Summer 5-2019

Fire Department Support And Physical Activity Of Volunteer Firefighters: A Cross-Sectional Examination

Sarah Wagner
UTHealth School of Public Health

FIRE DEPARTMENT SUPPORT AND PHYSICAL

ACTIVITY OF VOLUNTEER FIREFIGHTERS:

A CROSS-SECTIONAL EXAMINATION

by

SARAH JANE WAGNER, BS

APPROVED:

R. Sue Day

R. SUE DAY, MS, PHD

Laura S.

LAURA S. MOORE, MED, RD, LD

FIRE DEPARTMENT SUPPORT AND PHYSICAL ACTIVITY OF VOLUNTEER FIREFIGHTERS: A CROSS-SECTIONAL EXAMINATION

by

SARAH WAGNER
BS, Lipscomb University, 2017

Presented to the Faculty of The University of Texas

School of Public Health

in Partial Fulfillment

of the Requirements

for the Degree of

MASTER OF PUBLIC HEALTH

THE UNIVERSITY OF TEXAS
SCHOOL OF PUBLIC HEALTH
Houston, Texas
May, 2019

ACKNOWLEDGEMENTS

Thank you to Dr. Day for allowing me to be a part of this important research and for helping me through every step of the process. I could not have completed this project without you. Thank you to Ms. Moore for ongoing support and encouragement as I took on this project, as well as the rest of the Nourish team and dietetic internship for being respectful of my time as I balanced my thesis, internship rotations, and graduate assistant work. I would also like to acknowledge the funding source for this study – FEMA – Federal Emergency Management Agency EMW- EMW-2013-FP-00983. Lastly, thank you to my family for unwavering support, always.

FIRE DEPARTMENT SUPPORT AND PHYSICAL ACTIVITY OF VOLUNTEER FIREFIGHTERS: A CROSS-SECTIONAL EXAMINATION

Sarah Wagner, BS, MPH
The University of Texas
School of Public Health, 2019

Thesis Chair: R. Sue Day, MS, PhD

Greater health and fitness of volunteer firefighters protects them from cardiovascular disease-related deaths, reduces risk of injury, and improves job performance, which subsequently provides better protection for the majority of the U.S. population who is served by volunteers. Given the strong social support system characteristic of the U.S. fire service, there seems to be potential opportunity to influence the behaviors of firefighters by creating a culture that promotes healthy habits rather than unhealthy. Objective: Determine the association between fire department culture's encouragement of physical activity and volunteer firefighters' moderate- to vigorous-intensity aerobic activity. Methods: A cross-sectional analysis was performed using baseline data from the cluster RCT The First Twenty for Volunteer Firefighters (TF20). Data was collected from a national sample of volunteer firefighters from 9 U.S. departments, including measurements of perceived peer and leadership support of physical activity and firefighters' self-reported frequency of moderate- and vigorous-intensity physical activity. Logistic regression analyses of perceived support and average minutes per week of physical activity were conducted and odds ratios interpreted

at the 0.05 significance level. Results: Peer and leadership support were not significantly associated with meeting CDC exercise guidelines for disease prevention. Meeting exercise recommendations was associated with being male, not having a leadership position, being a minority, and having lower BMI and younger age. Conclusions: Due to volunteer firefighters' limited time at the fire station, physical activity levels were not impacted by support from the department or peers.

TABLE OF CONTENTS

LIST OF TABLES

BACKGROUND AND LITERATURE REVIEW

Scientific Context

Cardiovascular disease (CVD), a health problem experienced by 1 in 3 Americans and the cause of 1 of every 4 deaths, disproportionately affects various subgroups of the U.S. population.[1] Specifically, the U.S. fire service is more severely impacted by CVD than the general public, with CVD causing 45% of all on-duty deaths of firefighters.[2] This greater proportion of CVD-related deaths among firefighters compared to other emergency or uniformed professions likely results from firefighters' increased exposure to stressors of CVD compared to their non-firefighting peers.

Over 1.1 million firefighters serve the American public, making a large subpopulation whose own health directly impacts the safety of others.[3] Despite popular perception of firefighters as physically fit and healthy, U.S. firefighters actually have greater risk of some chronic disease than the general population. The literature estimates more than 75% of firefighters are overweight or obese, a higher prevalence than found in the general American population, of which 68% are obese or overweight.[4] Furthermore, firefighters have an elevated risk of CVD due to factors including obesity, age, hypertension, job stresses, poor diet, and low physical activity (PA), all of which contribute to CVD being the leading cause of line-of-duty (LOD) deaths in the profession.[2]

Beyond their impact on individual health, CVD and obesity also have significant economic impacts. CVD cost the U.S. economy over $500 billion in 2016[5], and conservative estimates suggest obesity costs the nation more than $200 billion annually.[6] These calculated

economic burdens include both direct costs from medical services and drugs as well as indirect costs from lost productivity; and the expenses are projected to grow in the next two decades. In the fire service specifically, these health issues contribute to early and/or disability retirements. As government employees or volunteers to the public, firefighters' retirement benefits are generally funded by taxpayers, again relating this health issue directly to the general population.[2]

Environmental Factors of CVD

Firefighters experience an abnormally high level of cardiovascular (CV) stressors as part of their essential firefighting duties. Beginning with the fire station alarm sounding to signal an emergency, firefighters experience an activation of the sympathetic nervous system[7], elevating blood pressure and heart rate, with research suggesting heart rates are at or near maximum levels during alarm response.[8] The exposure to loud noise during an alarm response additionally increases blood pressure, further increasing acute CV stress and potentially having a long-term impact.[2] A case control study found a relative risk of death from coronary heart disease five times higher during alarm response compared to during non-active firefighting duties.[9] After the initial alarm response, heart rates remain high while fire suppression duties introduce additional CV stressors, including aerobic activity required to climb, carry, and chop as well as the use of anaerobic power movements for heavy lifting and forcible entries. To further intensify the strain on a firefighter's heart, wearing personal protective equipment that weighs up to 60 pounds in the extreme heat puts firefighters at serious risk for hyperthermia and dehydration.[7] Given these strenuous conditions, researchers

have found 33% of CVD-related deaths occur during fire-suppressing activities despite firefighters spending less than 5% of their time on this part of the job.[8] Even for a healthy individual, firefighting introduces a severe strain on the CV system. Individuals with underlying CV risk factors and poor overall health have significantly higher relative risks of a fatal on-duty CVD event or a CVD-related retirement.[2]

While CVD events are the cause of nearly half of all on-duty firefighter deaths, more than 60% of these events occur during activities other than active firefighting, indicating poor overall health among firefighters.[7] Several behavioral and environmental factors beyond the physical strain of responding to a call contribute to the elevated risk of CVD. Firefighting introduces psychological stresses due to entering dangerous situations, witnessing traumatic events and being in a constant state of anticipation while on duty. Shift work disrupts the normal circadian rhythm, which has a negative impact on health-related behaviors including diet, sleep pattern, and PA.[2] These stressors may be amplified among volunteer firefighters who make up 70% of the U.S. fire service and must balance their time between 24-hour shifts with their local department and separate full- or part-time jobs.[3]

Physical Activity Level and Health

Although responding to a fire emergency requires significant physical exertion, the majority of a firefighter's shift involves sedentary behavior. With most fire departments not mandating any standard fitness level after hire, firefighters have little extrinsic motivation to maintain physical fitness. The chronic sedentary behavior commonplace in fire stations contributes to weight gain and increased fat mass and is a known risk factor for CVD.[2,10]

Based on strong evidence, the U.S. Centers for Disease Control and Prevention (CDC) recommends adults incorporate at least 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity aerobic exercise per week and resistance training at least two days per week for general health and chronic disease prevention, with higher levels of PA having greater health benefits.[11] The AHA recommends additional exercise to lower elevated blood pressure and cholesterol levels.[12] Beyond physical health, the benefits of PA include improved mental health as exercise reduces psychological stress, also an independent risk factor for CVD.[13]

A strong body of evidence supports recommendations for regular PA, which improves several health outcomes individually while also reducing risk of disease by promoting weight management. Additionally, even in the absence of weight loss, being physically active alone has a positive impact on health outcomes.[11] A review of the literature on PA and hypertension found risk of incident hypertension decreased with increasing PA, and sedentary behaviors may influence hypertension incidence independent of PA.[10]

Physical Activity in the Fire Service

Despite the positive effects of PA, fewer than half of Americans meet the national guidelines.[11] The volunteer fire service is no exception to this trend, faring worse than the general public. Because firefighting duties require such high levels of strength and endurance, some experts recommend firefighters perform job-specific exercise beyond the minimum PA guidelines for Americans and have training regimens more similar to athletes.[14] According to a 2011 report for the National Volunteer Fire Council, fewer than 1 in 4

volunteer firefighters meet the suggested fitness thresholds provided by the National Fire Protection Association (NFPA).[14] The lack of enforcement of the NFPA's entry fitness standards throughout the job tenure likely contributes to firefighter's poor maintenance of physical fitness.

Other factors potentially influencing PA among firefighters include age, gender, and race/ethnicity, each with substantial data suggesting their impact.[15] Furthermore, previous studies have considered the potential influences of department size and location as well as fire service rank on firefighters' health and wellness behaviors.[16] The impact of department size and location on activity levels is rooted in the range of resources available at different departments, i.e. while one large urban department may have state-of-the-art exercise facilities and equipment and a strong wellness program, a rural department with only 20 volunteer personnel may have fewer resources to allocate to health promotion.

Increasing PA has proven beneficial in both the general U.S. population as well as within the fire service. In addition to the physical improvement of CV health, a study of the economic impact of PA found cost of health care expenses decreased with increasing PA in individuals both with and without existing CVD.[17] In the fire service, fitter firefighters perform active firefighting tasks more effectively and more quickly than less fit peers and are less likely to become injured.[14] In recent decades the NFPA and the International Association of Fire Fighters (IAFF) have begun promoting more frequent medical evaluations for firefighters and establishing health and wellness initiatives. In a national study of career fire departments firefighters in departments with health promoting wellness programs were

generally healthier than their peers in departments without wellness programs.[16] Still the obesity epidemic continues in the fire service, and more research is needed, especially addressing the health of volunteer firefighters who make up more than two-thirds of the fire service.

Health Environment of the Fire Station

The National Volunteer Fire Council acknowledges several environmental factors as contributors to the obesity epidemic within the fire service, including poor nutrition environment in the firehouse, shift work, sleep disruption, and physical inactivity.[14]

Qualitative data collected by Jahnke and colleagues revealed both positive and negative characteristics of fire house food environments, including the value of meal times as social bonding opportunities as well as the poor nutritional quality and large portion sizes of foods consumed in the fire house.[14] Interviewed firefighters also reported difficulty planning healthy meals due to a tight budget and unpredictable work schedule.[14] In the same qualitative study, volunteer firefighters noted barriers to healthy behaviors stemming from their decreased amount of free time available to exercise or prepare healthful meals. Ironically, community members, who benefit from having a healthy fire department, often provide foods such as cookies and cakes for the department, further contributing to the poor nutrition environment at the station.[14]

The nature of shift work offers a potential benefit of providing an environment conducive to PA during on-duty time not spent responding to calls. However, fire stations across the country vary greatly in their available resources. One station may have the latest

exercise equipment while another has only a few dumbbells and/or broken fitness machines.[18] While high intensity interval training, functional exercise, and CrossFit training are potentially effective exercise programs for firefighters because they incorporate job-related movements and improve health markers, they require varying degrees of equipment or expertise to implement and may not be feasibly implemented to their full extent in departments with fewer resources.[14] Various firefighting magazine and blog websites have published workouts using equipment found at the firehouse, including hoses, ladders, and sledge hammers.[19,20] Utilizing and repurposing these available resources helps firefighters overcome the barrier of lacking resources while promoting exercises incorporating job-specific movements.

Workplace Attitudes and Health Behaviors

Studies have shown workplace interventions to be effective for increasing leisure time PA and weight loss.[21,22] One study on the role interpersonal factors have on the health outcomes of uniformed professionals found social support was significantly correlated with lower perceived job stress and better health status of employees.[23] Furthermore, work stress had a strong influence on uniformed employees' health status, suggesting the importance of organizational support for healthy behaviors in this population.[23]

Looking at workplace ideologies in general, researchers Takeuchi, Yun, and Wong utilized the social exchange theory as a tool to describe how coworkers interact with one another.[24] In practice, the perceptions and attitudes of coworkers can influence an individual's own perceptions.[24] Research has shown a similar trend in the context of health

behaviors in a fire station, with the health-related attitudes of peer firefighters influencing one's own perception of a health behavior.[18] While some departments may promote healthy eating and others encourage large portions of unhealthy foods, in either case peers play a major role in the food choices of individual firefighters.[14]

Firehouse culture is unique to that of other workplaces, even when compared to other uniformed professions, in that camaraderie is a vital component of job performance. Firefighting duties require teamwork, and the nature of shifts promote family-like relationships within a firehouse. This culture can have a positive influence on interventions targeting firefighter health. For example, in one study on the eating culture of firehouses, the research team collected qualitative and quantitative data from over 200 fire captains regarding dietary habits and work group performance at their stations.[25] Group interviews revealed over 80% of fire captains in the sample valued cooking together in the firehouse and 92% had groups cooking all four days of a regular shift. Survey data from the sample showed greater work group performance and cooperative behavior among groups who ate and cooked together compared to those who did not. In a study on the occupational factors for obesity in male career firefighters, Choi and colleagues found low organizational support associated with low exercise at the station, and low supervisor support was associated with obesity rates.[26] Additionally, supervisor support correlated positively with coworker support, indicating the role leadership has on organizational culture at the station.[26] Another commonly-referenced study, the PHLAME Firefighter Study, found increased PA in firefighters who participated in a team-based fitness intervention.[27] While the strong bonds

between firefighters and the culture of traditions within a department are generally positive characteristics of the fire service, they can conversely have a negative impact on an individual's desire and ability to improve health behaviors when the norm tends to be unhealthy. For example, interviews with firefighters serving in large cities revealed some firefighters would use their tightknit culture as a means of excluding those deemed to not "fit in" at the firehouse.[25] Utilizing the positive attributes of camaraderie and traditions could be a useful approach for promoting healthy behaviors in fire departments.

Similar to the factors influencing physical activity levels, demographic characteristics may also impact firefighters' perception of the health environment in the workplace. For example, Middlestadt et al. found different age groups of employees had varying levels of intent to participate in a workplace wellness program.[28] In the fire service, age, gender and race/ethnicity may impact how individuals perceive the health attitudes of peers and supervisors in the field dominated by white males.[3,29] Likewise, while the fire service as a whole has a unique culture of camaraderie, individual fire houses may vary in the emphases they place on different issues such as health or station unity, impacting individuals' perception of their environment. By considering all relevant factors, researchers can gain a better understanding of the reasons firefighters are or are not physically active and develop means of improving health and fitness in the fire service.

The First Twenty for Volunteer Firefighters

The proposed project uses baseline survey data from The First Twenty for Volunteer Firefighters study (TF20) to evaluate whether an association exists between firefighters' PA

level and their perception of the department's encouragement of PA. Because limited research is available on the impact of organizational support of healthy behaviors for the volunteer fire service, the proposed project can provide useful data in measuring the existing relationship in a national sample of volunteer firefighters. Results have the potential to improve health and wellness programs and to guide the development of future health interventions in this population.

Public Health Significance

With volunteers making up almost three-fourths of the U.S. fire service and limited research available in this population, a need exists for further evaluation of the health of these individuals, their behaviors, and their perceptions of organizational support. Because physical fitness reduces risk of chronic disease and injury and improves performance of basic firefighting duties, adequate and specific PA has important benefits for both individual firefighters and whole departments. The health of volunteer firefighters additionally impacts the public as two-thirds of fire departments in the U.S. are staffed entirely by volunteers, and those departments protect half of the U.S. population.[3] Therefore, future interventions aimed at improving the health of these firefighters have the potential to impact public health beyond the health status of departments and reach the lives of millions of Americans through better fire service protection. Research into the impact of fire department culture on health behaviors like regular PA will contribute to future intervention planning by developing a better understanding of the influential behavioral and environmental factors among volunteer firefighters.

Research Objective

Determine the association between fire department culture's encouragement of physical activity and volunteer firefighters' frequency of moderate- to vigorous-intensity aerobic physical activity using baseline data from The First Twenty for Volunteer Firefighters study collected during 2015-2017.

METHODS

Study Design

The project uses secondary data from The First Twenty for Volunteer Firefighters (TF20), a cluster randomized controlled trial of the efficacy of TF20 to reduce weight of volunteer firefighters. This project utilizes the baseline cross-sectional data from all participants of TF20. Before the trial was initiated, TF20 study protocols were approved by the Institutional Review Boards at the UTHealth School of Public Health and the National Development and Research Institutes, Inc. and firefighters were consented to participate in person. Dr. R. Sue Day, principal investigator for the study, has provided permission for use of de-identified data for this thesis (see Appendix).

Study Population

Initial recruitment involved emailing volunteer fire departments nation-wide and utilizing social media outlets to identify those interested in participating. The 209 departments that responded within 2 weeks were screened by an investigator via phone interviews with the department chief or department designee. Department inclusion criteria were: 1) personnel were mostly or all volunteers; 2) no department sponsored health or wellness program currently being implemented; 3) had at least 10 active firefighters on the department roster; and 4) the chief self-reported the department was interested in improving their health. Screening processes narrowed the pool to 10 departments, in 10 different states, of varying sizes. TF20 trial randomized the departments into treatment and control groups with 5 departments in each group. The design included a cross-over such that the control group (no intervention) crossed over after 6 months to the intervention to allow potential

health benefits to all participants. Each condition included 1 large (>150 personnel), 1 medium-large (75-149 personnel), 2 medium (31-74 personnel), and 1 small department (10-30 personnel).

Fire service employees from the 10 departments were eligible for participation if they were at least 18 years old, present at recruitment and willing to complete all assessments, and had both a computer and internet access. Support staff, auxiliary personnel, administrative only staff, and firefighters not present at a recruitment session were excluded from participation. Because the following analysis examines baseline data only, the study population includes all eligible participants from the 10 departments from TF20 who responded to all the questionnaire components in the analysis (n = 421 firefighters).

Variables

The dependent variable of interest is firefighters' moderate and vigorous aerobic physical activity (MVPA), a continuous variable measured in minutes per week. The independent variable of interest is fire department culture, measured using the following two categorical variables scored using a Likert scale:

a. Agreement that fire department leadership encourages PA (Leader Support)
b. Agreement that culture among firefighters encourages PA (Peer Support)

Data Collection

TF20 trial included three in-person assessments of the control group and two assessments of the treatment group. However, only the trial baseline data for both groups was used for analysis. At each assessment, participants completed a physical assessment, a food frequency questionnaire, and a health and demographics questionnaire either on paper or via

the Qualtrics® software platform on tablets.[30] The health questionnaire assessed a range of topics, including mental health; use of medications, tobacco, alcohol, and e-cigarettes; sleep pattern; work stress; on-duty injuries; perception of fire service culture regarding healthy behaviors; and basic demographics. The questionnaire measured PA with self-reported frequency, intensity, and duration of aerobic activity and strength training over the past 30 days. Sedentary behaviors were assessed with a question about time spent sitting and sleeping on workdays and non-workdays. Additionally, environmental factors such as available exercise equipment, facilities, and team sport opportunities were assessed in the questionnaire.

The health questionnaire was used to collect data for MVPA in terms of minutes per day and days per week with the prompt: *During the PAST 30 DAYS, how often did you do the following kinds of physical activity for at least 10 minutes continuously?* Participants could select the appropriate number of days ranging from *not at all in the past 30 days* to *about every day* for moderate PA, vigorous PA, and strength training. They could then input average minutes per day for each of these three activity types. Other questions addressed type of workouts performed and available facilities and equipment.

Data for leadership support of PA was collected with the prompt: *In general, the leadership in my fire department encourages physical activity* and a 5-point Likert scale from *strongly disagree* to *strongly agree*. Similarly, data for peer support of PA was collected with the prompt: *In general, the culture among firefighters in my fire department encourages physical activity* and the same 5-point Likert scale.

Data Analysis

Objective

Determine the association between fire department culture's encouragement of physical activity and volunteer firefighters' frequency of moderate- to vigorous-intensity aerobic physical activity using baseline data from The First Twenty for Volunteer Firefighters study collected during 2015-2017.

Hypotheses

a. Greater perceived peer support is associated with greater MVPA among volunteer firefighters.
b. Greater perceived leadership support is associated with greater MVPA among volunteer firefighters.

Data Cleaning and Description

The raw data was evaluated for accuracy and consistency prior to analyses. Range and logic checks were conducted and original questionnaires reviewed to confirm any outliers or questionable answers. Individuals with missing data for both moderate and vigorous PA and/or both support variables were excluded from analyses. The following exclusions were made: 53 observations excluded due to insufficient physical activity data; 4 observations excluded due to insufficient support data; 6 observations excluded due to extreme physical activity responses (≥600 min/day, or ≥10 hours/day); 2 support staff excluded; and 4 observations excluded due to age < 18 years. One of the 10 departments was excluded because technical issues with the tablets used for survey completion prevented the firefighters from completing a portion of the baseline survey with the physical activity

questions. The final sample size for analyses was N = 328, from 9 departments. The peer support model had one less participant (n=327) than the leader support model due to missing data for the peer support question only for one participant.

Responses to the question of fire department culture provide data for the independent variable of peer support. Responses to the question of department leadership provide data for the independent variable of leader support. Due to the distribution of responses for both support variables, the variables were regrouped into dichotomous independent variables with the following coding: 0 = strongly disagree or disagree and 1= neither agree nor disagree, agree, or strongly agree.

A new continuous variable was created for moderate-to-vigorous physical activity (*MVPA*), measured in average minutes per week, by combining the number of days and average minutes per day of both moderate PA and vigorous PA as participants reported in the questionnaire. Because possible answers for PA frequency include two-day ranges, the average number of days was used for the calculation of *MVPA*. For example, if a participant reported moderate PA 3-4 days per week and 90 minutes per day, the sum moderate PA would be 315 minutes per week (3.5 days x 90 minutes/day). A similar calculation was done for vigorous PA, and the two amounts were combined for that individual's average MVPA minutes per week. Based on the distribution of the continuous variable *MVPA*¸ a dichotomous variable was created based on national recommendations for physical activity to prevent chronic disease among the general population, as published by the Centers for Disease Control and Prevention and the American Heart Association. The dichotomous

variable labeled *MVPAcdc* was created and labeled as follows: 0 = 149 minutes or less of MVPA per week and 1 = 150 minutes or more of MVPA per week.

Gender was coded as 1 = male, 0 = female. BMI was included in the model as a continuous variable. Rank was included in the model as a dichotomous variable labeled *Leader* and coded: 0 = non-leader, 1 = leadership role. Race/Ethnicity is dichotomous, labeled *minority* and coded as follows: 0 = non-minority and 1 = minority.

Data Description & Summarization

Counts and proportions were generated for the categorical variables, and means, standard deviations, and medians calculated for the continuous variables. A variable to indicate department affiliation was included in each model to account for variance associated with the cluster design of TF20 study.

Main Analyses

STATA Statistical Software 15 (StataCorp LLC, College Station, TX) was used to complete the analyses. Due to the high correlation between the two measures of support, two separate logistic regression analyses assessed the associations between 1) peer support and MVPA and 2) leadership support and MVPA.

The logistic regression models each included the department variable and the potential confounding factors age, gender, BMI, rank, and ethnicity. These covariates were included based on review of the literature and plausibility of a relationship with PA level and/or perception of fire department culture. By including department in the model, adjustments were made for the cluster design and the similarity in responses of participants working in the same environment. The change in estimate method was used to select

variables for inclusion in the model. In the peer support model, gender did not exhibit a significant percent change; nor did minority status or BMI in the leader support model. However, these variables remained in the model based on their support in the literature regarding a relationship with level of physical activity.

Age and BMI were included as continuous variables, department is a categorical variable, and gender, rank and race/ethnicity were treated as binary variables. The results of the logistic regression provided odds ratios for each variable, and significance of the odds ratios were interpreted using a significance level of 0.05.

JOURNAL ARTICLE

Department support not associated with physical activity of volunteer firefighters

Journal of Occupational and Environmental Medicine

Abstract

Objective: Determine the association between fire department culture's encouragement of physical activity and volunteer firefighters' moderate- to vigorous-intensity aerobic activity.

Methods: Cross-sectional analysis of baseline data from cluster RCT for volunteer firefighters from 9 U.S. fire departments. Logistic regression analyses of perceived peer and leadership encouragement of physical activity and average minutes per week of physical activity.

Results: Peer and leadership support were not significantly associated with meeting CDC moderate to vigorous exercise guidelines. Meeting exercise recommendations was associated with being male, non-leader, minority, lower BMI, and younger age.

Conclusions: Due to volunteer firefighters' limited time at the fire station, physical activity levels were not impacted by support from the department or peers.

Clinical Relevance

Physical fitness reduces risk of chronic disease and injury and improves job performance of volunteer firefighters who make up 70% of the U.S. fire service and serve the majority of the US population.[1] Research on relevant factors of PA behaviors will contribute to future intervention planning.

Introduction

Of the 1.1 million firefighters serving our nation, 70% are volunteers, and two-thirds of all U.S. fire departments are staffed entirely by volunteers, serving about half of the U.S. population.[1] While career departments serve large urban areas, smaller communities rely on volunteers to provide emergency services.[1] Volunteers typically have 24- or 48-hour shifts when on duty and may stay at the fire station or be away from the station with a pager when on call, prepared to respond at a moment's notice to a wide variety of emergency calls, including fires, vehicle accidents, natural disasters, or other emergency or general public service calls.

Cardiovascular disease, which includes heart attack, stroke, and high blood pressure, affects 1 in 3 Americans and causes 1 in 4 deaths in the general population.[2] Firefighters are one of several subpopulations disproportionately affected by cardiovascular disease. In this population, 45% of on-duty deaths are caused by cardiovascular disease, a higher incidence than in other uniformed professions.[3] Despite firefighters spending only about 5% of their time actively fighting fires, 33% of cardiovascular-disease related deaths occur during active firefighting, likely a result of the acute stressors of responding to an emergency alarm.[4] When the alarm goes off, a firefighter's sympathetic nervous system is activated, increasing heart rate and blood pressure. When responding to a call, both aerobic and anaerobic physical exertion are often required while wearing 60 or more pounds of gear in high heat situations prone to dehydration and hyperthermia.[5] This acute stress is a significant danger even for healthy individuals, but cardiovascular-related deaths among firefighters occur primarily in those with underlying cardiovascular disease.[3]

Risk factors for cardiovascular disease common among firefighters include obesity, older age, chronic hypertension, poor diet, low physical activity levels, and chronic stress from the psychological impact of responding to traumatic events, shift work, and balancing multiple jobs and responsibilities in addition to firefighting.[3] Because of such stressors characterizing the fire service, annual medical evaluations are recommended for firefighters. However, medical evaluations are not always provided by volunteer departments. A lack of medical evaluations is reflected in the literature as some studies report a large percentage of volunteer firefighters are unaware of their indicators of cardiovascular disease, such as blood pressure and lipid profiles.[6] Both chronic and acute stressors increase firefighters' risk of chronic disease and cardiovascular disease-related death compared to the general American population. Additionally, obesity is a risk factor of chronic disease which has a higher prevalence among firefighters than the general American population (75% of firefighters are overweight or obese, compared to 68% of all Americans).[7]

The literature strongly supports the role of diet and physical activity in prevention of chronic disease, and cardiovascular disease specifically, with evidence for a benefit of physical activity regardless of weight loss.[8] The Centers for Disease Control and Prevention (CDC) as well as the American Heart Association have published evidence-based guidelines for physical activity levels to prevent chronic disease, recommending at least 150 minutes per week of moderate aerobic activity or 75 or more minutes per week of vigorous aerobic activity and strength training at least 2 days per week. About half of Americans currently meet these recommendations.[9]

Greater fitness of firefighters increases efficiency and performance and reduces the risk of injury, helping them better serve their communities. Fire service standards for physical fitness measure strength, endurance, aerobic capacity, body composition, and flexibility but are only required for entrance into the fire service and are not enforced throughout a firefighter's time of service. According to a 2011 report, fewer than 25% of volunteer firefighters met National Fire Protection Association fitness standards.[10] The nature of firefighting does not promote physical activity, as firefighters spend only a small amount of time on-duty actively responding to calls and the rest of the job can be sedentary, a concerning reality given evidence supporting an association between a sedentary lifestyle and weight gain with subsequent increased risk of chronic disease.[3,11]

There has been some research on workplace environmental factors and health status which shows an association between workplace interventions and physical activity of employees.[12,13] One study on this relationship among uniformed professionals found social support associated with improved health status.[14] Results of other research studies suggest a similar trend in the health-related attitudes of peers influencing the health behaviors of individual firefighters.[15] Fire departments are unique in regards to the workplace environment, as teamwork and camaraderie are crucial to job completion and success in the fire service even more than in other occupations. Firefighters rely on one another to perform their duties both during active emergency response and in routine activities of station maintenance, and they will generally refer to their crew as a second family. While volunteers spend less time at the station than career firefighters, this family mindset holds true for volunteers as well. Cooking a family meal together while on duty is typical in most fire

stations, and these firehouse meals are notorious for being calorie-dense with large portions of meat and refined carbohydrates.[10,16]

Given the strong social support system, there seems to be a significant opportunity to influence the behaviors of firefighters by creating a culture that promotes healthy habits rather than unhealthy. Greater health and fitness of individual firefighters not only protects them from cardiovascular disease-related deaths, reduces risk of injury, and improves job performance, but also subsequently provides better protection for the majority of the U.S. population served by volunteers. Despite the need for health and fitness intervention in this population, there is currently no national fitness initiative addressing the unique needs of volunteer firefighters, and there has been limited research on this group of the population. By increasing understanding of the factors influencing volunteer firefighter health, we can better approach health intervention planning and create programs appropriate to the target population.

Methods

Design – This project utilizes a cross-sectional study design utilizing secondary data from the baseline examination of The First Twenty for Volunteer Firefighters (TF20), a cluster randomized controlled trial of the efficacy of TF20 to reduce weight of volunteer firefighters. Before the trial was initiated, TF20 study protocols were approved by the Institutional Review Boards at the UTHealth School of Public Health and the National Development and Research Institutes, Inc. and firefighters were consented to participate in person.

Study Population – Fire departments were recruited per TF20 study protocol described elsewhere. TF20 study included a national sample of 10 departments meeting the following criteria: 1) personnel were mostly or all volunteers; 2) no department sponsored health or wellness program currently being implemented; 3) had at least 10 active firefighters on the department roster; and 4) the chief self-reported the department was interested in improving their health. Fire department employees were eligible for participation if they were at least 18 years old, present at recruitment, willing to complete all assessments, and had both a computer and internet access. Support staff, auxiliary personnel, administrative only staff, and firefighters not present at a recruitment session were excluded from participation.

Exclusions were made to the original data set due to insufficient data for the variables of interest and extreme physical activity responses (reports of ≥10 hours/day). One of the 10 departments was excluded due to technical issues with the tablets used for survey completion preventing participants from completing a portion of the baseline survey with the physical activity questions. The final sample size for analyses was N = 328, from 9 departments. The peer support model had one less participant (n=327) than the leader support model due to missing data for the peer support variable.

Data Collection - TF20 baseline data from both the control and treatment groups were used in this analysis. Participants completed a physical assessment, food frequency questionnaire, and health and demographics questionnaire either on paper or via the Qualtrics® software platform on tablets.[17] The health questionnaire assessed a range of topics, including self-reported measurement of PA. The prompt: *During the PAST 30 DAYS,*

how often did you do the following kinds of physical activity for at least 10 minutes continuously? was used to collect data for MVPA in terms of minutes per day and days per week. Participants could select the appropriate number of days ranging from *not at all in the past 30 days* to *about every day* for moderate PA, vigorous PA, and strength training. They then input average minutes per day for each of these three activity types. Strength training was not included as an outcome of interest in this study due to the variability in types of exercise and amount of time spent being physically active during periods of strength training. The questionnaire defined moderate activity as exertion that raises heart rate and breathing but still allows a conversation to be comfortably held during the activity. Vigorous activity was defined as exertion high enough that it's difficult to carry on a conversation during the activity. A new continuous variable was created for moderate-to-vigorous physical activity (*MVPA*), measured in average minutes per week, by combining the number of days and average minutes per day of both moderate PA and vigorous PA as reported in the questionnaire. A binary variable was created based on the CDC recommendations for PA; participants either met CDC exercise guidelines (≥150 minutes MVPA per week) or they did not meet CDC exercise guidelines (≤149 minutes of MVPA per week).

The exposure of fire department culture was divided into two variables: leader support and peer support, which were assessed individually in the health questionnaire. Data for leadership support of PA was collected with the prompt: *In general, the leadership in my fire department encourages physical activity* and a 5-point Likert scale from *strongly disagree* to *strongly agree*. Similarly, data for peer support of PA was collected with the prompt: *In general, the culture among firefighters in my fire department encourages physical*

activity and the same 5-point Likert scale. Due to the distribution of responses for both support variables, the variables were regrouped into binary independent variables, i.e. participants reported either having or lacking the given support.

Data Analysis - The raw data was evaluated for accuracy and consistency prior to analyses. Range and logic checks were run on the data, referring to the original questionnaires to confirm any outliers or questionable answers. STATA Statistical Software 15 (StataCorp LLC, College Station, TX) was used to complete the analyses. Two separate logistic regression analyses assessed the associations between 1) peer support and MVPA and 2) leadership support and MVPA, because these two measures of support were highly correlated.

The logistic regression models each included department and the potential confounding factors of age, gender, BMI, rank, and ethnicity. The variable indicating department affiliation was included in each model to account for variance associated with the cluster design of TF20 study and potential similarity in responses of participants working in the same environment. Potential confounders were selected based on review of the literature and plausibility of a relationship with PA level and/or perception of fire department culture. The change in estimate method was used to select variables for inclusion in the model. In the peer support model, gender did not exhibit a significant percent change; nor did minority status or BMI in the leader support model. However, these variables remained in the model based on their support in the literature regarding a relationship with level of physical activity. The results of the logistic regression provided odds ratios for each variable, and significance of the odds ratios were interpreted using a significance level of 0.05.

Results

Table 1 summarizes the firefighter characteristics. The sample was majorly white and male, and most participants were not in a leadership role. Interestingly, the sample had a higher proportion of female firefighters than the general U.S. firefighting population with 23% females compared to less than 9% nationally. Firefighters in the sample had an average BMI in the obese category (BMI 30 – 34.9), and 77% of the sample was either overweight or obese, which is similar to the national profile of the volunteer fire service. The average age of the sample was 37.2 years old (SD 12.7).

The amount of MVPA among participants varied greatly across the sample with a mean of 374.1 minutes per week (average 6.2 hours) (SD = 577.0 min., or 9.61 hours). Self-reported activity ranged from 0 minutes per week to 59 hours per week. High responses may indicate respondents having labor intensive primary jobs in addition to activity in firefighting or leisure time physical activity. Approximately half of participants met the CDC's guidelines for weekly exercise, similar to estimates for the general American population.[10]

Table 1 Characteristics of firefighters, N=328

Variable	Subcategory	Percent
Gender	Male	77.4
	Female	22.6
Race/Ethnicity	Minority	6.2
	Non-minority (White)	93.8
Rank	Leadership role	28.0
	Non-leader	72.0

	Mean (SD)	Range
BMI (kg/m^2)	30.3 (6.5)	(16.4, 53.9)
Age (years)	37.2 (12.7)	(18, 77)
MVPA (min/wk)*	374 (577.0)	(0, 3540)

*median MVPA = 175 min/wk

Peer support and MVPA – The odds ratios of the variables included in the peer support model are summarized in Table 2. Peer support was not significantly associated with meeting CDC exercise guidelines as previously hypothesized (OR = 0.88; CI: 0.44 – 1.75). Those meeting CDC exercise guidelines had 2.06 (CI: 1.15 – 3.68) times greater odds of being male than female after adjustment for BMI, department, leadership status, minority status, and age. Having a non-leadership role in the fire department had a beneficial impact on MVPA, as those meeting CDC exercise guidelines had 0.57 times (CI: 0.33 – 0.98) the odds of being a leader versus not in the adjusted model. Participants meeting CDC exercise guidelines had 4.92 times (CI: 1.32 – 18.34) greater odds of being a minority race/ethnicity

than being white in the adjusted model. For every unit increase in BMI (1 kg/m^2), the odds of firefighters meeting CDC exercise guidelines were 4% less (CI: 0.92 – 0.99) in the adjusted model. Age had a similar association with MVPA: for every one-year increase in age, the odds of meeting CDC exercise guidelines were 3% less (CI: 0.95 – 0.99) in the adjusted model.

Table 2 Logistic regression of peer support, age, gender, BMI, department, rank, and ethnicity with firefighters' MVPA[a]

Variable	OR	P>|z|	95% CI	
Peer support	0.88	0.709	0.44	1.75
Male	2.06	0.015	1.15	3.68
Minority	4.92	0.018	1.32	18.34
Leadership Rank	0.57	0.044	0.33	0.98
Department	1.01	0.867	0.91	1.13
BMI	0.96	0.024	0.92	0.99
Age	0.97	0.002	0.95	0.99

[a] moderate- to vigorous-intensity aerobic physical activity

Leader support and MVPA – The odds ratios of the variables included in the leader support model are summarized in Table 3. Results of this model were similar to those of the peer support model. Leader support for physical activity was not significantly associated with meeting CDC exercise guidelines (OR = 0.62; CI: 0.31 – 1.25). Those meeting CDC exercise recommendations had twice the odds (OR = 2.11; CI: 1.18 – 3.79) of being male than female after adjustment for BMI, department, leadership status, minority status, and age. Participants meeting CDC exercise recommendations had 0.56 times (CI: 0.32 – 0.98) the odds of being in a leadership position than not in the adjusted model. Among those meeting CDC exercise

guidelines, the odds of being a minority were five times (CI: 1.35 – 19.01) greater than being white in the adjusted model. Again, both increasing BMI and increasing age were significantly associated with decreased odds of meeting CDC exercise guidelines.

Table 3 Logistic regression of leadership support, age, gender, BMI, department, rank, and ethnicity with firefighters' MVPA[a]

Variable	OR	P>|z|	95% CI	
Leader support	0.62	0.183	0.31	1.25
Male	2.11	0.012	1.18	3.79
Minority	5.06	0.016	1.35	19.01
Leadership Rank	0.56	0.041	0.32	0.98
Department	1.01	0.799	0.91	1.13
BMI	0.96	0.020	0.92	0.99
Age	0.97	0.001	0.95	0.99

[a] moderate- to vigorous-intensity aerobic physical activity

Discussion

There is limited research on the topic of workplace culture and physical activity, and only a handful of studies focusing on this topic among firefighters. With a longstanding culture of teamwork and camaraderie in the fire service, it is logical to assume physical activity culture in individual departments would be associated with the exercise habits of firefighters. However, in this sample of volunteer firefighters, results did not support the research hypotheses that greater peer and leader support would be associated with greater MVPA among volunteer firefighters. This may be related to the amount of time volunteer

firefighters spend with their department. Whereas career firefighters spend the entirety of their shifts at the fire station, volunteer firefighters have fewer shifts per month and may be away from the station when on call. Thus, the social support for healthy behaviors provided by the fire department may have less of an impact in this population. Alternatively, results could be explained by this population being more internally motivated for exercise practices, which would require further research into what specific factors do motivate volunteer firefighters to perform regular physical activity.

The odds ratio for the gender variable reflects the general trend of males having higher physical activity levels than females, which can be seen in the general US population.[9] The association between race and physical activity is not reflective of national statistics on physical activity level. Additionally, a study on health disparities within the fire service found no significant differences in physical activity levels between minority and non-minority firefighters but did find minority firefighters had significantly higher average BMI and body fat % than non-minority firefighters.[18] The small number of minority firefighters in the sample potentially exaggerates the odds ratio, and because the sample was not selected to test this idea, it is not possible to generalize to minority firefighters across the U.S. fire service.

Increasing age is consistently associated with decreased physical activity frequency in national samples.[9] Due to a correlation between leadership and age in the sample, the strong association between meeting CDC exercise guidelines and not having a leadership position may be related to the factor of age as older firefighters were more likely to have a leadership position. Additionally, the nature of having a leadership role itself may have some impact on

physical activity levels secondary to increased time commitment and responsibilities required of leaders. This sample does not provide adequate numbers to explore this possibility in depth.

Lastly, increased BMI has a logical association with decreased physical activity with support from the literature. However, due to the cross-sectional design of the analyses, it cannot be determined whether individuals' low physical activity levels caused BMI to increase or if individuals with a higher BMI were less likely to exercise due to other barriers.

Limitations of this study include the cross-sectional design which does not allow for determination of temporality. Using self-reported physical activity responses resulted in extreme responses, which could not be clarified with the respondent. Extreme values were excluded from these analyses to avoid the possibility of inaccurate responses. Exclusion of one department due to missing data reduced the overall sample size and limited the power of the results. Lastly, because part of the inclusion criteria was a self-reported departmental interest in improving health, the leaders of departments in the sample may be more likely to encourage PA than the general volunteer fire service, reducing the generalizability of results.

Although the described analyses do not confirm the proposed research hypotheses, the results contribute to a limited, but growing body of evidence about volunteer firefighters. These data suggest volunteer firefighters have unexpectedly different risk factors for physical activity. The findings will aid developers in the creation of physical activity interventions in the fire service related to exercise practices specific to firefighters' needs.

References

1. Haynes HJG, Stein GP. NFPA's "U.S. fire department profile". *National Fire Protection Association*. April 2017.

2. National Center for Chronic Disease Prevention and Health Promotion. Heart disease facts. https://www.cdc.gov/heartdisease/facts.htm#. Updated 20172018.

3. Soteriades ES, Smith DL, Tsismenakis AJ, Baur DM, Kales SN. Cardiovascular disease in US firefighters: A systematic review. *Cardiology in Review*. 2011;19(4):202-215.

4. Perroni F, Guidetti L, cignitti L, Baldari C. *Psychophysiological responses of firefighters to emergencies: A review.* Vol 7.; 2014. 10.2174/1875399X01407010008.

5. Kales SN, Smith DL. Firefighting and the heart. *Circulation*. 2017;135(14):1296.

6. Yoo HL, Franke WD. Prevalence of cardiovascular disease risk factors in volunteer firefighters. *J Occup Envrion Med*. 2009;51(8):958-962.

7. Poston WSC, Haddock CK, Jahnke SA, Jitnarin N, Tuley BC, Kales SN. The prevalence of overweight, obesity, and substandard fitness in a population-based firefighter cohort. *J Occup Environ Med*. 2011;53(3):266-273.

8. 2018 Physical Activity Guidelines Advisory Committee. 2018 Physical Activity Guidelines Advisory Committee scientific report. *U S Department of Health and Human Services*. 2018.

9. Centers for Disease Control and Prevention. Participation in leisure-time aerobic and muscle-strengthening activities that meet the federal 2008 physical activity guidelines for Americans among adults aged 18 and over, by selected characteristics: United States, selected years 1998–2016. *Health*. 2017.

10. Haddock CK, Poston WSC, Jahnke SA. Addressing the epidemic of obesity in the United States fire service: A report prepared for the National Volunteer Fire Council. *Center for Fire, Rescue, and EMS Health Research, National Development and Research Institutes, LLC, National Volunteer Fire Council*. 2011.

11. Diaz KM, Shimbo D. Physical activity and the prevention of hypertension. *Curr Hypertens Rep*. 2013;15(6):659-668.

12. Mache S, Jensen S, Linnig S, et al. Do overweight workers profit by workplace health promotion, more than their normal-weight peers? Evaluation of a worksite intervention. *Journal of Occupational Medicine and Toxicology*. 2015;10(1):28.

13. Mache S, Jensen S, Jahn R, Steudtner M, Ochsmann E, Geraldine Preuß. Worksite health program promoting changes in eating behavior and health attitudes. *Health Promotion Practice*. 2015;16(6):826-836.

14. Oginska-Bulik N. The role of personal and social resources in preventing adverse health outcomes in employees of uniformed professions. *International Journal of Occupational Medicine and Environmental Health*. 2005;18(3):233-240.

15. Frattaroli S, Pollack KM, Bailey M, Schafer H, Cheskin LJ, Holtgrave DR. Working inside the firehouse: Developing a participant-driven intervention to enhance health-promoting behaviors. *Health Promotion Practice*. 2013;14(3):451-458.

16. Kniffin KM, Wansink B, Devine CM, Sobal J. Eating together at the firehouse: How workplace commensality relates to the performance of firefighters. *Hum Perform*. 2015;28(4):281-306.

17. Qualtrics XM. https://www.qualtrics.com/platform/; accessed 3/29/2019. .

18. Poston WS, Haddock CK, Jahnke SA, Jitnarin N, Day RS, and Daniels ID. Health disparities among racial and ethnic minority firefighters. *Journal of Health Disparities Research and Practice*. 2014;7(5):105-129.

CONCLUSION

In considering the results and limitations of my study, this project makes a relevant contribution to a growing body of evidence regarding the health of volunteer firefighters, especially in light of a need for health interventions in this population. It is important to continue research in this population in order to better meet their needs and provide the resources for optimal health.

Additionally, the results serve as a reminder of the importance of testing one's logical assumptions before proceeding with intervention or policy planning based on preconceived notions. The findings of this project contribute to future intervention planning for volunteer firefighters. Finding the lack of an association can be just as useful as finding an association when developing interventions and allocating resources to the factors which have the greatest association with the outcome of interest, physical activity in this case.

APPENDIX

UTHealth
The University of Texas
Health Science Center at Houston

School of Public Health
Division of Epidemiology, Human Genetics, and Environmental Sciences
Southwest Center for Occupational and Environmental Health
Michael & Susan Dell Center for Healthy Living
R. Sue Day, MS, PhD

MEMORANDUM

DATE: 10/04/2018

TO: Sarah J. Wagner

FROM: R. Sue Day, PhD
Principal Investigator

SIGNATURE: R. Sue Day

RE: PERMISSION FOR USE OF "The First Twenty for Volunteer Firefighters" DATA WITHOUT PERSONAL IDENTIFIERS

TITLE: FIRE DEPARTMENT SUPPORT AND PHYSICAL ACTIVITY OF VOLUNTEER FIREFIGHTERS: A CROSS-SECTIONAL EXAMINATION

This letter is to authorize you to utilize a subset of the de-identified data from The First Twenty for Volunteer Firefighters study for the purpose of secondary analysis described in the thesis proposal of the above title. Specifically, you have permission to:

- Analyze the data of The First Twenty subjects expressly for your thesis project. Data provided will be age, gender, race, height, weight, BMI, physical activity, rank, department, department size, leadership encouragement of physical activity, and firefighter culture encouragement of physical activity.
- Use this data only for the proposed analyses which will be provided without PERSONAL IDENTIFIERS.

I am the Principal Investigator for the study at SPH. Ms. Wagner is a graduate student at SPH and I have added her to the study protocol with CPHS.

This data was collected with the approval of an Institutional Review Board (IRB). A copy of the IRB approval notice is on file with the UT Health Science Center (UTHSC) Committee for the Protection of Human Subjects (CPHS) approval number HSC-SPH-14-0749. The project included collaborators at the National Development Research Institutes, Inc. (NDRI). The project was reviewed and approved by the NDRI IRB as well.

Phone 713.500.9317 | Fax 713.500.9329
Email rena.s.day@uth.tmc.edu
1200 Pressler | RAS Building, E1027 | Houston, TX 77030

REFERENCES

1. National Center for Chronic Disease Prevention and Health Promotion. Heart disease facts https://www.cdc.gov/heartdisease/facts.htm#. Updated 2017.

2. Soteriades ES, Smith DL, Tsismenakis AJ, Baur DM, Kales SN. Cardiovascular disease in US firefighters: A systematic review. Cardiology in Review. 2011;19(4):202-215.

3. Haynes HJG, Stein GP. NFPA's "U.S. fire department profile". National Fire Protection Association. April 2017.

4. Poston WSC, Haddock CK, Jahnke SA, Jitnarin N, Tuley BC, Kales SN. The prevalence of overweight, obesity, and substandard fitness in a population-based firefighter cohort. J Occup Environ Med. 2011;53(3):266-273.

5. Khavjou O, Phelps D, Leib A. Projections of cardiovascular disease prevalence and costs: 2015–2035. American Heart Association. 2016;0214680.003.001.001:1-54.

6. Hammond RA, Levine R. The economic impact of obesity in the United States. Diabetes, Metabolic Syndrome and Obesity:Targets and Therapy. 2010;3:285-295.

7. Kales SN, Smith DL. Firefighting and the heart. Circulation. 2017;135(14):1296.

8. Perroni F, Guidetti L, Cignitti L, Baldari C. Psychophysiological responses of firefighters to emergencies: A review. Vol 7; 2014. 10.2174/1875399X01407010008.

9. Kales SN, Soteriades ES, Christoudias SG, Christiani DC. Firefighters and on-duty deaths from coronary heart disease: A case control study. Environ Health. 2003;2(1):14.

10. Diaz KM, Shimbo D. Physical activity and the prevention of hypertension. Curr Hypertens Rep. 2013;15(6):659-668.

11. 2018 Physical Activity Guidelines Advisory Committee. 2018 Physical Activity Guidelines Advisory Committee scientific report. U S Department of Health and Human Services. 2018.

12. American Heart Association. American Heart Association recommendations for physical activity in adults. http://www.heart.org/HEARTORG/HealthyLiving/PhysicalActivity/FitnessBasics/American-Heart-Association-Recommendations-for-Physical-Activity-in-Adults_UCM_307976_Article.jsp#.W0Y_TtJKjIU. Updated 2017.

13. World Heart Federation. Risk factors. https://www.world-heart-federation.org/resources/risk-factors/. Updated 2017.

14. Haddock CK, Poston WSC, Jahnke SA. Addressing the epidemic of obesity in the united states fire service: A report prepared for the national volunteer fire council. Center for Fire, Rescue, and EMS Health Research, National Development and Research Institutes, LLC, National Volunteer Fire Council. 2011.

15. Saffer H, Dave D, Grossman M, Leung LA. Racial, ethnic, and gender differences in physical activity. Journal of Human Capital. 2011;7(4):378-410.

16. Poston WSC, Haddock CK, Jahnke SA, Jitnarin N, Day RS. An examination of the benefits of health promotion programs for the national fire service. BMC Public Health. 2013;13(1):805.

17. Valero-Elizondo J, Salami JA, Osondu CU, et al. Economic impact of Moderate-Vigorous physical activity among those with and without established cardiovascular disease:

2012 medical expenditure Panel Survey. J Am Heart Assoc. 2016;5(9). doi: 10.1161/JAHA.116.003614.

18. Frattaroli S, Pollack KM, Bailey M, Schafer H, Cheskin LJ, Holtgrave DR. Working inside the firehouse: Developing a participant-driven intervention to enhance health-promoting behaviors. Health Promotion Practice. 2013;14(3):451-458.

19. Firefighter Functional Fitness. "TOP 10" fire station functional fitness training equipment – part 1. Firefighter Toolbox Web site. http://firefightertoolbox.com/top-10-fire-station-functional-fitness-training-equipment-part-1/. Published November 4, 2016. Updated 2016.

20. McBee Z. Firefighter fitness on a budget: Firefighter fitness and health. Fire Rescue Magazine Web site. https://www.firerescuemagazine.com/articles/print/volume-9/issue-7/firefighter-fitness-and-health/firefighter-fitness-on-a-budget.html. Published July 1, 2014. Updated 2014.

21. Mache S, Jensen S, Linnig S, et al. Do overweight workers profit by workplace health promotion, more than their normal-weight peers? Evaluation of a worksite intervention. Journal of Occupational Medicine and Toxicology. 2015;10(1):28.

22. Mache S, Jensen S, Jahn R, Steudtner M, Ochsmann E, Geraldine Preuss. Worksite health program promoting changes in eating behavior and health attitudes. Health Promotion Practice. 2015;16(6):826-836.

23. Oginska-Bulik N. The role of personal and social resources in preventing adverse health outcomes in employees of uniformed professions. International Journal of Occupational Medicine and Environmental Health. 2005;18(3):233-240.

24. Takeuchi R, Yun S, Wong KFE. Social influence of a coworker: A test of the effect of employee and coworker exchange ideologies on employees' exchange qualities. Organizational Behavior and Human Decision Processes. 2011;115(2):226-237. doi: https://doi-org.ezproxyhost.library.tmc.edu/10.1016/j.obhdp.2011.02.004.

25. Kniffin KM, Wansink B, Devine CM, Sobal J. Eating together at the firehouse: How workplace commensality relates to the performance of firefighters. Hum Perform. 2015;28(4):281-306.

26. Choi B, Schnall P, Dobson M. Twenty-four-hour work shifts, increased job demands, and elevated blood pressure in professional firefighters. Int Arch Occup Environ Health. 2016;89(7):1111-1125.

27. Elliot DL, Goldberg L, Duncan TE, Kuehl KS. The PHLAME firefighters' study: Feasibility and findings. American Journal of Health Behavior. 2004;28(1):13-23.

28. Middlestadt SE, Sheats JL, Geshnizjani A, Sullivan MR, Arvin CS. Factors associated with participation in work-site wellness programs: Implications for increasing willingness among rural service employees. Health Educ Behav. 2011;38(5):502-509.

29. Poston WS, Haddock CK, Jahnke SA, Jitnarin N, Day RS, and Daniels ID. Health disparities among racial and ethnic minority firefighters. Journal of Health Disparities Research and Practice. 2014;7(5):105-129.

30. Qualtrics XM. https://www.qualtrics.com/platform/. Accessed 3/29/2019.