study could also track depressive symptoms following critical events within a fire agency. Group therapy, counseling, mental health education or accountability group effectiveness could also be accessed to determine potential steps toward decreased depressive symptom levels among firefighters. In the same way, physical fitness could also be monitored during traumatic times at the fire agency. Personal training, group training, or group fitness challenge effectiveness on physiological and mental health within the firehouse is another venue for future research.

Other future research could explore risk, protective, and promotive factors. This could help determine risk factors that increase the likelihood of the onset of depressive symptoms or

poor health and aid in target therapies and treatments to assist firefighters. Identifying and enhancing protective factors (counteract or buffer risk factors) would also be an area of profitable research. Finally promotive factors, which have a *direct path to healthy development regardless of levels of adversity*, would be beneficial to identify and encourage within the fire agency (Kia-Keating, 2011). Examples of risk factors could be marital status, stress levels, low resiliency or poor diet. Some protective and promotive factors may be good social relationships/ support, communication skills, or positive self-esteem. These and other variables should be thoroughly investigated and targeted to promote optimal health within the fire agency.

References

- ACSM. (2013). *ACSM's Guidelines for Exercise Testing and Prescription*. Lippincott Williams & Wilkins.
- Ahlberg, A.-C., Ljung, T., Rosmond, R., McEwen, B., Holm, G., Akesson, H. O., & Björntorp, P. (2002). Depression and anxiety symptoms in relation to anthropometry and metabolism in men. *Psychiatry Research*, 112(2), 101–110.
- Alberti, K., & Zimmet, P. (1998). Definition, diagnosis and classification of diabetes mellitus and its complications. Part 1: diagnosis and classification of diabetes mellitus. Provisional report of a WHO Consultation. *Diabetic Medicine*, 15(7), 539–553. [http://doi.org/10.1002/\(SICI\)1096-9136\(199807\)15:7<539::AID-DIA668>3.0.CO;2-S](http://doi.org/10.1002/(SICI)1096-9136(199807)15:7<539::AID-DIA668>3.0.CO;2-S)
- Alberti, K., Zimmet, P., Shaw, J., & IDF Epidemiology Task Force Consensus Group. (2005). Metabolic syndrome--a new worldwide definition. *Lancet (London, England)*, 366(9491), 1059–1062. [http://doi.org/10.1016/S0140-6736\(05\)67402-8](http://doi.org/10.1016/S0140-6736(05)67402-8)
- Alghamdi, M., Hunt, N., & Thomas, S. (2015). The effectiveness of Narrative Exposure Therapy with traumatized firefighters in Saudi Arabia: A randomized controlled study. *Behavior Research and Therapy*, 66, 64–71. <http://doi.org/10.1016/j.brat.2015.01.008>
- Amsterdam, J. D., & Maislin, G. (1991). Hormonal responses during insulin-induced hypoglycemia in manic-depressed, unipolar depressed, and healthy control subjects. *The Journal of Clinical Endocrinology and Metabolism*, 73(3), 541–548. <http://doi.org/10.1210/jcem-73-3-541>
- Amsterdam, J. D., Schweizer, E., & Winokur, A. (1987). Multiple hormonal responses to insulin-induced hypoglycemia in depressed patients and normal volunteers. *The American Journal of Psychiatry*, 144(2), 170–175.
- Antonellis, P., & Thompson, D. (2009). A firefighter's silent killer: suicide. *PennWell*.
- Barrett-Connor, E., Von Mühlen, D. G., & Kritz-Silverstein, D. (1999). Bioavailable testosterone and depressed mood in older men: the Rancho Bernardo Study. *The Journal of Clinical Endocrinology and Metabolism*, 84(2), 573–577. <http://doi.org/10.1210/jcem.84.2.5495>

- Baur, D. M., Christophi, C. A., Tsismenakis, A. J., Cook, E. F., & Kales, S. N. (2011). Cardiorespiratory fitness predicts cardiovascular risk profiles in career firefighters. *Journal of Occupational and Environmental Medicine*, 53(10), 1155–1160.
<http://doi.org/10.1097/JOM.0b013e31822c9e47>
- Baur, D. M., Christophi, C. A., & Kales, S. N. (2012). The Metabolic Syndrome Is Inversely Related to Cardiorespiratory Fitness in Male Career Firefighters. *Journal of Strength & Conditioning Research (Lippincott Williams & Wilkins)*, 26(9), 2331–2337.
- Bernabé, M., & Botia, J. M. (2015). Resilience as a mediator in emotional social support's relationship with occupational psychology health in firefighters. *Journal Of Health Psychology*.
- Block, J. P., He, Y., Zaslavsky, A. M., Ding, L., & Ayanian, J. Z. (2009). Psychosocial Stress and Change in Weight Among US Adults. *American Journal of Epidemiology*, 170(2), 181–192. <http://doi.org/10.1093/aje/kwp104>
- Björntorp, P., & Rosmond, R. (1999). Hypothalamic origin of the metabolic syndrome X. *Annals of the New York Academy of Sciences*, 892, 297–307.
- Björntorp, P. (2001). Do stress reactions cause abdominal obesity and comorbidities? *Obesity Reviews: An Official Journal of the International Association for the Study of Obesity*, 2(2), 73–86.
- Bordron, A., Massoubre, C., Lang, F., Grosselin, A., & Billard, S. (2013). Mental health assessment of a sample of firefighters: A cross-sectional descriptive study. *Archives Des Maladies Professionnelles Et De L Environnement*, 74(3), 289–293.
<http://doi.org/10.1016/j.admp.2013.02.001>
- Brunner, E. J., Hemingway, H., Walker, B. R., Page, M., Clarke, P., Juneja, M., Shipley MJ, Kumari M, Andrew R, Seckl JR, Papadopoulos A, Checkley S, Rumley A, Lowe GD, Stansfeld SA, Marmot, M. G. (2002). Adrenocortical, autonomic, and inflammatory causes of the metabolic syndrome: nested case-control study. *Circulation*, 106(21), 2659–2665.
- Camardese, G., Leone, B., Serrani, R., Szczepanczyk, P., Walstra, C., & Janiri, L. (2014). Resilience and Depression. *World Congress of Psychiatry*, 4(37).

- Carey, M. G., Al-Zaiti, S. S., Dean, G. E., Sessanna, L., & Finnell, D. S. (2011). Sleep Problems, Depression, Substance Use, Social Bonding, and Quality of Life in Professional Firefighters. *Journal of Occupational and Environmental Medicine / American College of Occupational and Environmental Medicine*, 53(8), 928–933. <http://doi.org/10.1097/JOM.0b013e318225898f>
- Centers for Disease Control and Prevention (CDC). (2010). Vital signs: state-specific obesity prevalence among adults --- United States, 2009. *MMWR. Morbidity and Mortality Weekly Report*, 59(30), 951–955.
- Choi, B., Schnall, P., Dobson, M., Israel, L., Landsbergis, P., Galassetti, P., Pontello A., Kojaku S., Baker, D. (2011). Exploring Occupational and Behavioral Risk Factors for Obesity in Firefighters: A Theoretical Framework and Study Design. *Safety and Health at Work*, 2(4), 301–312. <http://doi.org/10.5491/SHAW.2011.2.4.301>
- Chung, A. W.-H. (2015). *A cross-sectional analysis of the metabolic syndrome in San Diego firefighters: San Diego Sports Medicine Center 2005-2013* (M.P.H.). San Diego State University, United States -- California. Retrieved from <http://search.proquest.com/pqdtglobal/docview/1680273411/abstract/BA2CBF75EE714308PQ/1?accountid=10223>
- Clark, S., Rene, A., Theurer, W. M., & Marshall, M. (2002). Association of body mass index and health status in firefighters. *Journal of Occupational and Environmental Medicine / American College of Occupational and Environmental Medicine*, 44(10), 940–946.
- Colorado Department of Public Health and Environment. (2015).
- Cook, J. R., Sutton, L., & Useem, M. (2005). Developing Leaders for Decision Making Under Stress: Wildland Firefighters in the South Canyon Fire and Its Aftermath. *Academy of Management Learning & Education*, 4(4), 461–485. <http://doi.org/10.5465/AMLE.2005.19086788>

- Corrigan, M., McWilliams, R., Kelly, K. J., Niles, J., Cammarata, C., Jones, K., Wartenberg D., Hallman W., Kipen H., Glass L., Schorr J., Fierstein I., Prezant, D. J. (2009). A Computerized, Self-Administered Questionnaire to Evaluate Posttraumatic Stress Among Firefighters After the World Trade Center Collapse. *American Journal of Public Health*, 99(S3), S702–S709.
- Cota, D., Vicennati, V., Ceroni, L., Morselli-Labate, A. M., & Pasquali, R. (2001). Relationship between socio-economic and cultural status, psychological factors and body fat distribution in middle-aged women living in Northern Italy. *Eating and Weight Disorders: EWD*, 6(4), 205–213.
- Currie, A. R., & Symington, T. (1955). The pathology of the Pituitary and Adrenal Glands in Systemic Disease in Man. Retrieved August 6, 2015, from <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1919268/>
- DeLorme, J. (2015). *The investigation of repeated trauma exposure and psychological adjustment in firefighters*. ProQuest Information & Learning, US.
- Dill, J. (2015). Firefighter Behavioral Health Alliance.
- Deuschle, M., Weber, B., Colla, M., Depner, M., & Heuser, I. (1998). Effects of major depression, aging and gender upon calculated diurnal free plasma cortisol concentrations: a re-evaluation study. *Stress (Amsterdam, Netherlands)*, 2(4), 281–287.
- Donovan, R. G. (2008). C-Reactive Protein and the metabolic syndrome are Inversely Associated with Cardiorespiratory Fitness in Firefighters: 1481. *Medicine and Science in Sports and Exercise - MED SCI SPORT EXERCISE*, 40(5). <http://doi.org/10.1249/01.mss.0000322461.64145.d1>
- Dorfman, W. I., & Walker, L. E. (2007). *First responder's guide to abnormal psychology: Applications for police, firefighters and rescue personnel*. New York, NY, US: Springer Science + Business Media.
- Elsner, K. L., & Kolkhorst, F. W. (2008). Metabolic demands of simulated firefighting tasks. *Ergonomics*, 51(9), 1418–1425. <http://doi.org/10.1080/00140130802120259>

- Eskandari, F., Mistry, S., Martinez, P. E., Torvik, S., Kotila, C., Sebring, N., Drinkard B., Levy C., Reynolds J., Csako G., Gold P., Horne M., Cizza G. POWER (Premenopausal, Osteopenia/Osteoporosis, Women, Alendronate, Depression) Study Group. (2005). Younger, premenopausal women with major depressive disorder have more abdominal fat and increased serum levels of prothrombotic factors: implications for greater cardiovascular risk. *Metabolism: Clinical and Experimental*, 54(7), 918–924.
<http://doi.org/10.1016/j.metabol.2005.02.006>
- Evans, D. L., Charney, D. S., Lewis, L., Golden, R. N., Gorman, J. M., Krishnan, K. R. R., Nemeroff CB, Bremner JD, Carney RM, Coyne JC, Delong MR, Frasure-Smith N, Glassman AH, Gold PW, Grant I, Gwyther L, Ironson G, Johnson RL, Kanner AM, Katon WJ, Kaufmann PG, Keefe FJ, Ketter T, Laughren TP, Leserman J, Lyketsos CG, McDonald WM, McEwen BS, Miller AH, Musselman D, O'Connor C, Petitto JM, Pollock BG, Robinson RG, Roose SP, Rowland J, Sheline Y, Sheps DS, Simon G, Spiegel D, Stunkard A, Sunderland T, Tibbits P Jr, Valvo, W. J. (2005). Mood disorders in the medically ill: scientific review and recommendations. *Biological Psychiatry*, 58(3), 175–189. <http://doi.org/10.1016/j.biopsych.2005.05.001>
- Everson-Rose, S. A., & Lewis, T. T. (2005). Psychosocial factors and cardiovascular diseases. *Annual Review of Public Health*, 26, 469–500.
<http://doi.org/10.1146/annurev.publhealth.26.021304.144542>
- Everson-Rose, S. A., Meyer, P. M., Powell, L. H., Pandey, D., Torr ns, J. I., Kravitz, H. M., Bromberger J.T., Matthews, K. A. (2004). Depressive symptoms, insulin resistance, and risk of diabetes in women at midlife. *Diabetes Care*, 27(12), 2856–2862.
- Ford, E. S., Giles, W. H., & Dietz, W. H. (2002). Prevalence of the metabolic syndrome among US adults: findings from the third National Health and Nutrition Examination Survey. *JAMA*, 287(3), 356–359.
- Friedewald, W. T., Levy, R. I., & Fredrickson, D. S. (1972). Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. *Clinical Chemistry*, 18(6), 499–502.
- Fries, E., Hesse, J., Hellhammer, J., & Hellhammer, D. H. (2005). A new view on hypocortisolism. *Psychoneuroendocrinology*, 30(10), 1010–1016.
<http://doi.org/10.1016/j.psyneuen.2005.04.006>

- Giorgino, F., Laviola, L., & Eriksson, J. W. (2005). Regional differences of insulin action in adipose tissue: insights from in vivo and in vitro studies. *Acta Physiologica Scandinavica*, 183(1), 13–30. <http://doi.org/10.1111/j.1365-201X.2004.01385.x>
- Gist, R. (2007). Promoting resilience and recovery in first responders. In B. Bongar, L. M. Brown, L. E. Beutler, J. N. Breckenridge, P. G. Zimbardo, B. (Ed) Bongar, ... P. G. (Ed) Zimbardo (Eds.), *Psychology of terrorism*. (pp. 418–433). New York, NY, US: Oxford University Press
- Glassi, A., Reynolds, K., & He, J. (2006). The metabolic syndrome and risk of cardiovascular disease: a meta-analysis. *The American Journal of Medicine*, 119(10), 812–819. <http://doi.org/10.1016/j.amjmed.2006.02.031>
- Godsland, I. F., Leyva, F., Walton, C., Worthington, M., & Stevenson, J. C. (1998). Associations of smoking, alcohol and physical activity with risk factors for coronary heart disease and diabetes in the first follow-up cohort of the Heart Disease and Diabetes Risk Indicators in a Screened Cohort study (HDDRISC-1). *Journal of Internal Medicine*, 244(1), 33–41.
- Gold, P. W., & Chrousos, G. P. (2002). Organization of the stress system and its dysregulation in melancholic and atypical depression: high vs low CRH/NE states. *Molecular Psychiatry*, 7(3), 254–275. <http://doi.org/10.1038/sj.mp.4001032>
- Goldbacher, E. M., & Matthews, K. A. (2007). Are psychological characteristics related to risk of the metabolic syndrome? A review of the literature. *Annals of Behavioral Medicine: A Publication of the Society of Behavioral Medicine*, 34(3), 240–252. <http://doi.org/10.1080/08836610701677212>
- Grundy, S. M., Cleeman, J. I., Daniels, S. R., Donato, K. A., Eckel, R. H., Franklin, B. A., Gordon D., Krauss R., Savage P., Smith S., Spertus J., Costa, F. (2005). Diagnosis and Management of the Metabolic Syndrome An American Heart Association/National Heart, Lung, and Blood Institute Scientific Statement. *Circulation*, 112(17), 2735–2752. <http://doi.org/10.1161/CIRCULATIONAHA.105.169404>
- Gur, A., Cevik, R., Nas, K., Colpan, L., & Sarac, S. (2004). Cortisol and hypothalamic-pituitary-gonadal axis hormones in follicular-phase women with fibromyalgia and chronic fatigue syndrome and effect of depressive symptoms on these hormones. *Arthritis Research & Therapy*, 6(3), R232–238. <http://doi.org/10.1186/ar1163>

- Hach, I., Ruhl, U. E., Klotsche, J., Klose, M., & Jacobi, F. (2006). Associations between waist circumference and depressive disorders. *Journal of Affective Disorders*, 92(2-3), 305–308. <http://doi.org/10.1016/j.jad.2006.01.023>
- Han, T. S., Bijnen, F. C., Lean, M. E., & Seidell, J. C. (1998). Separate associations of waist and hip circumference with lifestyle factors. *International Journal of Epidemiology*, 27(3), 422–430.
- Haukkala, A., & Uutela, A. (2000). Cynical hostility, depression, and obesity: the moderating role of education and gender. *The International Journal of Eating Disorders*, 27(1), 106–109.
- Hegg-Deloye, S., Brassard, P., Jauvin, N., Prairie, J., Larouche, D., Poirier, P., Tremblay A., Corbeil, P. (2014). Current state of knowledge of post-traumatic stress, sleeping problems, obesity and cardiovascular disease in paramedics. *Emergency Medicine Journal*, 31(3), 242–247. <http://doi.org/10.1136/emmermed-2012-201672>
- Heiskanen, T. H., Niskanen, L. K., Hintikka, J. J., Koivumaa-Honkanen, H. T., Honkalampi, K. M., Haatainen, K. M., & Viinamäki, H. T. (2006). The metabolic syndrome and depression: a cross-sectional analysis. *The Journal of Clinical Psychiatry*, 67(9), 1422–1427.
- Hennekens, C., & Burning, J. (1987). Epidemiology in medicine.
- Herrman, H., Stewart, D., Diaz-Granados, N., Berger, E., & Jackson, B. (2011). What Is Resilience? *Canadian Journal of Psychiatry*. Retrieved from <http://search.proquest.com/openview/d6daaa44d2a25388021f09300661e40e/1?pq-origsite=gscholar>
- Herva, A., Laitinen, J., Miettunen, J., Veijola, J., Karvonen, J. T., Läksy, K., & Joukamaa, M. (2006 a). Obesity and depression: results from the longitudinal Northern Finland 1966 Birth Cohort Study. *International Journal of Obesity (2005)*, 30(3), 520–527. <http://doi.org/10.1038/sj.ijo.0803174>
- Herva, A., Räsänen, P., Miettunen, J., Timonen, M., Läksy, K., Veijola, J., Laitinen J., Ruokonen A., Joukamaa, M. (2006 b). Co-occurrence of the metabolic syndrome with depression and anxiety in young adults: the Northern Finland 1966 Birth Cohort Study. *Psychosomatic Medicine*, 68(2), 213–216. <http://doi.org/10.1097/01.psy.0000203172.02305.ea>

- Human Performance Clinical and Research Laboratory (HPCRL) Database. (2015).
- Holland, K. (2013). NFPA 1500: Standard on Fire Department Occupational Safety and Health Program.
- Holsboer, F. (2001). Stress, hypercortisolism and corticosteroid receptors in depression: implications for therapy. *Journal of Affective Disorders*, 62(1-2), 77–91.
- Horáček, J., Kuzmiaková, M., Höschl, C., Anděl, M., & Bahbonh, R. (1999). The relationship between central serotonergic activity and insulin sensitivity in healthy volunteers. *Psychoneuroendocrinology*, 24(8), 785–797.
- Ishizaki, N., Morikawa, Y., Nakagawa, H., Honda, R., Kawakami, N., Haratani, T., Kobayashi, F., Araki, S., Yamada, Y. (2004). The Influence of Work Characteristics on Body Mass Index and Waist to Hip Ratio in Japanese Employee.
- Ishizaki, M., Nakagawa, H., Morikawa, Y., Honda, R., Yamada, Y., Kawakami, N., & Japan Work Stress and Health Cohort Study Group. (2008). Influence of job strain on changes in body mass index and waist circumference--6-year longitudinal study. *Scandinavian Journal of Work, Environment & Health*, 34(4), 288–296.
- Jahnke, S. A., Poston, W. S. C., Haddock, C. K., & Jitnarin, N. (2013). Obesity and incident injury among career firefighters in the central United States. *Obesity (Silver Spring, Md.)*, 21(8), 1505–1508. <http://doi.org/10.1002/oby.20436>
- Jetté, M., Sidney, K., & Blümchen, G. (2009). The metabolic syndrome in exercise testing, exercise prescription, and evaluation of functional capacity.
- Kahl, K. G., Bester, M., Greggersen, W., Rudolf, S., Dibbelt, L., Stoeckelhuber, B. M., Gehl H.B., Sipos V., Hohagen F., Schweiger, U. (2005). Visceral fat deposition and insulin sensitivity in depressed women with and without comorbid borderline personality disorder. *Psychosomatic Medicine*, 67(3), 407–412. <http://doi.org/10.1097/01.psy.0000160458.95955.f4>
- Kales, S. N., Soteriades, E. S., Christophi, C. A., & Christiani, D. C. (2007). Emergency duties and deaths from heart disease among firefighters in the United States. *The New England Journal of Medicine*, 356(12), 1207–1215. <http://doi.org/10.1056/NEJMoa060357>

- Kallestad, H., Hansen, B., Langsrud, K., Ruud, T., Morken, G., Stiles, T. C., & Gråwe, R. W. (2012). Impact of sleep disturbance on patients in treatment for mental disorders. *BMC Psychiatry*, 12, 179. <http://doi.org/10.1186/1471-244X-12-179>
- Katon, W. J. (2003). Clinical and health services relationships between major depression, depressive symptoms, and general medical illness. *Biological Psychiatry*, 54(3), 216–226.
- Kia-Keating, M., Dowdy, E., Morgan, M. L., & Noam, G. G. (2011). Protecting and Promoting: An Integrative Conceptual Model for Healthy Development of Adolescents. *Journal of Adolescent Health*, 48(3), 220–228. <http://doi.org/10.1016/j.jadohealth.2010.08.006>
- Kim, T. W., Kim, K. S., & Ahn, Y. S. (2010). Relationship between Job Stress and Depressive Symptoms among Field Firefighters. *Korean Journal of Occupational and Environmental Medicine*, 22(4), 378–387.
- Kent, E. O. (2013). *Ambiguous loss and resilience in the families of firefighters: Moving forward in the fog*. ProQuest Information & Learning, US
- Kinder, L. S., Carnethon, M. R., Palaniappan, L. P., King, A. C., & Fortmann, S. P. (2004). Depression and the metabolic syndrome in young adults: findings from the Third National Health and Nutrition Examination Survey. *Psychosomatic Medicine*, 66(3), 316–322.
- Koslow, S. H., Stokes, P. E., Mendels, J., Ramsey, A., & Casper, R. (1982). Insulin tolerance test: human growth hormone response and insulin resistance in primary unipolar depressed, bipolar depressed and control subjects. *Psychological Medicine*, 12(1), 45–55.
- Kubzansky, L. D., Kawachi, I., Weiss, S. T., & Sparrow, D. (1998). Anxiety and coronary heart disease: a synthesis of epidemiological, psychological, and experimental evidence. *Annals of Behavioral Medicine: A Publication of the Society of Behavioral Medicine*, 20(2), 47–58.
- Kühner, C., Bürger, C., Keller, F., & Hautzinger, M. (2007). [Reliability and validity of the Revised Beck Depression Inventory (BDI-II). Results from German samples]. *Der Nervenarzt*, 78(6), 651–656. <http://doi.org/10.1007/s00115-006-2098-7>

- Lakka, H.-M., Laaksonen, D. E., Lakka, T. A., Niskanen, L. K., Kumpusalo, E., Tuomilehto, J., & Salonen, J. T. (2002). The metabolic syndrome and total and cardiovascular disease mortality in middle-aged men. *JAMA*, 288(21), 2709–2716.
- Lakdawalla, D., & Philipson, T. (2009). The Growth of Obesity and Technological Change. *Economics and Human Biology*, 7(3), 283–293.
<http://doi.org/10.1016/j.ehb.2009.08.001>
- Lambert, J. E., Benight, C. C., Harrison, E., & Cieslak, R. (2012). The Firefighter Coping Self-Efficacy Scale: measure development and validation. *Anxiety, Stress & Coping*, 25(1), 79–91.
- Lee, J.-S., Ahn, Y.-S., Jeong, K.-S., Chae, J.-H., & Choi, K.-S. (2014). Resilience buffers the impact of traumatic events on the development of PTSD symptoms in firefighters. *Journal of Affective Disorders*, 162, 128–133.
<http://doi.org/10.1016/j.jad.2014.02.031>
- Likert, R. (1932). A technique for the measurement of attitudes. *Archives of Psychology*, 22 140, 55.
- Lim, D.-K., Baek, K.-O., Chung, I.-S., & Lee, M.-Y. (2014). Factors Related to Sleep Disorders among Male Firefighters. *Annals of Occupational and Environmental Medicine*, 26, 11. <http://doi.org/10.1186/2052-4374-26-11>
- Magyari, P. M., Churilla, J. R., Steve, S., & Laurent, T. (2008). Prevalence of the metabolic syndrome among Active Duty Firefighters.: 1492. *Medicine & Science in Sports & Exercise*, 40(Supplement), S226.
<http://doi.org/10.1249/01.mss.0000322472.17511.8d>
- Marshall, J. A., Bessesen, D. H., & Hamman, R. F. (1997). High saturated fat and low starch and fibre are associated with hyperinsulinaemia in a non-diabetic population: the San Luis Valley Diabetes Study. *Diabetologia*, 40(4), 430–438.
<http://doi.org/10.1007/s001250050697>
- Mancuso, J. (2003). Overweight and Obesity on the Omaha Fire Department.
- Martin, S. E., Lambert, B. S., Dobson, J., Greene, N. P., Green, J. S., & Crouse, S. F. (2011). Association of Aerobic Fitness and the Metabolic Syndrome in Male Firefighters: 2140: Board #17 June 2 3:30 PM - 5:00 PM. *Medicine & Science in Sports & Exercise*, 43(5). <http://doi.org/10.1249/01.MSS.0000401540.00252.30>

- Maryam Kia-Keating, E. D. (2011). Protecting and Promoting: An Integrative Conceptual Model for Healthy Development of Adolescents. *The Journal of Adolescent Health : Official Publication of the Society for Adolescent Medicine*, 48(3), 220–8. <http://doi.org/10.1016/j.jadohealth.2010.08.006>
- McCaffery, J. M., Niaura, R., Todaro, J. F., Swan, G. E., & Carmelli, D. (2003). Depressive symptoms and metabolic risk in adult male twins enrolled in the National Heart, Lung, and Blood Institute twin study. *Psychosomatic Medicine*, 65(3), 490–497.
- McLeod, S. A. (2010). What is the Stress Response.
- McMahon, C. P. (2010). *A phenomenological study of stress and coping in the fire service*. ProQuest Information & Learning, US.
- McNeill, A. M., Rosamond, W. D., Girman, C. J., Golden, S. H., Schmidt, M. I., East, H. E., ... Heiss, G. (2005). The metabolic syndrome and 11-year risk of incident cardiovascular disease in the atherosclerosis risk in communities study. *Diabetes Care*, 28(2), 385–390.
- Meltzer, H. Y. (1989). Clinical studies on the mechanism of action of clozapine: the dopamine-serotonin hypothesis of schizophrenia. *Psychopharmacology*, 99 Suppl, S18–27.
- Mensink, M., Blaak, E. E., Corpeleijn, E., Saris, W. H., de Bruin, T. W., & Feskens, E. J. (2003). Lifestyle intervention according to general recommendations improves glucose tolerance. *Obesity Research*, 11(12), 1588–1596. <http://doi.org/10.1038/oby.2003.211>
- Meyer, E. C., Zimering, R., Daly, E., Knight, J., Kamholz, B. W., & Gulliver, S. B. (2012). Predictors of posttraumatic stress disorder and other psychological symptoms in trauma-exposed firefighters. *Psychological Services*, 9(1), 1–15. <http://doi.org/10.1037/a0026414>
- Michaelides, M. A., Parpa, K. M., Thompson, J., & Brown, B. (2008). Predicting performance on a firefighter's ability test from fitness parameters. *Research Quarterly for Exercise and Sport*, 79(4), 468–475. <http://doi.org/10.1080/02701367.2008.10599513>

- Miller, G. E., Freedland, K. E., Carney, R. M., Stetler, C. A., & Banks, W. A. (2003). Pathways linking depression, adiposity, and inflammatory markers in healthy young adults. *Brain, Behavior, and Immunity*, 17(4), 276–285.
- Morrison, P., & Leto, F. (2013). *Behavioral Health and Suicide Awareness*.
- Morikawa, Y., Nakagawa, H., Miura, K., Soyama, Y., Ishizaki, M., Kido, T., Naruse, Y., Suwazono, Y., Nogawa, K.. (2007). Effect of shift work on body mass index and metabolic parameters. *Scandinavian Journal of Work, Environment & Health*, 33(1), 45–50. Retrieved from <http://www.jstor.org/stable/40967620>
- Morrison, M. F., Redei, E., TenHave, T., Parmelee, P., Boyce, A. A., Sinha, P. S., & Katz, I. R. (2000). Dehydroepiandrosterone sulfate and psychiatric measures in a frail, elderly residential care population. *Biological Psychiatry*, 47(2), 144–150.
- Muldoon, M. F., Mackey, R. H., Korytkowski, M. T., Flory, J. D., Pollock, B. G., & Manuck, S. B. (2006). The metabolic syndrome is associated with reduced central serotonergic responsivity in healthy community volunteers. *The Journal of Clinical Endocrinology and Metabolism*, 91(2), 718–721. <http://doi.org/10.1210/jc.2005-1654>
- Muldoon, M. F., Mackey, R. H., Williams, K. V., Korytkowski, M. T., Flory, J. D., & Manuck, S. B. (2004). Low central nervous system serotonergic responsivity is associated with the metabolic syndrome and physical inactivity. *The Journal of Clinical Endocrinology and Metabolism*, 89(1), 266–271. <http://doi.org/10.1210/jc.2003-031295>
- Mummery, K., Schofield, G., Steele, R., Eakin, E., & Brown, W. (2005). Occupational Sitting Time and Overweight and Obesity in Australian Workers.
- Murphy, S. a., Bond, G. e., Beaton, R. d., Murphy, J., & Hohnson, L. c. (2002). Lifestyle practices and occupational stressors as predictors of health outcomes in urban firefighters. *International Journal of Stress Management*, 9(4), 311–327.
- Musselman, D. L., Betan, E., Larsen, H., & Phillips, L. S. (2003). Relationship of depression to diabetes types 1 and 2: epidemiology, biology, and treatment. *Biological Psychiatry*, 54(3), 317–329.

- Nelson, J. C., & Davis, J. M. (1997). DST studies in psychotic depression: a meta-analysis. *The American Journal of Psychiatry*, 154(11), 1497–1503.
- Nelson, T. L., Palmer, R. F., & Pedersen, N. L. (2004). The metabolic syndrome mediates the relationship between cynical hostility and cardiovascular disease. *Experimental Aging Research*, 30(2), 163–177.
<http://doi.org/10.1080/03610730490275148>
- Nelson, T. L., Palmer, R. F., Pedersen, N. L., & Miles, T. P. (1999). Psychological and behavioral predictors of body fat distribution: age and gender effects. *Obesity Research*, 7(2), 199–207.
- Peeters, M. C. W., Jonge, J. de, & Taris, T. W. (2013). *An Introduction to Contemporary Work Psychology*. John Wiley & Sons.
- Penninx, B. W., Beekman, A. T., Honig, A., Deeg, D. J., Schoevers, R. A., van Eijk, J. T., & van Tilburg, W. (2001). Depression and cardiac mortality: results from a community-based longitudinal study. *Archives of General Psychiatry*, 58(3), 221–227.
- Petruzzello, S. J., Poh, P. Y. S., Greenlee, T. A., Goldstein, E., Horn, G. P., & Smith, D. L. (2014). Physiological, Perceptual and Psychological Responses of Career versus Volunteer Firefighters to Live-fire Training Drills. *Stress and Health: Journal of the International Society for the Investigation of Stress*.
<http://doi.org/10.1002/smi.2620>
- Pineles, S. L., Rasmusson, A. M., Yehuda, R., Lasko, N. B., Macklin, M. L., Pitman, R. K., & Orr, S. P. (2013). Predicting emotional responses to potentially traumatic events from pre-exposure waking cortisol levels: a longitudinal study of police and firefighters. *Anxiety, Stress & Coping*, 26(3), 241–253.
- Plotsky, P. M., Owens, M. J., & Nemeroff, C. B. (1998). Psychoneuroendocrinology of depression. Hypothalamic-pituitary-adrenal axis. *The Psychiatric Clinics of North America*, 21(2), 293–307.

- Poston, W. S. C., Haddock, C. K., Jahnke, S. A., Jitnarin, N., Tuley, B. C., & Kales, S. N. (2011). The prevalence of overweight, obesity, and substandard fitness in a population-based firefighter cohort. *Journal of Occupational and Environmental Medicine / American College of Occupational and Environmental Medicine*, 53(3), 266–273. <http://doi.org/10.1097/JOM.0b013e31820af362>
- Prati, G., & Peitranconi, L. (2010). An application of the social support deterioration deterrence model to rescue workers - Prati - 2010 - Journal of Community Psychology - Wiley Online Library. Retrieved August 18, 2015, from <http://onlinelibrary.wiley.com/doi/10.1002/jcop.20404/abstract>
- R Development Core Team (2008). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL <http://www.R-project.org>.
- Radloff, L. S. (1977). The CES-D Scale A Self-Report Depression Scale for Research in the General Population. *Applied Psychological Measurement*, 1(3), 385–401. <http://doi.org/10.1177/014662167700100306>
- Ravaja, N., Keltikangas-Järvinen, L., & Keskivaara, P. (1996). Type A factors as predictors of changes in the metabolic syndrome precursors in adolescents and young adults--a 3-year follow-up study. *Health Psychology: Official Journal of the Division of Health Psychology, American Psychological Association*, 15(1), 18–29.
- Räikkönen, K., Keltikangas-Järvinen, L., & Hautanen, A. (1994). The role of psychological coronary risk factors in insulin and glucose metabolism. *Journal of Psychosomatic Research*, 38(7), 705–713.
- Räikkönen, K., Matthews, K. A., & Kuller, L. H. (2002). The relationship between psychological risk attributes and the metabolic syndrome in healthy women: antecedent or consequence? *Metabolism: Clinical and Experimental*, 51(12), 1573–1577. <http://doi.org/10.1053/meta.2002.36301>

- Räikkönen, K., Matthews, K. A., & Kuller, L. H. (2007). Depressive symptoms and stressful life events predict the metabolic syndrome among middle-aged women: a comparison of World Health Organization, Adult Treatment Panel III, and International Diabetes Foundation definitions. *Diabetes Care*, 30(4), 872–877. <http://doi.org/10.2337/dc06-1857>
- Räikkönen, K., Matthews, K. A., Kuller, L. H., Reiber, C., & Bunker, C. H. (1999). Anger, hostility, and visceral adipose tissue in healthy postmenopausal women. *Metabolism: Clinical and Experimental*, 48(9), 1146–1151.
- Räikkönen, K., Matthews, K. A., Sutton-Tyrrell, K., & Kuller, L. H. (2004). Trait anger and the metabolic syndrome predict progression of carotid atherosclerosis in healthy middle-aged women. *Psychosomatic Medicine*, 66(6), 903–908. <http://doi.org/10.1097/01.psy.0000143638.31297.11>
- Regehr, C. (2009). Social support as a mediator of psychological distress in firefighters. *The Irish Journal of Psychology*, 30(1-4), 87–98.
- Regehr, C., Hill, J., Knott, T., & Sault, B. (2003). Social support, self-efficacy and trauma in new recruits and experienced firefighters. *Stress and Health: Journal of the International Society for the Investigation of Stress*, 19(4), 189–193. <http://doi.org/10.1002/smi.974>
- Rhea, M. R., Alvar, B. A., & Gray, R. (2004). Physical fitness and job performance of firefighters. *Journal of Strength and Conditioning Research / National Strength & Conditioning Association*, 18(2), 348–352. <http://doi.org/10.1519/R-12812.1>
- Rosmond, R. (2005). Role of stress in the pathogenesis of the metabolic syndrome. *Psychoneuroendocrinology*, 30(1), 1–10. <http://doi.org/10.1016/j.psyneuen.2004.05.007>
- Rosmond, R., & Björntorp, P. (1998). Endocrine and metabolic aberrations in men with abdominal obesity in relation to anxio-depressive infirmity. *Metabolism: Clinical and Experimental*, 47(10), 1187–1193.
- Rustagi, N., & Singh, R. (2010). Mercury and health care. *Indian Journal of Occupational and Environmental Medicine*, 14(2), 45–48. <http://doi.org/10.4103/0019-5278.72240>

- Rutter, M. (1993). Resilience: Some conceptual considerations. *Journal of Adolescent Health, 14*(8), 626–631. [http://doi.org/10.1016/1054-139X\(93\)90196-V](http://doi.org/10.1016/1054-139X(93)90196-V)
- Rutter, M., Champion, L., Quinton, D., Maughan, B., & Pickles, A. (1995). Understanding individual differences in environmental-risk exposure. In P. Moen, G. H. Elder, Jr., & K. L. (Eds.), *Examining lives in context: Perspectives on the ecology of human development* (pp. 61–93). Washington, DC, US: American Psychological Association
- Saijo, Y., Ueno, T., & Hashimoto, Y. (2008). Twenty-four-hour shift work, depressive symptoms, and job dissatisfaction among Japanese firefighters. *American Journal of Industrial Medicine, 51*(5), 380–391. <http://doi.org/10.1002/ajim.20571>
- Samaras, K., & Campbell, L. V. (1997). The non-genetic determinants of central adiposity. *International Journal of Obesity and Related Metabolic Disorders: Journal of the International Association for the Study of Obesity, 21*(10), 839–845.
- Sattler, D. N., Boyd, B., & Kirsch, J. (2014). Trauma-exposed Firefighters: Relationships among Posttraumatic Growth, Posttraumatic Stress, Resource Availability, Coping and Critical Incident Stress Debriefing Experience. *Stress and Health, 30*(5), 356–365. <http://doi.org/10.1002/smi.2608>
- Savia, J. S. (2008). *Suicide among North Carolina professional firefighters: 1984--1999*. REGENT UNIVERSITY. Retrieved from <http://gradworks.umi.com/33/05/3305393.html>
- Scheer, F. A. J. L., Hilton, M. F., Mantzoros, C. S., & Shea, S. A. (2009). Adverse metabolic and cardiovascular consequences of circadian misalignment. *Proceedings of the National Academy of Sciences of the United States of America, 106*(11), 4453–4458. <http://doi.org/10.1073/pnas.0808180106>
- Scherwitz, L. W., Perkins, L. L., Chesney, M. A., Hughes, G. H., Sidney, S., & Manolio, T. A. (1992). Hostility and health behaviors in young adults: the CARDIA Study. Coronary Artery Risk Development in Young Adults Study. *American Journal of Epidemiology, 136*(2), 136–145.

- Shen, B.-J., Todaro, J. F., Niaura, R., McCaffery, J. M., Zhang, J., Spiro, A., & Ward, K. D. (2003). Are metabolic risk factors one unified syndrome? Modeling the structure of the metabolic syndrome X. *American Journal of Epidemiology*, 157(8), 701–711.
- Shields, A. T. (2002). Examination of the Obesity Epidemic from a Behavioral Perspective.
- Skilton, M. R., Moulin, P., Terra, J.-L., & Bonnet, F. (2007). Associations between anxiety, depression, and the metabolic syndrome. *Biological Psychiatry*, 62(11), 1251–1257. <http://doi.org/10.1016/j.biopsych.2007.01.012>
- Sliter, M., Kale, A., & Yuan, Z. (2014). Is humor the best medicine? The buffering effect of coping humor on traumatic stressors in firefighters. *Journal of Organizational Behavior*, 35(2), 257–272. <http://doi.org/10.1002/job.1868>
- Smith, S. M., & Vale, W. W. (2006). The role of the hypothalamic-pituitary-adrenal axis in neuroendocrine responses to stress. *Dialogues in Clinical Neuroscience*, 8(4), 383–395.
- Soteriades, E. S., Hauser, R., Kawachi, I., Christiani, D. C., & Kales, S. N. (2008). Obesity and risk of job disability in male firefighters. *Occupational Medicine (Oxford, England)*, 58(4), 245–250. <http://doi.org/10.1093/occmed/kqm153>
- Storer, T. W., Dolezal, B. A., Abrazado, M. L., Smith, D. L., Batalin, M. A., Tseng, C.-H., ... PHASER Study Group. (2014). Firefighter health and fitness assessment: a call to action. *Journal of Strength and Conditioning Research / National Strength & Conditioning Association*, 28(3), 661–671. <http://doi.org/10.1519/JSC.0b013e31829b54da>
- Suarez, E. C. (2006). Sex differences in the relation of depressive symptoms, hostility, and anger expression to indices of glucose metabolism in nondiabetic adults. *Health Psychology: Official Journal of the Division of Health Psychology, American Psychological Association*, 25(4), 484–492. <http://doi.org/10.1037/0278-6133.25.4.484>

- Timonen, M., Rajala, U., Jokelainen, J., Keinänen-Kiukaanniemi, S., Meyer-Rochow, V. B., & Räsänen, P. (2006). Depressive symptoms and insulin resistance in young adult males: results from the Northern Finland 1966 birth cohort. *Molecular Psychiatry*, *11*(10), 929–933.
<http://doi.org/10.1038/sj.mp.4001838>
- Todaro, J. F., Con, A., Niaura, R., Spiro, A., Ward, K. D., & Roytberg, A. (2005). Combined effect of the metabolic syndrome and hostility on the incidence of myocardial infarction (the Normative Aging Study). *The American Journal of Cardiology*, *96*(2), 221–226. <http://doi.org/10.1016/j.amjcard.2005.03.049>
- Tortora, G. (2009). *Principles Of Anatomy And Physiology 12th Ed G*. Retrieved from
http://archive.org/details/PrinciplesOfAnatomyAndPhysiology12thEdG.TortoraB_201404
- Tsismenakis, A. J., Christophi, C. A., Burrell, J. W., Kinney, A. M., Kim, M., & Kales, S. N. (2009). The Obesity Epidemic and Future Emergency Responders. *Obesity*, *17*(8), 1648–1650. <http://doi.org/10.1038/oby.2009.63>
- Van Amelsvoort, L. G. (1999). Duration of shiftwork related to body mass index and waist to hip ratio. Retrieved November 19, 2015, from
<http://www.nature.com/ijo/journal/v23/n9/abs/0801028a.html>
- Van Zandt, S. (2011). National Fire Protection Association Manditorium.
- Vargas de Barros, V., Martins, L. F., Saitz, R., Bastos, R. R., & Ronzani, T. M. (2013). Mental health conditions, individual and job characteristics and sleep disturbances among firefighters. *Journal of Health Psychology*, *18*(3), 350–358.
<http://doi.org/10.1177/1359105312443402>
- Vena, J. E., & Fiedler, R. C. (1987). Mortality of a municipal-worker cohort: IV. Fire fighters. *American Journal of Industrial Medicine*, *11*(6), 671–684.
- Vicennati, V., & Pasquali, R. (2000). Abnormalities of the hypothalamic-pituitary-adrenal axis in nondepressed women with abdominal obesity and relations with insulin resistance: evidence for a central and a peripheral alteration. *The Journal of Clinical Endocrinology and Metabolism*, *85*(11), 4093–4098.
<http://doi.org/10.1210/jcem.85.11.6946>

- Vitaliano, P. P., Scanlan, J. M., Zhang, J., Savage, M. V., Hirsch, I. B., & Siegler, I. C. (2002). A path model of chronic stress, the metabolic syndrome, and coronary heart disease. *Psychosomatic Medicine*, 64(3), 418–435.
- Vogelzangs, N., Suthers, K., Ferrucci, L., Simonsick, E. M., Ble, A., Schrager, M., Bandinelli S., Lauretani F., Giannelli S., Penninx, B. W. (2007). Hypercortisolemic Depression is Associated with the metabolic syndrome in Late-Life. *Psychoneuroendocrinology*, 32(2), 151–159.
<http://doi.org/10.1016/j.psyneuen.2006.11.009>
- Wagner, S. L., & Martin, C. A. (2012). Can Firefighters' Mental Health Be Predicted by Emotional Intelligence and Proactive Coping? *Journal of Loss & Trauma*, 17(1), 56–72. <http://doi.org/10.1080/15325024.2011.584027>
- Weber-Hamann, B., Hentschel, F., Kniest, A., Deuschle, M., Colla, M., Lederbogen, F., & Heuser, I. (2002). Hypercortisolemic depression is associated with increased intra-abdominal fat. *Psychosomatic Medicine*, 64(2), 274–277.
- Weber-Hamann, B., Werner, M., Hentschel, F., Bindeballe, N., Lederbogen, F., Deuschle, M., & Heuser, I. (2006). Metabolic changes in elderly patients with major depression: evidence for increased accumulation of visceral fat at follow-up. *Psychoneuroendocrinology*, 31(3), 347–354.
<http://doi.org/10.1016/j.psyneuen.2005.08.014>
- Weber, B., Schweiger, U., Deuschle, M., & Heuser, I. (2000). Major depression and impaired glucose tolerance. *Experimental and Clinical Endocrinology & Diabetes: Official Journal, German Society of Endocrinology [and] German Diabetes Association*, 108(3), 187–190. <http://doi.org/10.1055/s-2000-7742>
- Wing, R. R., Matthews, K. A., Kuller, L. H., Meilahn, E. N., & Plantinga, P. (1991). Waist to hip ratio in middle-aged women. Associations with behavioral and psychosocial factors and with changes in cardiovascular risk factors. *Arteriosclerosis and Thrombosis: A Journal of Vascular Biology / American Heart Association*, 11(5), 1250–1257.
- Yamada, Y., Ishizaki, M., & Tsuritani, I. (2002). Prevention of Weight Gain and Obesity in Occupational Populations: A New Target of Health Promotion Services at Worksites.

APPENDIX A

INFORMED CONSENT: HDPP 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 encoded 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

Signature

APPENDIX B

INSTITUTIONAL REVIEW BOARD APPROVAL FORM



NOTICE OF APPROVAL FOR HUMAN RESEARCH

DATE: February 11, 2014

TO: Nelson-Ceschin, Tracy, Health and Exercise Science

Dussinger, Beth, Health and Exercise Science, Lipsey, Tiffany, Health and Exercise Science,
Hickey, Matthew, Health and Exercise Science

FROM: Barker, Janell, Coordinator, CSU IRB 1

PROTOCOL TITLE:

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

FUNDING SOURCE: NONE

PROTOCOL NUMBER: 13-4391H

APPROVAL PERIOD: Approval Date: February 06, 2014 Expiration Date: October 03, 2014
The CSU Institutional Review Board (IRB) for the protection of human subjects has reviewed the protocol entitled: PREDICTORS OF HEALTH BEHAVIORS AND CARDIOVASCULAR DISEASE RISK FACTORS FOR PROFESSIONAL FIREFIGHTERS. The project has been approved for the procedures and subjects described in the protocol. This protocol must be reviewed for renewal on a yearly basis for as long as the research remains active. Should the protocol not be renewed before expiration, all activities must cease until the protocol has been re-reviewed. If approval did not accompany a proposal when it was submitted to a sponsor, it is the PI's responsibility to provide the sponsor with the approval notice. This approval is issued under Colorado State University's Federal Wide Assurance 00000647 with the Office for Human Research Protections (OHRP). If you have any questions regarding your obligations under CSU's Assurance, please do not hesitate to contact us.

Please direct any questions about the IRB's actions on this project to:

Janell Barker, Senior IRB Coordinator - (970) 491-1655 Janell.Barker@Colostate.edu

Evelyn Swiss, IRB Coordinator - (970) 491-1381 Evelyn.Swiss@Colostate.edu

Barker, Janell

Barker, Janell

Amendment approval is to add firefighters to the recruitment pool who have not been in the HPPP and have them complete two questionnaires and to use the revised flyer and consent form reflecting this change.

Approval Period: February 06, 2014 through October 03, 2014

Review Type: EXPEDITED

IRB Number: 00000202

Research Integrity & Compliance Review Office

Office of the Vice President for Research

321 General Services Building - Campus Delivery 2011 Fort Collins, CO

TEL: (970) 491-1553

FAX: (970) 491-2293

APPENDIX C

EMOTIONAL HEALTH QUESTIONNAIRE

The following questions measure emotions which may be indirectly related to cardiovascular disease.

Please fill out the questionnaires using your first response. Do not dwell on your answer as your first response is generally most accurate.

Read the directions carefully above each scale.

Thank You

CES-D DEPRESSION SCALE

Below is a list of the ways you may have felt or behaved. Please tell me how often you felt this way during the past week.

During the past week:	Rarely or none of the time (less than 1 day)	Some or a little of the time (1-2 days)	Occasionally or a moderate amount of time (3-4 days)	Most or all of the time (5-7 days)
1. I was bothered by things that usually don't bother me.				
2. I did not feel like eating; my appetite was poor.				
3. I felt that I could not shake off the blues even with help from my family or friends.				
4. I felt that I was just as good as other people.				
5. I had trouble keeping my mind on what I was doing.				
6. I felt depressed.				
7. I felt that everything I did was an effort.				
8. I felt hopeful about the future.				
9. I thought my life had been a failure.				
10. I felt fearful.				
11. My sleep was restless.				
12. I was happy.				
13. I talked less than usual.				
14. I felt lonely.				
15. People were unfriendly.				
16. I enjoyed life.				
17. I had crying spells.				
18. I felt sad.				
19. I felt that people dislike me.				
20. I could not get "going".				
Office use only	0	1	2	3

APPENDIX D

QUESTIONNAIRE SCORING

**SCORING THE
EMOTIONS QUESTIONNAIRE**

- **Hope Scale**
 - Omit # 3, 5, 7 and 11 from total.
 - Sum.
- **Anger Scale**
 - T = 1, F = 0
 - Except #16, where T = 0 and F = 1
- **CES-D Scale**
 - # 4, 8, 12 and 16 have reserved scores (3 = 0, 2 = 1, 1 = 2 and 0 = 3)
 - Sum.
- **Spielberger State Anxiety Scale**
 - **Use this scale to score tension.**
 - Reverse scores (5 = 1, 4 = 2, 3 = 3, 2 = 4 and 1 = 5) for the following statements:
 - I feel tense
 - I'm worried in case I fail
 - I feel nervous
 - I feel shaky
 - I feel anxious
 - I feel frightened
 - Sum and give the appropriate rating
 - 10 – 17 = No tension
 - 18 – 25 = Slight tension
 - 26 – 33 = Moderate tension
 - 34 – 41 = Tense
 - 42 – 50 = Very tense
- **Cook Medley Hostility Scale**
 - T = 1, F = 0
 - Except # 16, 20 and 33, where T = 0 and F = 1
 - Sum
- **Cynicism Scale (grade from questions on Cook Medley Hostility Scale)**
 - Question #'s: 4, 5, 6, 7, 9, 10, 19, 21, 24, 27, 34, 38, 50
 - Sum
- **Framingham Type A**
 - Sum
- **Forgiveness Scale**
 - Sum
- **Medical Outcomes Study Support Survey**
 - Do not include #1 (number of close friends and relatives)
 - Sum
- **Orientation to Life Questionnaire**
 - Reverse scores for # 1, 2, 3, 7 and 10 (1 = 7, 2 = 6, 3 = 5, 4 = 4, 5 = 3, 6 = 2 and 7 = 1)
 - Sum

APPENDIX E

CIRCUMFERENCE PROTOCOL

Circumference Assessment Protocol

Circumference Sites:

- **For HPCRL Testing:**

Be sure the individual's feet are together.

Umbilicus	At the level of the umbilicus
Ant. Supra.	At the level where anterior iliac crest begins to incline downwards
Max Hip	At the level of maximal hip circumference (determine by sight from the side of the person)
Greater Troc.	At the level of the greater trochanter of the femur (may need to have the person externally rotate his/her foot to locate)
Min. Waist	At the level of minimal waist circumference (determine by sight; step back and look at torso)

- *Keep in mind that a few of these measurements may anatomically be assessed in the same places depending on the individual.*
-

Procedures:

- The client should stand upright but relaxed during assessment.
- Place the tape perpendicular to the long axis of the body part in each case.
- Pull the tape to the proper tension without pinching the skin (to the notch on the handle).
- Take duplicate measures at each site and retest if measurements are not within 1/4 in. (or 7 mm).

APPENDIX F

BLOOD PRESSURE PROTOCOL

Blood Pressure Assessment Protocol

- The technician should have the client either lie down (supine), sit, or stand for at least 1 minute before blood pressure is assessed, depending on which position the blood pressure reading needs to be taken.
- Cuff selection
 - Choosing the appropriate size cuff for each client will help to ensure accurate blood pressure assessments.
 - Cuff size is determined by how much of the arm the cuff covers. Follow the markers indicated on the cuff.
- With the client in the proper position, the cuff should be applied approximately an inch above the antecubital space (natural crease of the elbow), with the center of the bladder directly over the medial (inner) surface of the arm.
- With the client's arm slightly flexed, the technician should support the full weight of the arm and firmly place the stethoscope head over the brachial artery in the antecubital space, but with little pressure.
- After the air pressure regulator screw of the sphygmomanometer has been tightened (turned clockwise), the technician can begin inflating the bladder.
- The bladder can be inflated while feeling the radial pulse to about 30-40 mm Hg above the point at which the pulse disappears. (For most adults during a *resting* blood pressure assessment, inflating the bladder to approximately 200 mm Hg is a good reference point. During exercise, this number may need to increase depending on the individual).
- At the point in which the technician ceases inflation, pressure in the cuff should be released (by turning air pressure regulator screw counterclockwise) at a rate of approximately 2-5 mm Hg per second.
- As the pressure is released, *systolic blood pressure* is determined at the point where initial pulse sound is heard.
- *Diastolic blood pressure* is determined at the point where pulse sound disappears.
- The recordings should be expressed as systolic over diastolic pressure (ex. 134/80).
 - **Remember:** Carefully examine the tick marks on the sphygmomanometer. Most only read in increments of 2 mmHg, so in that case, it is not appropriate to "hear" a beat on an odd number. Generally, readings are recorded in even numbers.
- If proper assessment of blood pressure cannot be determined in one trial, the bladder should be deflated completely, and at least one minute should be allowed before making the next recording.
- **In some cases**, pulse sounds become less intense (muffled) and can still be heard at lower pressures (40-50 mm Hg) or even all the way down to zero. In this case, systolic should be recorded the same way as mentioned before, while diastolic should be recorded as the point at which there is a clear, definite change in sound (ex. from strong to muffled). The complete disappearance of the sound should also be recorded as the final number (ex. 120/60/0).

ACSM Eighth Edition. Modified from National High Blood Pressure Education Program.

APPENDIX G

BLOOD CHEMISTRY RESULTS EXAMPLE

RUN DATE: 05/20/15 University of Colorado Health
 RUN TIME: 0823 Laboratory Services

Specimen Inquiry

PAGE 1

PATIENT: _____

SPEC #: _____ COLL: 05/20/15-0648 STATUS: COMP REQ #: _____
 RECD: 05/20/15-0724 SUBM DR: LBCLN ONLY-HUMAN, PERF CL

ENTERED: 05/20/15-0646 OTHR DR: _____

ORDERED: CMP, URIC ACID, LIPID, IRON, CRPHS

COMMENTS: ORDERED URGENT FOR THE PURPOSE OF PRINTING.
 FAX RESULTS TO: 491-7677 ATTN: TIFFANY LIPSEY
 PHONE CRITICAL RESULTS TO 491-7035 ATTN: TIFFANY LIPSEY
 EXP FAX: 94917677

Test	Result	Flag	Reference	Perf Site
CMP				
BASIC				
SODIUM	136		134-145 MEQ/L	PVH
POTASSIUM	3.7		3.5-5.1 MEQ/L	PVH
CHLORIDE	102		98-107 MEQ/L	PVH
CO2	28		21-31 MMOL/L	PVH
ANION GAP	6		4-15	PVH
GLUCOSE	80		70-99 MG/DL	PVH
BUN	35	H	7-25 MG/DL	PVH
CREAT, SERUM	1.2		0.7-1.3 MG/DL	PVH
eGFRif AFR AMER	> 60		see note see note	PVH
eGFR	> 60		see note see note	PVH
Note: Normal ≥ 60 mL/min/1.73m squared Chronic kidney disease 15-60 mL/min/1.73m squared Acute kidney failure < 15 mL/min/1.73m squared				
BUN/CR RATIO	29.2			PVH
CALCIUM	9.7		8.8-10.6 MG/DL	PVH
PROTEIN TOTAL S	7.6		6.4-8.9 G/DL	PVH
ALBUMIN, SERUM	4.7		3.5-5.7 GM/DL	PVH
TOTAL BILIRUBIN	0.5		0.3-1.0 MG/DL	PVH
ALK PHOS:	54		34-104 U/L	PVH
AST	38		13-39 U/L	PVH
URIC ACID	5.0		4.2-8.0 MG/DL	PVH
GLOBULIN	2.9		2.3-3.9 GM/DL	PVH
A/G RATIO	1.6			PVH
ALT	39		7-52 U/L	PVH
LIPID				
TRIG	60		<150 MG/DL	PVH
NCEP guidelines: Desirable: < 150 Borderline High: 150-199 High: 200-499 Very High: > 499				
CHOLESTEROL	149		<200 MG/DL	PVH
NCEP II guidelines: Desirable: < 200 Borderline: 200-240 Higher Risk: > 240				
HDL	49		MG/DL	PVH
NCEP II guidelines: < 40 increased risk of heart disease				

PVH - POUDRE VALLEY HOSPITAL LAB
 POUDRE VALLEY HOSPITAL MAIN LABORATORY
 1024 LEMAY AVE, FORT COLLINS, CO 80524 (970)495-8700
 CHRISTOPHER BEE, M.D.

LEGEND: H=above normal; L=below normal; #=exceeds delta check limit; *exceeds critical value

RUN DATE: 05/20/15
RUN TIME: 0823

University of Colorado Health
Laboratory Services

Specimen Inquiry

PAGE 2

SPEC #: [REDACTED] COLL: 05/20/15-0648 STATUS: COMP REQ #: [REDACTED]
RECD: 05/20/15-0724 SUBM DR: LBCLN ONLY-HUMAN, PERF CL
ACCT#: [REDACTED] ENTERED: 05/20/15-0646 OTHR DR:
ORDERED: CMP, URIC ACID, LIPID, IRON, CRPHS
COMMENTS: ORDERED URGENT FOR THE PURPOSE OF PRINTING.
FAX RESULTS TO: 491-7677 ATTN: TIFFANY LIPSEY
PHONE CRITICAL RESULTS TO 491-7035 ATTN: TIFFANY LIPSEY

Test	Result	Flag	Reference	Perf Site
		40-60 desirable, average risk		
		> 60 desirable, less than average risk		
LDL, CALC	88		MG/DL	PVH
NCEP II guidelines:				
TARGET VALUE <70 if you are at high risk for heart disease				
<100 if you have heart disease or diabetes				
<130 if you have two or more risk factors				
<160 if you have one or no risk factors				
Risk factors include: Cigarette smoking, Hypertension,				
Family history, Age (male >45, female >55)				
LDL/HDL RATIO	1.80		0.0-3.5	PVH
CHOL/HDL RATIO	3.04		0.0-5.0	PVH
IRON	63		45-208 UG/DL	PVH
CRP, HI-SENS	0.460		MG/L	PVH
PER AHA AND CDC:				
<1.0 LOW RISK FOR FUTURE CARDIAC RISK				
1.0-3.0 INTERMEDIATE RISK				
>3.0 HIGH RISK				

PVH - POUDRE VALLEY HOSPITAL LAB
POUDRE VALLEY HOSPITAL MAIN LABORATORY
1024 LEMAY AVE, FORT COLLINS, CO 80524 (970)495-8700
CHRISTOPHER BEE, M.D.

LEGEND: H=above normal; L=below normal; #=exceeds delta check limit; *exceeds critical value