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# Effectiveness of Wellness Programming to Improve Health and Fitness Metrics in Rural Firefighters

Macy Weeks

EFFECTIVENESS OF WELLNESS PROGRAMMING TO IMPROVE HEALTH AND FITNESS METRICS IN RURAL FIREFIGHTERS

by

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(Under the Direction of Bridget Melton)

ABSTRACT

**Background:** Worksite wellness programs are an excellent option to help promote health and wellness among employees. However, there is little research discussing these benefits among firefighters. **Purpose:** The purpose of this study was to evaluate the effectiveness of a wellness program to improve or maintain health and fitness metrics in rural, career firefighters over a 9-month period. **Methods:** Thirty-six firefighters from a department in southeast Georgia participated in this wellness program. All health and fitness metrics tested were recommended by the National Fire Protection Agency. The wellness program that took place over 9-months provided basic tools and knowledge regarding exercise and nutrition. Firefighters were separated into four groups based on their exercise adherence for data collection (Q1 = lowest, Q2 = low, Q3 = moderate, Q4 = highest). **Results:** For health metrics, there was no meaningful differences for the weight or body fat percentage for the entire group, but Q2 was the only group that weight change was larger than the smallest worthwhile change (SWC). Blood glucose for the entire group and all attendance quartiles showed meaningful differences. Q3 and Q4 for HDL and Q3 for LDL group mean differences were larger than the SWC signifying meaningful differences. For fitness metrics, $VO_{2max}$ did not show any meaningful differences for the entire group or attendance quartiles. There were meaningful differences with an increase of muscular strength via handgrip strength and leg press for the entire group and all attendance quartiles. Flexibility decreased for the entire group, and Q1 had the largest decrement based off SWC. **Discussion***:* This program was successful in aiding in improvements and maintenance in many health and fitness metrics for rural firefighters. **Conclusion:** This occupation is different compared to many corporate and business settings, and it may take more time to get "buy-in" from the department to see how a wellness program impacts firefighters.

INDEX WORDS: Wellness, Intervention, Tactical

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MACY WEEKS

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MASTER OF SCIENCE

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# CHAPTER 1

## INTRODUCTION

Worksite wellness programs are an excellent option to positively impact the health of many individuals that are in the workforce. With the large increases in sedentary behaviors and chronic diseases among workers, paired with increasing costs of healthcare, many employers have started to implement worksite wellness programs to improve the overall health of their employees (Osilla et al., 2012). American workers spend the majority of their waking hours at work (ATUS, 2017). Therefore, these worksite wellness programs can help provide education on disease prevention and improving health behaviors while employees are on the job (McCoy et al., 2014). Wellness programs are commonly implemented to increase physical activity, improve cost-effectiveness on healthcare costs, boost productivity, and improve worksite morale of the employees (Hall et al., 2017; Osilla et al., 2012). Employers realize that offering basic health and wellness programs for their employees can be beneficial for both sides in the long term (Osilla et al., 2012). These programs can play a valuable role by providing employees with the tools needed to reduce their risks of certain diseases and improving their quality of life (Hall et al., 2017). Even providing a minimally invasive wellness program by providing basic education on a healthy lifestyle has been shown to provide positive health and fitness outcomes over a short period of time (Butler et al., 2015). Worksite wellness programs have traditionally been implemented within businesses and corporations, however limited research has explored the impact on emergency service personnel (e.g., firefighters) (Poston et al., 2013).

Wellness programming in the fire service has historically been put on the back burner for many departments due to limited budgets with the primary focus being on maintaining and purchasing new fire equipment (IAFF, 2008; Poston et al., 2013). The fire service demonstrates certain challenges that are not typical for other businesses and corporations. Most firefighters work 24-hour shifts and work in a setting that is different from the average American worker. Being able to recognize the differences of implementing a worksite wellness program in the fire service compared to other businesses is necessary in order to effectively implement a program in the fire service. One of the most popular wellness

programs that has been implemented in the fire service is the Promoting Healthy Lifestyle: Alternative Models' Effect (PHLAME) study. This was a program that had a team-based or individual meetings approach which focused on increasing physical activity, importance of nutrition, and maintaining a healthy body weight. After a one year follow-up all groups did gain weight, but the two intervention groups gained significantly less weight compared to the control group which gained. The individual group gained 74% less weight than the control group, and the team group gained 65% less weight than the control group (Elliot et al., 2007). Unfortunately, wellness programs like this are typically seen in larger, more developed areas in the United States.

In 2015, the Fourth Needs Assessment recognized the barriers that rural communities have when it comes to providing these programs for their employees (NFPA, 2016). The lack of wellness programming in the fire service can be attributed to the lack of policies that are in place regarding the health status of firefighters. Fitness in the fire service is still seen as a top priority, and there are recommendations from the Fire Service Joint Labor Management Wellness Fitness Initiative (WFI), which is adopted by the National Fire Protection Agency (NFPA). Poston et al. (2013) determined that the fire departments that had a wellness program in place that followed the WFI had a decrease in obesity prevalence and exercised more often and more consistently while on-duty compared to departments that did not have wellness programming in place. Firefighting demonstrates high levels of physical requirements, unfortunately, many career firefighters are struggling to maintain necessary fitness levels to be able to perform this job in a safe and effective manner (Poston et al., 2013; Michaelides et al., 2011).

The International Association of Firefighters (IAFF) suggests allocating 60 to 90 minutes of exercise for firefighters that are on-duty (IAFF, 2008). However, many departments in the United States do not require exercise while firefighters are on-duty (Jahnke et al., 2012). While the NFPA only sets recommendations, it sets a high standard for health and wellness in the fire service. However, recent research suggests that a majority of United States fire departments do not follow the recommendations set by the NFPA (Andrews et al., 2019). Further, 70% of fire departments in the United States do not have

basic worksite wellness programming in place for their employees (Michaelides et al., 2011; Storer et al., 2014). The departments that require exercise time while on-duty, access to gym equipment, and exercise professionals aim to improve the health and fitness of firefighters and decrease risk factors (Pencina et al., 2009).

While there are initiatives (e.g., WFI) to help combat the lack of physical fitness and knowledge of health and in the fire service, many smaller fire departments and budget-restricted departments may not have wellness programs in place to be proactive. There is some research regarding wellness programs for fire departments in more urban areas, however limited research has been established on the effectiveness of wellness programs among rural fire departments. It will be important to determine if a wellness program can be an effective and feasible approach for smaller fire departments. Therefore, the purpose of this study was to evaluate the effectiveness of a wellness program to improve or maintain health and fitness metrics in rural, career firefighters over a nine month period.

# CHAPTER 2

# METHODS

## *Participants*

A convenience sample of career firefighters (n = 36) from a fire department in rural, southeast Georgia were recruited for this study. Firefighters in this study had been with this department on average for 10 ± 9 years. The average age of the participants was 35 ± 9 years with a range from 21-57 years. Thirty-three (92%) identified as white, two (6%) identified as African American, and one identified as Hispanic or Latin American (2%). Firefighters in this department served an area of about 13.9 square miles through two fire stations with an estimated population of 31,667 (U.S Census, 2018). This specific department does not run EMS calls, but will assist EMS and police on special rescues and helicopter landings. During this time period, this department ran approximately 709 calls ranging from structure fires, fire alarms, vehicle crashes, hazmat incidents, and assisting with EMS and police calls. Firefighters within this department work a 24-hour shift every three days and are required to exercise for at least 45-minutes while on-duty per the departmental policy.

Participants were recruited through the fire chief and were informed of this study's benefits, risks, and purpose. To have been included for data analysis for this study, participants must have been full-time firefighters in the department from baseline to follow-up testing and be over the age of 18. All participants completed a Physical Activity Readiness Questionnaire and a health history questionnaire to screen for any high risk individuals. Any participant that was classified as "high risk" needed medical clearance from a physician prior to participating. Baseline data was collected in January 2019 as part of the department's yearly physicals. Firefighters completed both a physical examination by a physician and a fitness assessment. Participants then completed a follow-up evaluation 9-months after baseline testing, October 2019. All participants gave consent for investigators to analyze blood profiles for this study. The research reported in this manuscript was reviewed and approved by the Georgia Southern University Institutional Review Board and written consent was acquired from each participant prior to testing.

### *Measures*

#### *Annual Physical Evaluations*

As per NFPA recommendations, firefighters should perform an annual physical examination and fitness assessment (NFPA, 2018; Rita, Fahy, & Molis, 2019). The health metrics included: body mass index (BMI) , blood pressure, waist-to-hip ratio (W:H), and blood serum profile (total cholesterol [TC], high-density lipoprotein [HDL], low-density lipoproteins [LDL], triglycerides [TG], blood glucose [BG]). The fitness metrics included body composition (via 3-site skinfold), aerobic capacity ($VO_{2max}$) (Gerkin treadmill protocol), muscular strength (3RM bench press [BP] and 3RM leg press [LP]), muscular endurance (push up test and timed plank), muscular power via vertical jump [VJ], and flexibility (i.e., sit and reach [SR]). Baseline data was collected in January 2019 and the follow-up data was collected in October 2019. All testing was conducted under the supervision of trained exercise personnel and in accordance with guidelines set by the WFI adopted by the NFPA and/or National Strength and Conditioning guidelines (NFPA 1582, 2018; Haff & Triplett, 2016).

#### *Exercise Adherence*

All participants were informed to log their attendance every time they used the onsite gym facility on a self-reported sign-in sheet. Attendance logs were requested for January 2019 through October 2019. These logs were self-reported, and the attendance data were coded to protect the identity of each participant. For data analysis, participants were placed into one of four attendance classifications to determine if attendance to the gym had an impact on the health and fitness metrics of the firefighters during this wellness program.

### Intervention

The intervention for the current study consisted of a 9-month wellness program. The structure of this program was designed to provide basic tools and knowledge that can be implemented into fire departments that are potentially constrained by budgetary resources or qualified external personnel (e.g., tactical strength and conditioning coaches or nutrition experts). The elements that were included within

this intervention included: shift and group resistance training sessions, one-on-one health consultations, athletic training services, mobility clinics, and nutritional education. Additionally, firefighters were allotted access to a health clinic and fitness facility to be used at their discretion. The fitness facility included a staff of two fitness professionals to help with facility supervision.

*Resistance Training Sessions*

While the firefighters were given access to a fitness facility, prior to the intervention there were no structured training sessions offered. Thus, the program introduced two new sessions that included a voluntary workout that occurred every shift, and a mandatory workout that took place once every three weeks. The voluntary sessions were carried out in small groups once per day with firefighters encouraged to participate. However, the mandatory session was required to attend by the shift currently on-duty, as per departmental policy. Thus, each shift completed the mandatory workout at least once per month. The exercise selection for both sessions were similar and consisted of occupational-specific training with an overall goal to focus on proper movement patterns and increase muscular strength and endurance. A large portion of the exercises included within the workouts mimicked tasks performed on a fire scene (e.g., farmers carry, deadlifts, step-ups). All sessions were completed under the direction of trained exercise professionals.

*One-on-One Consultation*

After baseline and follow-up testing were completed, each participant received a one-on-one health and wellness consultation with an exercise professional. During these consultations, results from each participant's physical evaluation and fitness assessment were discussed along with values deemed at-risk for cardiovascular or metabolic disorders based on the American College of Sports Medicine (ACSM) guidelines. Within the follow-up consultation, individual changes in health and fitness were relayed to either show improvement or decrements in a given variable. Additionally, basic recommendations for improving their current health status were given (e.g., increase aerobic exercise levels) to each firefighter.

*Mobility Clinics & Athletic Training Services*

Throughout the intervention, mobility clinics were incorporated for the on-duty firefighters. These clinics focused on improving range of motion and flexibility. A trained exercise professional traveled to both fire stations for a short 30-minute session with the goal to provide education on the importance of proper mobility and movement patterns. A certified athletic trainer was also available to help aid with any minor musculoskeletal injuries by appointment. The athletic trainer was responsible for injury evaluations, referrals, rehabilitation services that fell in their standing order of treatment, and consulted with the team on how to infuse injury prevention exercise in small and large group training sessions.

*Nutritional Education*

Participants were offered weekly educational sessions lasting 15-minutes each which were designed to increase basic nutritional knowledge. The topics discussed were suggested by the firefighters themselves, with each session directed under the supervision of a registered dietitian nutritionist.

**Statistical Analysis**

All data analyses were performed using IBM SPSS Statistics 25 (IBM Corp., Armonk, NY). Paired-samples *t*-tests were performed to examine the difference between baseline testing to follow-up for health and fitness metrics for the entire group. To examine the effects of exercise adherence rates, participants were placed into quartiles using the self-reported attendance logs. The classifications were factored as following: lowest attendance (Q1) (< 34.5 sessions; n = 9), low attendance (Q2) (34.5-54.9 sessions; n = 9), moderate attendance (Q3) (55 - 68.75 sessions; n = 9), and highest attendance (Q4) (> 68.75 sessions; n = 9). Multiple one-way analyses of variance (ANOVA's) were used to analyze health and fitness metrics based on the attendance classifications over the 9-month time period. Post- hoc analysis was conducted via Bonferroni comparisons. Delta changes were also calculated for each attendance quartile from baseline to follow-up testing for each metric. Practical significance was assessed using Cohen's *d* statistics (Cohen, 1992). Hopkin's scale of magnitude was utilized to determine practical significance was

0 - 0.19 for trivial, 0.20 - 0.49 for small, 0.50 - 0.79 for medium, and greater than 0.8 for large effect size (Hopkins et al., 2009). To determine practical significance between the attendance rates, all quartiles were compared to Q1. This comparison was performed using Q1 as a control group (i.e., individuals who did not participate in exercise or had very-low attendance rates); thus, the practical effect of physical activity and exercise could be established. Additionally, the smallest worthwhile change (SWC) for the entire group and attendance quartiles were also analyzed to account for daily fluctuations within each variable (e.g., daily change in bodyweight not limited to measurement error). The smallest worthwhile change was calculated using the baseline standard deviation multiplied by a small effect size of 0.30.

# CHAPTER 3

# RESULTS

Thirty-six firefighters were included for data analysis. However, due to timing conflicts during follow-up testing and inaccurate readings, only 34 were included for BF%, BP, push-up, plank, blood analysis, and 33 were included for LP.

## ***Health Metrics***

### *Weight*

Data indicates that post 9-month intervention; body weight displayed a group mean change of 1.24kg. However, this value was less than the calculated SWC (i.e., 4.52 kg) indicating no meaningful difference. Based off attendance, Q2 was the only group with a meaningful difference with the group mean change being larger than the SWC.

### *Body Fat Percentage*

There was no significant changes in BF% for the entire group. However, there were statistically significant differences between Q2 and Q4 for BF%, and post-hoc test revealed that Q2 had a greater change compared to Q4, but both group means were in range for daily fluctuations based off SWC.

### *Waist-to-Hip Ratio*

There was statistically significant difference between Q3 and Q4 for W:H, and post-hoc test revealed that Q3 had a greater change compared to Q4. Both Q2 and Q3 had mean difference that was larger than the SWC. There were three individuals that were in Q3 went from moderate to high risk level from baseline to follow-up testing. However, there were two individuals in Q4 that went from a high to moderate risk factor for CVD from baseline to follow-up testing.

### *Blood Profiles*

For the blood profiles, there were improvements of group mean differences for HDL, LDL, and BG. However, BG was the only group mean difference that was larger than the SWC (i.e., 2.48 mg/dL) indicating a meaningful difference. Mean difference for triglycerides did increase from baseline, but

remained at an optimal level for the entire group (i.e., < 150 mg/dL) and was in range for daily fluctuations. Based off attendance, Q3 and Q4 for HDL and Q3 for LDL group mean differences were larger than the SWC, which indicated a meaningful change. All attendance quartiles for BG had improvements in mean differences, and all were meaningful based off SWC.

Values from baseline to follow-up testing for health metrics and blood markers for the entire group are included in Table 1. Values from baseline to follow-up testing based on attendance quartiles for health metrics are included in Table 2 and Figure 1, and values for blood markers are located in Table 3.

Table 1. Baseline to follow-up health metrics for the entire group.

| | | Baseline | Follow-up | *p* | | | Baseline | Follow-up | *p* | | | Baseline | Follow-up | *p* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **WEIGHT** | M(SD) | 92.6 (15.1) | (93.9 (14.9) | 0.05* | **BF%** | M(SD) | 23.3 (5.4) | 23.7 (5.3) | 0.35 | **LDL** | M(SD) | 111.4 (31.8) | 103.8 (29.5) | 0.02* |
| | Δ | 1.24 (3.7) | | | | Δ | 0.4 (2.3) | | | | Δ | -7.6 (16.9) | | |
| | *d* | 0.08 | | | | *d* | 0.07 | | | | *d* | 0.25 | | |
| | SWC | 4.52 | | | | SWC | 1.62 | | | | SWC | 3.76 | | |
| **BMI** | M(SD) | 28.9 (4.8) | 29.3 (4.6) | 0.13 | **W:H Ratio** | M(SD) | 0.9 (0.1) | 0.9 (0.1) | 0.03* | **TG** | M(SD) | 94.1 (67.9) | 84.1 (7.8) | 0.10 |
| | Δ | 0.3 (1.3) | | | | Δ | 0.02 (0.04) | | | | Δ | 11.3 (38.9) | | |
| | *d* | 0.07 | | | | *d* | 0.09 | | | | *d* | 0.18 | | |
| | SWC | 1.44 | | | | SWC | 9.95 | | | | SWC | 20.39 | | |
| **SBP** | M(SD) | 125.9 (9.9) | 124.8 (11.1) | 0.58 | **TC** | M(SD) | 175.6 (33.2) | 172.7 (33.0) | 0.45 | **BG** | M(SD) | 89.1 (8.3) | 84.1 (7.8) | <0.01* |
| | Δ | -1.6 (12.7) | | | | Δ | -2.9 (21.4) | | | | Δ | -4.9 (7.0) | | |
| | *d* | 0.07 | | | | *d* | 0.09 | | | | *d* | 0.62 | | |
| | SWC | 1.44 | | | | SWC | 9.95 | | | | SWC | 2.48 | | |
| **DBP** | M(SD) | 79.4 (7.3) | 77.6 (5.9) | 0.24 | **HDL** | M(SD) | 45.3 (12.5) | 48.8 (11.9) | <0.01* | | | | | |
| | Δ | -2.5 (8.9) | | | | Δ | 3.5 (5.5) | | | | | | | |
| | *d* | 0.27 | | | | *d* | 0.25 | | | | | | | |
| | SWC | 2.19 | | | | SWC | 3.76 | | | | | | | |

**Note:** Mean ± SD; delta changes; effect size (d); smallest worthwhile change; BMI = body mass index (kg/m2), SBP = systolic blood pressure (mmHg), DBP = diastolic blood pressure (mmHg), BF% = body fat percentage, W:H = waist: hip ratio (in), TC = total cholesterol (mg/dL); HDL = high-density lipoprotein (mg/dL), LDL = low-density lipoprotein (mg/dL), TG = triglycerides (mg/dL), BG = blood glucose (mg/dL).

*Statistically significant ($p < 0.05$).

Table 2. Baseline to follow-up health metrics within attendance quartiles.

| | | $Q1_{Baseline}$ | $Q1_{Follow-up}$ | $Q2_{Baseline}$ | $Q2_{Follow-up}$ | $Q3_{Baseline}$ | $Q3_{Follow-up}$ | $Q4_{Baseline}$ | $Q4_{Follow-up}$ |
|---|---|---|---|---|---|---|---|---|---|
| WEIGHT | M(SD) | 100.3 (15.1) | 100.7 (17.1) | 89.75 (6.0) | 91.8 (6.7) | 85.1 (12.4) | 87.2 (14.1) | 95.4 (17.3) | 95.8 (14.9) |
| | Δ | 0.5 (5.0) | | 2.1 (2.2) | | 2.06 (3.9) | | 0.4 (3.7) | |
| | *d* | --- | | 0.40 | | 0.35 | | 0.03 | |
| | SWC | 1.51 | | 1.80 | | 3.72 | | 1.11 | |
| BMI | M(SD) | 31.9 (6.7) | 32.1 (6.2) | 28.2 (3.0) | 28.8 (3.1) | 26.6 (3.3) | 27.0 (3.3) | 29.3 (4.4) | 29.4 (4.3) |
| | Δ | 0.2 (1.6) | | 0.6 (0.6) | | 0.4 (1.6) | | 0.2 (1.4) | |
| | *d* | --- | | 0.32 | | 0.14 | | 0 | |
| | SWC | 2.02 | | 0.91 | | 0.98 | | 1.33 | |
| SBP | M(SD) | 126.0 (13.3) | 122.4 (14.7) | 126.4 (8.7) | 127.1 (10.9) | 124.7 (9.4) | 125.8 (10.8) | 126.7 (9.2) | 123.8 (8.6) |
| | Δ | -3.6 (17.0) | | 0.7 (9.7) | | 1.1 (13.9) | | -5.43 (8.9) | |
| | *d* | --- | | 0.31 | | 0.30 | | 0.14 | |
| | SWC | 3.98 | | 2.60 | | 2.81 | | 2.77 | |
| DBP | M(SD) | 77.3 (6.8) | 76.4 (7.5) | 81.1 (5.8) | 79.1 (7.2) | 77.1 (5.4) | 78.7 (4.7) | 82.0 (10.2) | 76.2 (4.4) |
| | Δ | -3.1 (10.5) | | -2.0 (7.7) | | 1.6 (5.1) | | -7.4 (11.2) | |
| | *d* | --- | | 0.12 | | 0.57 | | 0.40 | |
| | SWC | 2.03 | | 1.73 | | 1.62 | | 3.06 | |
| BF% | M(SD) | 25.6 (5.1) | 26.6 (4.2) | 22.4 (5.7) | 24.1 (5.6) | 20.7 (5.3) | 20.72 (5.7) | 25.13 (4.9) | 23.8 (4.2) |
| | Δ | 1.1 (1.7) | | 1.7 (2.0)* | | 0 (2.9) | | -1.3 ( 2.5) | |
| | *d* | --- | | 0.33 | | 0.46 | | 1.13 | |
| | SWC | 1.53 | | 1.72 | | 1.58 | | 1.46 | |
| W:H | M(SD) | 0.9 (0.1) | 0.9 (0.1) | 0.9 (0.1) | 0.9 (0.1) | 0.8 (0.02) | 0.9 (0.04) | 0.9 (0.1) | 0.9 (0.1) |
| | Δ | 0.01 (0.03) | | 0.03 (0.03) | | 0.04 (0.04)$^{\alpha}$ | | -0.02 (0.1) | |
| | *d* | --- | | 0.67 | | 0.85 | | 0.73 | |
| | SWC | 0.02 | | 0.2 | | 0.01 | | 0.02 | |

**Note:** Mean ± SD; delta changes; effect size (*d*) with Q1 being the control; Q1 = Gym Attendance < 34.5; Q2 = Attendance 34.5 – 55; Q3 = Attendance 55 – 68.75; Q4 = > 68.75; BMI = body mass index (kg/m$^2$), SBP = systolic blood pressure (mmHg), DBP = diastolic blood pressure (mmHg), BF% = body fat percentage, W:H = waist: hip ratio (in).

* Significantly different than Q4 ($p = 0.04$).

$^{\alpha}$ Significantly different than Q4 ($p = 0.01$).

Table 3. Baseline to follow-up blood lipid profiles within attendance quartiles.

| | | $Q1_{Baseline}$ | $Q1_{Follow-up}$ | $Q2_{Baseline}$ | $Q2_{Follow-up}$ | $Q3_{Baseline}$ | $Q3_{Follow-up}$ | $Q4_{Baseline}$ | $Q4_{Follow-up}$ |
|---|---|---|---|---|---|---|---|---|---|
| TC | M(SD) | 187.4 (26.9) | 184.42 (35.6) | 160.9 (25.8) | 162.4 (22.9) | 169.7 (41.1) | 159.9 (35.8) | 185.3 (33.1) | 185.7 (32.7) |
| | Δ | -3.0 (11.9) | | 1.5 (21.2) | | -9.8 (20.6) | | 0.33 (28.7) | |
| | *d* | --- | | 0.26 | | 0.40 | | 0.15 | |
| | SWC | 8.09 | | 7.73 | | 12.32 | | 9.94 | |
| HDL | M(SD) | 45.9 (7.0) | 46.6 (8.4) | 47.4 (21.9) | 51.6 (17.1) | 45.2 (11.0) | 49.0 ( 13.4) | 43.0 (6.3) | 47.7 (8.0) |
| | Δ | 0.7 (5.3) | | 4.3 (6.2) | | 3.8 (5.5) | | 4.7 (5.4) | |
| | *d* | --- | | 0.62 | | 0.57 | | 0.74 | |
| | SWC | 2.10 | | 6.58 | | 3.30 | | 1.88 | |
| LDL | M(SD) | 122.6 (19.5) | 114.7 (23.1) | 97.1 (34.5) | 92.8 (30.7) | 105.4 (37.4) | 92.8 (29.2) | 121.3 (29.2) | 116.1 (29.7) |
| | Δ | -7.86 (8.0) | | -4.4 (18.9) | | -12.7 (15.8) | | -5.22 (22.2) | |
| | *d* | --- | | 0.24 | | 0.38 | | 0.16 | |
| | SWC | 5.85 | | 10.34 | | 11.23 | | 8.76 | |
| TG | M(SD) | 89.4 (29.7) | 122.7 (43.1) | 78.1 (36.5) | 89.0 (57.4) | 101.67 (107.7) | 98.0 (69.5) | 104.3 (67.7) | 114.0 (48.3) |
| | Δ | 33.3 (14.8) | | 10.9 (35.2) | | -3.7 (50.8) | | 9.67 (39.2) | |
| | *d* | --- | | 0.83 | | 0.99 | | 0.80 | |
| | SWC | 8.90 | | 10.96 | | 32.31 | | 20.31 | |
| BG | M(SD) | 92.0 (10.7) | 85.9 (10.9) | 89.8 (8.78) | 83.4 (6.7) | 88.0 (7.2) | 81.2 (6.3) | 86.9 (6.8) | 86.1 (6.9) |
| | Δ | -6.1 (5.4) | | -6.4 (10.4) | | -6.8 (6.5) | | -0.8 (3.8) | |
| | *d* | --- | | 0.03 | | 0.11 | | 1.14 | |
| | SWC | 3.22 | | 2.63 | | 2.16 | | 2.05 | |

**Note:** Mean ± SD; delta changes; effect size (*d*) with Q1 being the control; smallest worthwhile change; Q1 = Gym Attendance < 34.5; Q2 = Attendance 34.5 – 55; Q3 = Attendance 55 – 68.75; Q4 = > 68.75; TC = total cholesterol (mg/dL); HDL = high-density lipoprotein (mg/dL), LDL = low-density lipoprotein (mg/dL), TG = triglycerides (mg/dL), BG = blood glucose (mg/dL).

| | Q1 | Q2 | Q3 | Q4 | Entire Group |
|---|---|---|---|---|---|
| Weight | | | | | |
| BMI | | | | | |
| SBP | | | | | |
| DBP | | | | | |
| BF% | | | | | |
| W:H | | | | | |
| TC | | | | | |
| HDL | | | | | |
| LDL | | | | | |
| TG | * | | | | |
| BG | | | | | |

Figure 1. Effect sizes of health metrics with Q1 being the control. (ES ≥ 0.5). * Denotes that Q1 showed a moderately unhealthy change compared to Q2 and Q4 based on effect size. Q1 = Gym Attendance < 34.5; Q2 = Attendance 34.5 – 55; Q3 = Attendance 55 – 68.75; Q4 = > 68.75; BMI = body mass index (kg/m$^2$), SBP = systolic blood pressure (mmHg), DBP = diastolic blood pressure (mmHg), BF% = body fat percentage, W:H = waist: hip ratio (in), TC = total cholesterol (mg/dL); HDL = high-density lipoprotein (mg/dL), LDL = low-density lipoprotein (mg/dL), TG = triglycerides (mg/dL), BG = blood glucose (mg/dL).

| ≥ Moderate ES Unhealthy | Trivial & Small ES (No change) | ≥ Moderate ES Healthy |
|---|---|---|
| | | |

***Fitness Metrics***

Data indicates that post 9-month intervention, $VO_{2max}$ displayed a group mean difference of 0.62 mL/kg/min. However, this value was less than the calculated SWC (i.e., 1.38 mL/kg/min) indicating no meaningful difference. All attendance quartiles showed improvements for group mean changes, but all quartiles were within range for just daily fluctuations. However, the NFPA sets a specific recommendation for aerobic capacity. There were three individuals, one from Q1, Q3, and Q4, that improved above to the NFPA's recommendation at follow-up testing.

*Muscular Strength*

The entire group for $HGS_{dom}$, $HGS_{nondom}$, and LP showed increases in mean group differences. These values were larger than the SWC, indicating a meaningful difference. Based off attendance, all

attendance quartiles for $HGS_{dom}$, $HGS_{nondom}$, and LP showed meaningful group differences based off the SWC.

*Flexibility*

For the entire group, there was a group mean difference for SR of -1.81 cm, but this value was less than the calculated SWC (2.91 cm). Based off attendance, Q1 showed the largest decrement for SR of -4.00 cm, which was larger than the SWC (3.58 cm).

Table 4 represents data associated with the fitness metrics for the entire group. Data from baseline to follow-up testing based on attendance quartiles for fitness metrics are included in Table 5 and Figure 2.

Table 4. Baseline to follow-up fitness metrics for the entire group.

| | | Baseline | Follow-up | *p* | | | Baseline | Follow-up | *p* | | | Baseline | Follow-up | *p* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **$VO_{2max}$** | M(SD) | 41.3 (4.6) | 42.2 (4.7) | 0.07 | **LP** | M(SD) | 233.7 (74.3) | 259.2 (94.1) | 0.03* | **VJ** | M(SD) | 47.9 (11.6) | 49.8 (9.4) | 0.05* |
| | Δ | 0.6 (1.9) | | | | Δ | 25.6 (63.9) | | | | Δ | 1.8 (5.3) | | |
| | *d* | 0.20 | | | | *d* | 0.30 | | | | *d* | 0.17 | | |
| | SWC | 1.38 | | | | SWC | 22.28 | | | | SWC | 3.48 | | |
| **$HGS_{dom}$** | M(SD) | 41.9 (7.8) | 49.7 (9.5) | 0.01* | **BP** | M(SD) | 90.3 (24.8) | 91.3 (22.9) | 0.08 | **PLANK** | M(SD) | 101.6 (60.5) | 113.1 (55.4) | 0.08 |
| | Δ | 7.8 (5.9) | | | | Δ | 1.0 (8.4) | | | | Δ | 11.5 (37.9) | | |
| | *d* | 0.90 | | | | *d* | 0.04 | | | | *d* | 0.20 | | |
| | SWC | 2.34 | | | | SWC | 7.44 | | | | SWC | 18.15 | | |
| **$HGS_{nondom}$** | M(SD) | 39.3 (9.4) | 48.6 (10.9) | 0.01* | **PU** | M(SD) | 22.8 (10.7) | 22.4 (11.1) | 0.71 | **SR** | M(SD) | 28.7 (9.7) | 26.9 (9.5) | 0.02* |
| | Δ | 9.3 (6.7) | | | | Δ | -0.4 (5.5) | | | | Δ | -1.81 (4.7) | | |
| | *d* | 0.90 | | | | *d* | 0.03 | | | | *d* | 0.19 | | |
| | SWC | 2.83 | | | | SWC | 3.20 | | | | SWC | 2.91 | | |

**Note**: Mean ± SD; delta changes; effect size (d); smallest worthwhile change; VO2max = aerobic capacity (mL/kg/min), VJ = vertical jump (cm), HGSdom = dominant handgrip strength (kg), HGSnondom = non-dominant handgrip strength (kg), BP = bench press (kg), LP = leg press (kg), PU = pushups (reps), SR = sit and reach (cm).

*Statistically significant ($p < 0.05$).

Table 5. Baseline to follow-up fitness metrics within attendance quartiles.

| | | $Q1_{Baseline}$ | $Q1_{Follow\text{-}up}$ | $Q2_{Baseline}$ | $Q2_{Follow\text{-}up}$ | $Q3_{Baseline}$ | $Q3_{Follow\text{-}up}$ | $Q4_{Baseline}$ | $Q4_{Follow\text{-}up}$ |
|---|---|---|---|---|---|---|---|---|---|
| $VO_{2max}$ | M(SD) | 37.1 (5.4) | 38.8 (5.8) | 42.2 (3.8) | 43.2 (4.8) | 43.7 (2.8) | 43.9 (2.9) | 41.6 (4.1) | 42.9 (3.5) |
| | Δ | 0.7 (2.2) | | 1.03 (2.6) | | 0.2 (1.2) | | 0.6 (1.8) | |
| | *d* | --- | | 0.13 | | 0.31 | | 0.08 | |
| | SWC | 1.62 | | 1.14 | | 0.84 | | 1.24 | |
| VJ | M(SD) | 43.8 (13.8) | 47.0 (9.5) | 43.5 (10.9) | 46.4 (8.3) | 53.9 (10.1) | 53.1 (9.2) | 51.4 (9.1) | 52.9 (10.2) |
| | Δ | 3.3 (6.5) | | 2.9 (4.9) | | -0.5 (3.6) | | 1.6(6.0) | |
| | *d* | --- | | 0.07 | | 0.71 | | 0.27 | |
| | SWC | 4.13 | | 3.30 | | 3.01 | | 2.71 | |
| $HGS_{dom}$ | M(SD) | 41.3 (7.2) | 46.7 (7.9) | 40.6 (8.2) | 46.6 (7.5) | 41.8 (8.2) | 52.0 (10.6) | 43.9 (9.7) | 53.7 (10.8) |
| | Δ | 5.33 (3.9) | | 6.0 (5.9) | | 10.2 (8.6) | | 9.8 (3.3) | |
| | *d* | --- | | 0.13 | | 0.73 | | 1.22 | |
| | SWC | 2.15 | | 2.46 | | 2.46 | | 2.92 | |
| $HGS_{nondom}$ | M(SD) | 40.2 (8.6) | 47.7 (8.7) | 35.1 (10.4) | 44.2 (12.2) | 40.4 (9.2) | 51.0 ± (11.2) | 41.6 (9.8) | 51.7 (11.8) |
| | Δ | 7.4 (2.6) | | 9.1 (5.7) | | 10.6 (10.8) | | 10.1 (5.8) | |
| | *d* | --- | | 0.37 | | 0.37 | | 0.59 | |
| | SWC | 2.58 | | 3.12 | | 2.75 | | 2.93 | |
| BP | M(SD) | 86.4 (15.4) | 88.1 (15.7) | 82.7 (25.0) | 83.3 (18.8) | 85.5 (25.8) | 87.6 (26.4) | 105.8 (26.4) | 105.7 (24.4) |
| | Δ | 1.7 (4.7) | | 0.6 (12.2) | | 2.1 (4.2) | | -0.1 (10.5) | |
| | *d* | --- | | 0.12 | | 0.09 | | 0.22 | |
| | SWC | 4.61 | | 7.50 | | 7.74 | | 7.92 | |
| LP | M(SD) | 246.4 (88.8) | 275.9 (92.2) | 200.9 (36.9) | 216.7 (80.2) | 216.6 (50.2) | 241.3 (87.3) | 278.52 (98.9) | 312.6 (104.0) |
| | Δ | 29.6 (78.4) | | 15.8 (53.2) | | 24.7 (57.3) | | 34.03 (78.7) | |
| | *d* | --- | | 0.21 | | 0.07 | | 0.06 | |
| | SWC | 26.63 | | 11.09 | | 15.05 | | 29.67 | |
| PLANK | M(SD) | 68.3 (32.5) | 75.0 (18.5) | 110.7 (69.1) | 123.5 (63.9) | 118.8 (61.9) | 131.6 (58.1) | 103.5 (64.2) | 113.7 (56.3) |
| | Δ | 9.7 (26.9) | | 12.8 (47.5) | | 12.8 (54.7) | | 10.2 (11.9) | |
| | *d* | --- | | 0.08 | | 0.07 | | 0.02 | |

| | | | | | |
|---|---|---|---|---|---|
| | SWC | 9.74 | 20.74 | 18.56 | 19.25 |
| PU | M(SD) | 14.3 (8.1) 15.0 (9.1) | 23.7 (12.8) 21.4 (14.4) | 24.3 (6.9) 25.3 (5.9) | 26.9 (11.1) 26.2 (11.5) |
| | Δ | 0.7 (4.9) | -2.2 (5.9) | 1.00 (7.7) | -0.7 (2.6) |
| | *d* | --- | 0.54 | 0.05 | 0.35 |
| | SWC | 2.42 | 3.71 | 2.07 | 3.33 |
| SR | M(SD) | 28.7 (11.9) 24.7 (10.9) | 24.6 (11.4) 22.8 (10.8) | 31.9 (6.7) 30.2 (7.4) | 29.5 (7.9) 29.7 (7.9) |
| | Δ | -4.0 (6.2) | -1.7 (4.9) | -1.7 (3.0) | 0.2 (2.4) |
| | *d* | --- | 0.41 | 0.48 | 0.89 |
| | SWC | 3.58 | 3.43 | 2.00 | 2.36 |

**Note:** Mean ± SD; delta changes; effect size (*d*) with Q1 being the control; smallest worthwhile change; Q1 = Gym Attendance < 34.5; Q2 = Attendance 34.5 – 55; Q3 = Attendance 55 – 68.75; Q4 = > 68.75; $VO_{2max}$ = aerobic capacity (mL/kg/min), VJ = vertical jump (cm), $HGS_{dom}$ = dominant handgrip strength (kg), $HGS_{nondom}$ = non-dominant handgrip strength (kg), BP = bench press (kg), LP = leg press (kg), PU = pushups (reps), SR = sit and reach (cm).

| | Q1 | Q2 | Q3 | Q4 | Entire Group |
|---|---|---|---|---|---|
| $VO_{2max}$ | | | | | |
| VJ | | | | | |
| $HGS_{dom}$ | | | | | |
| $HGS_{nondom}$ | | | | | |
| BP | | | | | |
| LP | | | | | |
| Push-ups | | | | | |
| Plank | | | | | |
| SR | | | | | |

Figure 2: Effect sizes of fitness metrics with Q1 being the control. (ES ≥ 0.5) Q1 = Gym Attendance < 34.5, Q2 = Attendance 34.5 – 55, Q3 = Attendance 55 – 68.75, Q4 = > 68.75, $VO_{2max}$ = aerobic capacity (mL/kg/min), VJ = vertical jump (cm), $HGS_{dom}$ = dominant handgrip strength (kg), $HGS_{nondom}$ = non-dominant handgrip strength (kg), BP = bench press (kg), LP = leg press (kg), PU = pushups (reps), SR = sit and reach (cm).

| ≥ Moderate ES Unhealthy | Trivial & Small ES (No change) | ≥ Moderate ES Healthy |
|---|---|---|
| | | |

# CHAPTER 4

# DISCUSSION

While the consensus is that worksite wellness programs can be beneficial to employees' health and wellness that are located in corporate and business settings, not much research has been established for rural firefighters. The purpose of this study was to evaluate the effectiveness of a worksite wellness program to improve or maintain health and fitness outcomes in career firefighters. Over the course of 9-months, most of the firefighters began to "buy-in" to this wellness program, and there were some improvements and maintenance of health and fitness metrics that are described below.

## *Health Metrics*

Weight gain over the course of the 9-month intervention was slightly higher (1.24 ± 3.71 kg) than what is typically seen by the average American (e.g., 0.2-0.8 kg), but the weight gain was also in range for daily weight fluctuations (SWC 4.52 kg) (Hertz et al., 2004; Poston et al., 2012). The weight gain seen may have been due to an increase of skeletal muscle mass over the duration of this wellness program. However, there was not a significant change in body fat percentage during this time period. The results seen are similar to a study performed by Kerksick et al. (2009) which saw a slight increase in body mass over the course of an 8-week resistance training protocol in middle aged men, but there was not an increase of body fat percentage over the course of the program.

The improvements seen in the blood profiles for the entire group of firefighters. There were positive changes in HDL, LDL, and BG for the entire group. At baseline testing there were three firefighters, one in Q1, Q3, and Q4, that were in pre-diabetic ranges (i.e., 100-125 mg/dL). However, at follow-up testing, only one individual in Q1 was still considered pre-diabetic. There were some individual blood lipid improvements also. There were two individuals in both Q2 and Q4 that had HDL below 40 mg/dL, but were able to increase above 40 mg/dL for follow-up testing. This is important since having a HDL of 40 mg/dL or higher is a negative risk factor for cardiovascular disease. Increasing overall physical activity has been shown to have positive implications on overall blood profiles (Philippe et al.,

2017). This is an important consideration since there were some improvements in even the lowest attendance quartile. Even some of the firefighters that participated minimally in the wellness program saw some improvements. In conjunction with becoming more physically active, proper diet can also show improvements in blood profiles (Yang et al., 2014). The nutritional education that was offered once a week to the shift that was on-duty may have provided some information to firefighters so that they could make better food choices. Nutritional education was just general information on how to read food labels and how to count macronutrients. Further research is needed to determine if long-term nutritional education improves the blood profiles of firefighters.

*Fitness Metrics*

The NFPA has specific recommendations regarding aerobic capacity. The recommendation set by the NFPA is that firefighters have a minimum $VO_{2max}$ of 42 mL/kg/min. At baseline testing, 58% of firefighters (n = 36) were below the recommended threshold. For follow-up testing, one individual from Q1, Q3, and Q4 showed improvements to meet the recommendations that are set by the NFPA. Aerobic capacity is extremely important when performing occupational tasks since the average $VO_2$ demand for firefighting tasks is 41.5 mL/kg/min, and the inability to meet these recommendations can put firefighters at greater risk of a sudden cardiac event occurring (Michaelides et al., 2011; Gledhill & Jamnik, 1992). While this study was able to show a few individual improvements, over half of the participants in this study still failed to meet the minimal recommendation. Approximately 72% of firefighters that were in Q1 and Q2 did not meet the recommendation at follow-up testing. Whereas individuals that utilized the gym more often (Q3 and Q4), only had 29% that did not meet the recommendation during follow-up testing. As previously stated, this wellness program evolved over the 9-month period to get more “buy-in” from the fire department. Many of the firefighters enjoyed the resistance training more than the cardiovascular training. Therefore, many of the shift and group workouts that are in place focused more so on increasing strength rather than increasing cardiovascular endurance. Going forward, more cardiovascular training should be implemented to help increase the aerobic capacity of firefighters.

Throughout the duration of this program, we saw improvements in upper body strength (i.e., hand grip strength) and in lower body strength (i.e., leg press). The entire group showed improvements from baseline to follow-up testing, and individuals that were in Q3 and Q4 saw the largest increase in strength compared to the individuals in Q1 for dominant hand grip strength, but all quartiles showed meaningful improvements. Individuals in Q3 saw a 20% increase and Q4 saw an 18% increase compared to the individuals in Q1 which only saw an 11% increase. Improvements in handgrip strength may have been due to the type of exercises that were performed during shift and group training sessions. Many of the shift and group training sessions involved movements that utilized kettlebells, dumbbells, barbells, battle ropes and would be used to replicate movements that may be seen on the fire scene (e.g., kettlebell farmers carry, high pulls, deadlifts). Additionally, those who were in the Q3 and Q4 participated in more exercise than the other groups, which may explain the attendance difference. Similarly, a study performed by Quednow et al. (2015) saw a significant increase in dominant hand grip strength after a 5-week training protocol that incorporated kettlebell and battle rope circuit training. These movements are taxing on grip strength, and may have played a part in the improvements that were seen.

Upon reflection of this study, the training consisted of about 80% strength training and about 20% cardiovascular training. While there were some improvements in the strength components, we did not see as many improvements for aerobic capacity. As this program evolves, it will be an important consideration to focus on cardiovascular training in the future. Cardiovascular endurance is a crucial component to a firefighter's overall job performance, and this will need to be a bigger part of training moving forward with this wellness program. With this study, the primary goal was to see how the wellness program affected health and fitness outcomes. It will be important to see how future studies look at how each component specifically impacted these measures. For example, future studies should look at if nutritional education help increase vegetables and fruit intake during a wellness intervention.

*Limitations*

Limitations of the study should be acknowledged. The attendance records that were collected were a self-reported sign-in sheet that was located in the fitness facility. It is possible that firefighters might have forgotten to sign in and out while they were in the gym, and it is possible that just because the firefighters did sign-in it does not mean that they participated in an appropriate workout. In addition, the attendance records do not account for workouts that were completed outside of the gym, and they do not account for other activities that would be completed on days that firefighters are not on-duty. Additionally, while gym attendance on-duty was part of departmental policy, not all firefighters followed the policy that was in place. This may have been dependent on the shift-culture and particular commanding officers' priorities while firefighters were on shift. All shifts differ due to the chain of command on each shift. Some shifts advocate for their firefighters to exercise while other shifts are more lax in terms of participating and exercising. This may become more of an issue for younger firefighters that are just coming into the fire service. For instance if a younger firefighter is a big advocate for working out, but they get put on a crew where the chain of command does not enjoy the gym, the younger firefighter may not have the chance to exercise while on-duty. All aspects of this wellness program that were implemented were based on the recommendations of the firefighters. Lastly, some of the protocols that the NFPA suggests from the WFI (i.e., Gerkin treadmill protocol and 3-site skinfold locations), have very little literature supporting the validity of these measures (Dolezal et al., 2015; Meier & Gibson, 2004).

# CHAPTER 5

# CONCLUSION

Health and wellness programs have proven to be an excellent option to positively impact the health of many individuals in the workforce. While it has been shown that wellness programming is lacking in the fire service, it is becoming imperative that fire departments implement wellness programming to better the health of their employees. This wellness program was an effective and feasible option in aiding in improvements and maintenance of many health and fitness metrics for rural firefighters. Health and fitness professionals coming into the fire service to implement a wellness program need to be aware of how long it takes to get "buy-in" from a fire department. This occupation is different compared to many corporate and business settings, therefore, it may take more time for programs like this to be accepted. Even though it may take more time, educating the firefighters on a healthy lifestyle may help them in the future to understand the importance of maintaining and improving health and fitness metrics.

# REFERENCES

Andrews, K. L., Gallagher, S., & Herring, M. P. (2019). The effects of exercise interventions on health and fitness of firefighters: A meta-analysis. *Scandinavian Journal of Medicine & Science in Sports, 29*(6), 780–790.

ATUS Charts. (2017). Retrieved from https://www.bls.gov/tus/charts.htm

Baicker, K., Cutler, D., & Song, Z. (2010). Workplace wellness programs can generate savings. *Health Affairs, 29*(2), 304-311.

Butler, C. E., Clark, B. R., Burlis, T. L., Castillo, J. C., & Racette, S. B. (2015). Physical activity for campus employees: a university worksite wellness program. *Journal of Physical Activity and Health, 12*(4), 470-476.

Davis, P. O., Dotson, C. O., & Santa, D. M. (1982). Relationship between simulated firefighting tasks and physical performance measures. *Medicine and Science in Sports and Exercise*, *14*(1), 65-71.

Dennison, K. J., Mullineaux, D. R., Yates, J. W., & Abel, M. G. (2012). The effect of fatigue and training status on firefighter performance. *The Journal of Strength & Conditioning Research, 26*(4), 1101-1109.

Dolezal, B. A., Barr, D., Boland, D. M., Smith, D. L., & Cooper, C. B. (2015). Validation of the firefighter WFI treadmill protocol for predicting VO2 max. *Occupational Medicine, 65*(2), 143-146.

Elliot, D. L., Goldberg, L., Kuehl, K. S., Moe, E. L., Breger, R. K., & Pickering, M. A. (2007). The PHLAME (Promoting Healthy Lifestyles: Alternative Models' Effects) firefighter study: outcomes of two models of behavior change. *Journal of Occupational and Environmental Medicine, 49*(2), 204-213.

Gledhill, N., & Jamnik, V. K. (1992). Characterization of the physical demands of firefighting. *Canadian Journal of Sport Sciences*, *17*(3), 207-213.

Hall, J. L., Kelly, K. M., Burmeister, L. F., & Merchant, J. A. (2017). Workforce characteristics and attitudes regarding participation in worksite wellness programs. *American Journal of Health Promotion, 31*(5), 391-400.

Hertz, R. P., Unger, A. N., McDonald, M., Lustik, M. B., & Biddulph-Krentar, J. (2004). The impact of obesity on work limitations and cardiovascular risk factors in the US workforce. *Journal of Occupational and Environmental Medicine, 46*(12), 1196-1203.

Hopkins, W. G., Marshall, S. W., Batterham, A. M., & Hanin, J. (2009). Progressive statistics for studies in sports medicine and exercise science.

Hunter, A. L., Shah, A. S., Langrish, J. P., Raftis, J. B., Lucking, A. J., Brittan, M., ... & Graveling, R. (2017). Fire simulation and cardiovascular health in firefighters. *Circulation, 135*(14), 1284-1295.

International Association of Fire Fighters. (2008). The fire service joint labor management wellness-fitness initiative.

Jahnke, S. A., Poston, W. S., Jitnarin, N., & Haddock, C. K. (2012). Health concerns of the US fire service: perspectives from the firehouse. *American Journal of Health Promotion, 27*(2), 111-118.

Jahnke, S. A., Poston, W. S. C., Haddock, C. K., & Jitnarin, N. (2013). Injury among a population based sample of career firefighters in the central USA. *Injury Prevention, 19*(6), 393-398.

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, 21*(8), 1505-1508.

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. *New England Journal of Medicine, 356*(12), 1207-1215.

Kales, S. N., Soteriades, E. S., Christoudias, S. G., & Christiani, D. C. (2003). Firefighters and on-duty deaths from coronary heart disease: a case control study. *Environmental Health, 2*(1), 14.

Kales, S. N., Tsismenakis, A. J., Zhang, C., & Soteriades, E. S. (2009). Blood pressure in firefighters, police officers, and other emergency responders. *American Journal of Hypertension, 22*(1), 11-20.

Kahn, S. A., Woods, J., & Rae, L. (2015). Line of duty firefighter fatalities: an evolving trend over time. *Journal of Burn Care & Research, 36*(1), 218-224.

Kerksick, C. M., Wilborn, C. D., Campbell, B. I., Roberts, M. D., Rasmussen, C. J., Greenwood, M., & Kreider, R. B. (2009). Early-phase adaptations to a split-body, linear periodization resistance training program in college-aged and middle-aged men. *The Journal of Strength & Conditioning Research, 23*(3), 962-971.

Korre, M., Sotos-Prieto, M., & Kales, S. N. (2017). Survival Mediterranean style: lifestyle changes to improve the health of the US fire service. *Frontiers in Public Health, 5*, 331.

Lowden, A., Moreno, C., Holmbäck, U., Lennernäs, M., & Tucker, P. (2010). Eating and shift work—effects on habits, metabolism, and performance. *Scandinavian Journal of Work, Environment & Health*, 150-162.

McCoy, M. K., Stinson, M. K., Scott, M. K., Tenney, M. L., & Newman, L. S. (2014). Health promotion in small business: a systematic review of factors influencing adoption and effectiveness of worksite wellness programs. *Journal of Occupational and Environmental Medicine, 56*(6), 579.

Michaelides, M. A., Parpa, K. M., Henry, L. J., Thompson, G. B., & Brown, B. S. (2011). Assessment of physical fitness aspects and their relationship to firefighters' job abilities. *The Journal of Strength & Conditioning Research, 25*(4), 956-965.

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.

National Fire Protection Association. (2015). NFPA 1583: standard on health-related fitness programs for Fire Department members. National Fire Protection Association.

National Fire Protection Association. (2018). NFPA 1582, Standard on comprehensive occupational medical program for fire departments. National Fire Protection Association.

National Fire Protection Association (2016). Fourth needs assessment of the U.S. fire service. Quincy, MA: National Fire Protection Association.

Nazari, G., MacDermid, J. C., Sinden, K. E., & Overend, T. J. (2018). The relationship between physical fitness and simulated firefighting task performance. *Rehabilitation Research and Practice.*

Osilla, K. C., Van, K. B., Schnyer, C., Larkin, J. W., Eibner, C., & Mattke, S. (2012). Systematic review of the impact of worksite wellness programs. *The American Journal of Managed Care*, *18*(2), e68-81.

Pencina, M. J., D'Agostino Sr, R. B., Larson, M. G., Massaro, J. M., & Vasan, R. S. (2009). Predicting the thirty-year risk of cardiovascular disease: the Framingham Heart Study. *Circulation*, *119*(24), 3078.

Philippe, M., Gatterer, H., Eder, E. M., Dzien, A., Somavilla, M., Melmer, A., ... & Burtscher, M. (2017). The effects of 3 weeks of uphill and downhill walking on blood lipids and glucose metabolism in pre-diabetic men: a pilot study. *Journal of Sports Science & Medicine*, *16*(1), 35.

Poston, W. S., Jitnarin, N., Haddock, C. K., Jahnke, S. A., & Tuley, B. C. (2012). The impact of surveillance on weight change and predictors of change in a population-based firefighter cohort. *Journal of Occupational and Environmental Medicine*, *54*(8), 961-968.

Poston, W. S., Haddock, C. K., Jahnke, S. A., Jitnarin, N., & Day, R. S. (2013). An examination of the benefits of health promotion programs for the national fire service. *BMC Public Health*, *13*(1), 805

Poston, W. S., 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*, *53*(3), 266.

Quednow, J., Sedlak, T., Meier, J., Janot, J., & Braun, S. (2015). The effects of high intensity interval-based kettlebells and battle rope training on grip strength and body composition in college-aged adults. *International Journal of Exercise Science*, *8*(2), 3.

Rhea, M. R., Alvar, B. A., & Gray, R. (2004). Physical fitness and job performance of firefighters. *Journal of Strength and Conditioning Research*, *18*(2), 348-352.

Rita, F., Fahy, R. F., & Molis, J. L. (2019). Firefighter Fatalities in the US- 2018.

Soteriades, E. S., Hauser, R., Kawachi, I., Liarokapis, D., Christiani, D. C., & Kales, S. N. (2005). Obesity and cardiovascular disease risk factors in firefighters: a prospective cohort study. *Obesity Research, 13*(10), 1756-1763.

Soteriades, E. S., Smith, D. L., Tsismenakis, A. J., Baur, D. M., & Kales, S. N. (2011). Cardiovascular disease in US firefighters: a systematic review. *Cardiology in Review*, *19*(4), 202-215.

Wilkinson, M. L., Brown, A. L., Poston, W. S., Haddock, C. K., Jahnke, S. A., & Day, R. S. (2014). Physician weight recommendations for overweight and obese firefighters, United States, 2011-2012. *Preventing Chronic Disease, 11*, E116. doi:10.5888/pcd11.140091

Yang, J., Farioli, A., Korre, M., & Kales, S. N. (2014). Modified Mediterranean diet score and cardiovascular risk in a North American working population. *PLoS One*, *9*(2), e87539.

Yang, J., Farioli, A., Korre, M., & Kales, S. N. (2015). Dietary preferences and nutritional information needs among career firefighters in the United States. *Global Advances in Health and Medicine*, 4(4), 16-23.

APPENDIX A- PARTICIPATION FORMS

## FITNESS READINESS QUESTIONNAIRE

| **Name *(Last, First, M.I.):*** | • **M** ☐ **F** | **DOB *(xx/xx/xx):*** | **Age:** |
|---|---|---|---|

**Physical Activity Readiness Questionnaire PAR-Q**

| | Questions | Yes | **No** |
|---|---|---|---|
| **1** | Has your doctor ever said that you have a heart condition and that you should only perform physical activity recommended by a doctor? | | |
| **2** | Do you feel pain in your chest when you perform physical activity? | | |
| **3** | In the past month, have you had chest pain when you were not performing any physical activity? | | |
| **4** | Do you lose your balance because of dizziness or do you ever lose consciousness? | | |
| **5** | Do you have a bone or joint problem (for example, back, knee or hip) that could be made by a change in your physical activity? | | |
| **6** | Is your doctor currently prescribing drugs (for example, water pills) for your blood pressu for a heart condition? | | |
| **7** | Do you know of <u>any other reason</u> why you should not engage in physical activity? | | |

***If you have answered "Yes" to one or more of the above questions, consult your physician before engaging in physical activity. Tell your physician which questions you answered "Yes" to. After a medical evaluation, seek advice from your physician on what type of activity is suitable for your current condition.***

**Personal Health History**

**Are you currently being treated for high blood pressure? ___ yes ____no**

**If you know your average blood pressure, please enter _____/_____**

**Please check all conditions or diagnoses that apply to you:**

| | | | | |
|---|---|---|---|---|
| ☐ | Allergies | ☐ | Chest Pain or Shortness of Breath | **Briefly explain if you checked any boxes to the left:** |
| ☐ | Arthritis | ☐ | Back Pain | |
| ☐ | Asthma | ☐ | Orthopedic Problems | |
| ☐ | Diabetes | ☐ | Recent Surgery | |
| ☐ | Dizziness | ☐ | High Blood Pressure | |
| ☐ | Epilepsy | ☐ | Dysmenorrhea (females only) | |
| ☐ | Migraines | ☐ | Pregnant* (currently) | |

**Family History: Have your mother, father, or sibling suffered from (please select all that apply)**

| | | | |
|---|---|---|---|
| ☐ | Heart attack or heart surgery prior to 55 | ☐ | High Choleste |
| ☐ | Stroke prior to the age of 50 | ☐ | Diabetes |
| ☐ | Congenital heart disease or left ventricular hypertrophy | ☐ | Obesity |
| ☐ | Hypertension | ☐ | Asthma |
| ☐ | Leukemia or cancer prior to age 60 | ☐ | Osteoporosis |

**Medications: Please select any medication you are currently using**

| | | | |
|---|---|---|---|
| ☐ | Diuretics | ☐ | Other Cardiovascular |
| ☐ | Beta-Blockers | ☐ | NSAID/Antiflammators (Motrin, Advil) |
| ☐ | Vasodilators | ☐ | Cholesterol |
| ☐ | Alpha-Blockers | ☐ | Diabetes/Insulin |
| ☐ | Calcium Channel Blokcers | ☐ | Other Drugs (record below) |

**Lifestyle:**

**Are you a cigarette smoker? If so how many per day _____**

**Previously a cigarette smoker? If so when did you quit? _____**
**How many years have you smoked or did you smoke before quitting? _____**

**Tobacco Products: What tobacco products do you currently use?**

| | | | |
|---|---|---|---|
| ☐ | Cigarettes | ☐ | Smokeless tobacco |
| ☐ | e-cigarettes/vape | ☐ | Cigars |

APPENDIX B: INFORMED CONSENT

**WATERS COLLEGE OF HEALTH PROFESSIONS**

**DEPARTMENT OF HEALTH SCIENCES AND KINESIOLOGY**

**Informed Consent**
**EFFECTIVENESS OF WELLNESS PROGRAMMING ON RURAL FIREFIGHTERS TO IMPROVE NFPA HEALTH AND WELLNESS COMPONENTS**

You are being invited to participate in the **Effectiveness of Wellness Programming on Rural Firefighters to Improve NFPA Health and Fitness Components** study. The purpose of the study is to evaluate the effectiveness of wellness programming to improve NFPA health and fitness components among rural firefighters over a 9-month period. The primary investigator, Macy Weeks, is a current Master's student at Georgia Southern University. You may contact her with questions at any point by phone (478-279-3997) or by email (mw08679@georgiasouthern.edu). For questions concerning your rights as a research participant, contact Georgia Southern University Institutional Review Board at 912-478-5465.

Your participation in this study is completely voluntary and you may end your participation at any time by telling the primary investigator, Macy Weeks. Please understand that you do not have to answer any questions that you do not want to answer. You may withdraw from the study at any time without penalty. The investigator may in her absolute discretion terminate the investigation at any time. You will not receive any compensation for this study and you will not be responsible for any additional cost of this study.

You are invited to participate if you are:

- A full time employee of a fire department in southeast Georgia
- Over the age of 18
- Not currently pregnant or trying to become pregnant
- Fluent English Speaker

There is no deception involved in this study. As a participant in this study, you will receive information regarding your current health status. Data obtained from this study may be used to help researchers and departments understand the current health status of firefighters from this region. Given this information, departments may choose to address weaknesses and structure training regimens appropriately.

If you agree to participate in this study you will be asked to come to the Human Performance Lab in Hanner Fieldhouse for 2 visits and the City Gym for a minimum of 1 visit. Visits to the Human Performance Lab should last approximately 30 minutes to 1 hour, and total testing at the City Gym should last approximately 1.5 hours. During these visits we will assess the following:

**Human Performance Lab:**

- Height, weight, and body composition via a stadiometer, a scale, and a variety of different body composition methods.
    - Body fat percentage will be measured 6 different ways. The most basic method will consist of standing on a metal scale. One method involves being pinched in 7 different

locations (i.e., upper chest, arm, stomach, hip, thigh, upper back, and side of the body underneath the arm). Two methods involve the application of electrodes to your hands and wrists. Another method will require you to sit still in a small chamber for approximately 3 minutes. Lastly, one technique will perform a low dose x-ray of your entire body.

- Hydration status
    - A small urine sample will be requested to determine hydration status.
- Handgrip strength
- Vertical jump
- Resting blood pressure, heart rate, and ECG
- Lung function
    - You will be asked to exhale forcefully through a small tube for ~5 seconds.
- Aerobic capacity
    - Cardiorespiratory endurance will be measured using a submaximal test. For this test, you will walk or jog on a treadmill until your heart rate reaches a predetermined limit based upon your age. Each minute of testing, the treadmill will alternate increasing speed or grade until completion.
    - <u>This will be done during the second visit to the Human Performance Lab.</u>

**<u>City Gym:</u>**

- Muscular strength
    - Upper and lower body strength will be assessed using the bench press and leg press, respectively. You will be asked to perform a test will only allow you to lift a weight a maximum of 3 times, and from that we will estimate your 1-repetition maximum
- Muscular Endurance
    - Trunk endurance will be measured by performing a plank until fatigue. The test will stop upon fatigue or automatically after 4 minutes. To assess upper body endurance we will ask you to perform push-ups to the beat of a metronome. The test will stop upon fatigue or automatically after 2 minutes.
- Flexibility
    - Lower back and hamstring flexibility will be assessed using a sit and reach test. To assess trunk flexibility we will ask you to lie face down on the floor and raise your upper body as far off the ground as you can. To assess shoulder flexibility we will ask you to lift your arms above your head while still lying on the floor.
- Mobility
    - Dr. Melton or Dr. Ryan will determine your mobility through a functional movement screen (FMS). During this test you will be asked to perform a deep squat, hurdle step, in-line lunge, straight leg raise, push up, and specific tests for rotary stability and shoulder mobility.

**This study has few risks involved:**

- There is a risk of muscle soreness and fatigue commonly associated with exercise which is no greater than a traditional exercise routine.
- Muscle soreness may occur during the days after testing.
- General feelings of fatigue, light-headedness, and general discomfort.
- Injuries, such as strains and sprains, can also occur during weight training.
- Additionally during traditional resistance training, there is a risk of the barbell falling on your chest
  during the movement.
- There is minimal radiation exposure with the dual energy x-ray absorptiometry (DEXA).
- Risk of allergic reaction to skin adhesives.

*Risks will be minimized by:*

- Monitoring you during measurements and making sure you are comfortable at all times.
- Stopping procedures if you appear uncomfortable during measurements (i.e., unable to complete exercises due to fatigue, appear dizzy or lightheaded, etc).
- Stopping the test if you show any signs or symptoms of illness.
- Having trained personnel present during all testing.
- Having 2 spotters to guide the barbell and aide in lifting.
- Individuals that have had a high dose x-ray in the past 12 months will not participate in the DEXA scan.

I understand that medical care is available in the event of injury resulting from research but that neither financial compensation nor free medical treatment is provided. If needed, Georgia Southern University Health Services can be reached at (912) 478-5641 and is located at 984 Plant Drive on the Georgia Southern campus.

Only the investigators of this study will have access to your complete data set. Previously collected data will be de-identified using a random number generator to maintain confidentiality. You will not be identified by name in the data set or any reports using information obtained from this study, and your confidentiality as a participant will remain secure. Subsequent uses of records and data will be subject to standing data use policies, which protect the anonymity of individuals and institutions. Data from this study will be stored in an investigator's office and maintained in a de-identified manner for future use.

If you sign this document, you give permission to the investigators of this study at Georgia Southern University to use or disclose (release) your health information that identifies you for the research study described here: Effectiveness of Wellness Programming on Rural Firefighters to Improve NFPA Health and Fitness Components. The health information that we may use or disclose (release) for this research includes the results of your physical examination: your body composition, aerobic capacity, pulmonary function, ECG, blood pressure, and cholesterol.

The health information listed above may be used by and/or disclosed (released) to:

- Dr. Bridget Melton (Co-Principal Investigator),
- Dr. Greg Ryan (Investigator), and
- Dr. Ron Snarr (Investigator)

Georgia Southern University is required by law to protect your health information. By signing this document, you authorize Georgia Southern University to use and/or disclose (release) your health information for this research. Those persons who receive your health information may not be required by Federal privacy laws (such as the Privacy Rule) to protect it and may share your information with others without your permission, if permitted by laws governing them.

You must be 18 years of age or older to consent to participate in this research study. If you consent to participate in this research study and to the terms above, please sign your name and indicate the date below.

You will be given a copy of this consent form to keep for your records. This project has been reviewed and approved by the GSU Institutional Review Board under tracking number H19098.

Title of Project: Effectiveness of Wellness Programming on Rural Firefighters to Improve NFPA Health and Fitness Components

Principal Investigator: Macy Weeks, Hollis 2112, 478-279-3997, mw08679@georgiasouthern.edu
Faculty Advisor: Dr. Bridget Melton, Health Sciences & Kinesiology, P.O. Box 8076, 912-478-1973, bmelton@georgiasouthern.edu

_____ _____

Participant Signature Date

I, the undersigned, verify that the above informed consent procedure has been followed.

_____ _____

Investigator Signature Date

# APPENDIX C: IRB APPROVAL

Georgia Southern University
Office of Research Services & Sponsored Programs

**Institutional Review Board (IRB)**

Phone: 912-478-5465
Fax: 912-478-0719
IRB@GeorgiaSouthern.edu
Veazey Hall 3000
PO Box 8005
Statesboro, GA 30460

**To:** Melton, Bridget; Snarr, Ron; Ryan, Greg; Weeks, Macy

**From:** Office of Research Integrity

**Date:** 2/24/2020

**Original Approval Date:** 3/12/2019

**Expiration Date:** 2/28/2021

**Subject:** Status of Modification **(# 2 )** & Extension Request for Approval to Utilize Human Subjects in Research – Originally Approved by **Full Medical Board Review**

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After a review of your Extension & Modification Request for research project numbered **H19098**, and titled **"Physiological Profile of First Responders in Southeast Georgia,"** it appears that (1) the research subjects are at minimal risk, (2) appropriate safeguards are planned, and (3) the research activities involve only procedures which are allowable. You are authorized to enroll up to a maximum of **75** subjects.

***Therefore, as authorized in the Federal Policy for the Protection of Human Subjects, I am pleased to notify you that the Institutional Review Board has approved your extension and modification.***

**Modification description: Deletion of Emily Langford. Update of the title of the project to "Physiological Profile of First Responders in Southeast Georgia."**

Please provide the IRB with any information concerning any significant adverse event, **whether or not it is believed to be related to the study**, within five working days of the event. In addition, if a change or modification of the approved methodology becomes necessary, you must notify the IRB Coordinator **prior** to initiating any such changes or modifications. At that time, an amended application for IRB approval may be submitted. Upon completion of your data collection, you are required to complete a *Research Study Termination* form to notify the IRB Coordinator, so your file may be closed.

Sincerely,

Eleanor Haynes
Compliance Officer

APPENDIX D:

LITERATURE REVIEW

## INTRODUCTION

To be able to gain a better understanding of wellness programs in the fire service, this chapter will review the current literature that is available regarding wellness programs in the fire service. This chapter includes wellness programs that have been implemented in the fire service and how it has impacted the health and wellness of employees. It will explore the average health status and lifestyle of a career firefighter, recommendations for wellness programs in the fire service, cost-effectiveness that wellness programs bring to departments, and the effectiveness that wellness programs have on healthy eating and exercise among firefighters.

## HEALTH AND LIFESTYLE OF A CAREER FIREFIGHTER

Firefighting is inherently a dangerous profession where firefighters are often in threatening situations which can put their lives and health at risk (Smith et al., 2016). The conditions that firefighters are exposed to require them to wear heavy and restrictive personal protective equipment which can cause high levels of cardiovascular strain. Interestingly enough, despite the immediate risks that firefighters are exposed to (e.g., smoke inhalation, burn injuries), a sudden cardiac event is the leading cause of on-duty fatalities in the United States (Smith et al., 2016). Cardiovascular events in the fire service account for approximately 45 percent of all on-duty related deaths (Hunter et al., 2017; Kales et al., 2003). Firefighters are at an elevated risk for cardiovascular events occurring due to the physical and psychological stresses of the job, smoke exposure, obesity prevalence, hypertension, lack of physical activity, and poor dietary habits (Kahn et al., 2015). While it is widely known that physical activity can help reduce and lower the risks of cardiovascular disease, the long periods of infrequent and inadequate amounts of physical activity are extremely common in most firehouses which can attribute to the rise of sudden cardiac events occurring on fire scenes (Soteriades et al., 2011).

According to the National Fire Protection Agency (NFPA), in 2018 overexertion and stress accounted for 44 percent (28 deaths) of all on-duty fatalities, and 25 out of the 28 were classified as a sudden cardiac event. These sudden cardiac events usually referred to as a heart attack (Rita et al., 2019). In almost every year since 1977, sudden cardiac death has had the largest share of deaths annually. Between the years of 1977-1986, an average of 60 firefighters died per year from a sudden cardiac event with 44.7% of the deaths occurring while the firefighter was on duty (Rita et al., 2019). While there has been a promising sign that the average number of deaths from a sudden cardiac event fell from 44 in the 1990s to 31 average deaths in the past decade it remains the number one cause of death in the fire service (Rita et al., 2019). The majority of these cases can be associated with the lifestyle that is around the firehouse. This includes long sedentary periods, poor dietary habits, and for most departments, no required exercise while on-duty (Jahnke et al., 2012; Soteriades et al., 2011).

The obesity prevalence amidst the American workers over the past several decades has increased significantly in adults in the United States gaining anywhere from 0.2-0.8 kg per year depending on factors like sex and ethnicity (Poston et al., 2012; Hertz et al., 2004). Along with the general population, firefighters are becoming increasingly heavier, and more fire recruits are coming into the service from a less fit general population. Approximately 67%-77% of young firefighters are considered either overweight or obese (Tsismenakis et al., 2009; Fahs et al., 2009; Korre et al., 2017). Obesity is a major concern regarding firefighter health and safety, and it is associated with an increased risk of cardiovascular disease, hypertension, and job-related disabilities (Wilkinson et al., 2014; Jahnke et al., 2013; Tsismenakis et al., 2009; Soteriades et al., 2011). Researchers have investigated both career and volunteer firefighters and determined that the high obesity prevalence was indeed due to excess adiposity rather than a misclassification of muscle mass through the measurement of body mass index (BMI) (Poston et al., 2011). This study showed that obesity was actually more prevalent when assessing body fat percentage compared to just using BMI to classify obesity (Poston et al., 2011). Most of the risk factors

that are associated with obesity can be attenuated with a healthy lifestyle, improving dietary choices, improving overall wellness, and increasing physical activity.

There are certain challenges that can arise for firefighters when it comes to dietary choices and opportunities. In the firehouse, it is common that firefighters will share meals with one another which can result in unhealthy eating habits (Frattaroli et al., 2013). “Firehouse culture” is typically seen as mostly sedentary behavior and communal meals which are high in calories, fat, and refined carbohydrates (Yang et al., 2015). There is also an increased likelihood of firefighters choosing fast food and takeout food due to irregular meal times from unscheduled emergency calls and shift work (Korre et al., 2017). In most cases, firefighters do not make the healthiest eating choices that may be available due to the need to eat quickly and consuming inexpensive foods. This leads to firefighters consuming meals that are higher in both sugars and saturated fats (Lowden et al., 2010; Yang et al., 2014). Research shows that an increase in fast food consumption is associated with obesity prevalence, hypertension, and increases the risk of cardiovascular disease (Duffey et al., 2012; Pereira et al., 2005). It has been noted that two dietary factors that separate non-obese firefighters and obese firefighters is the overall consumption of both sugary drinks and fast foods (Yang et al., 2014). Sweetened beverages are the biggest contributor to overall added sugar in one’s diet in the United States for the general population, and this research is consistent with firefighters (Korre et al., 2017). Firefighters' shift work has been associated with an overall increase in weight and blood pressure (Soteriades et al., 2011; Fujii et al., 2008).

The cultural environment is what makes firefighting different from another emergency personal. The shifts for a firefighter are usually a 24-hour shift at a time where firefighters are spending time alongside their fellow coworkers (Deutsch, 2005). The cultural environment is an important consideration when studying firefighters because of how different it is from a typical corporate or business setting. Firefighters have to work as a team in order to successfully complete the tasks that they are challenged with, therefore it is important for them to collaborate together through cooperative activities (i.e., eating together) (Kniffin et al., 2015). One study discussed the importance of “fitting in” to the culture of the

firehouse. If a person does not fit that quota then the rest of the crew “will make it easy for you to want to quit” the job (Kniffin et al., 2017).

## RECOMMENDATIONS FOR WELLNESS PROGRAMS IN THE FIRE SERVICE

### *NFPA*

The NFPA is a non-profit organization that’s purpose is to eliminate “...death, injury, property, and economic loss due to fire, electrical, and related hazards” (NFPA, 2018). This organization publishes standards for fire departments regarding the development of occupational medical programs and the development of health-related fitness programs (NFPA, 2018; NFPA, 2015). Standards like NFPA 1582 and 1583 are optional for fire departments to follow, but it sets a high bar for occupational health and wellness for firefighters. NFPA 1582 outlines occupational medical programs that help reduce the risks of firefighters and provide health and safety standards for fire departments (NFPA, 2018). It goes over 13 job-specific tasks and recommends for fire departments to evaluate the tasks to conclude if their firefighters will encounter these tasks on a day to day basis. Chapter 8 of this standard discusses fitness evaluations for employees. Once information is evaluated a physician can then determine medical performance.

Standard NFPA 1583, which coincides with 1582, recommends that all employees have annual medical and fitness evaluations, and to develop health-related fitness programs among fire departments (NFPA, 2015). 1583 discusses different components to assess the health of a firefighter. The components that are recommended as follows: body composition, aerobic capacity, muscular strength, muscular endurance, and flexibility. This standard also suggests some aspects that should be a part of a health and wellness program. Some components include having individualized exercise programs based on individual assessments, and education on proper warm-ups and cooldowns. These components of the NFPA 1583 can help to build a health and wellness program for the fire department.

### *IAFF*

The International Association of Firefighters (IAFF) has explained the importance of fitness in the fire service through the guidance of the Fire Service Joint Labor Management Wellness Fitness Initiative (WFI). The IAFF and the International Association of Fire Chiefs developed the WFI 3rd Edition (IAFF, 2008). Researchers revealed that fire departments that implemented WFI were healthier than departments that did not have wellness programs in place (Poston, Haddock, Jahnke, Jitnarin, & Day, 2013). The WFI's primary goal is to improve the quality of life for all uniformed personnel by investing in wellness resources for the duration of the personnel's career so that they can maintain healthy firefighters and EMS responders (IAFF, 2008). An evaluation of WFI implementation took place during 1991-1997 and after 1998- 2004 with four departments that implemented the WFI and four departments that did not. During these time periods WFI departments had significantly lower rises in their average claims (5 vs 22 percent change for the time periods), fewer lost workdays (-28 vs 55 percent change for the time periods), and smaller increases of average total cost (3 vs 58 percent change for the time periods) (IAFF, 2008). WFI recommends firefighters have at least 60-90 minutes allocated every work shift for exercise.

*CPAT*

*T*he Candidate Physical Activity Test (CPAT) is an occupational assessment recognized in North America as one of the most valuable tools for assessing a firefighter's physical ability for job-specific tasks). The CPAT was established in 1999 and created by ten cities by the International Association of Fire Fighters, and the International Association of Fire Chiefs Joint Labor Management Wellness-Fitness Initiative Task Force (International Association of Fire Fighters, 2014) reasoning for the CPAT is to ensure that firefighters exhibit the mandatory physical ability to be able to execute important tasks through this structured and consistent evaluation. It screens candidates that have been suggested to construct individual components of physical fitness and the "content" approach in which tasks incorporate a circuit that simulates firefighting demands (Willliam-Bell et al., 2009). Men and women who are not successful in completing the CPAT show decreased results in strength and endurance to successful

candidates (Williams-Bell et al., 2009). This can help with pre-employment screenings to ensure that candidates that are applying to join the fire service already have a base fitness level prior to being hired (Faught, 2017).

The CPAT is comprised of eight job-related tasks in which the candidate has to wear a 50-pound weighted vest, gloves, long pants, and a helmet for the entire test. The eight tasks are listed as follows: stair climb with a 25-pound hose pack, ladder raise with extension, hose drag, equipment carry, forcible entry, search (crawling through a dark tunnel), rescue drag with a 180-pound mannequin and a ceiling push/pull. The time limit to complete all eight tasks is 10 minutes and 20 seconds. It is a "pass/fail" test. So, any individual that does not complete the eight tasks in the allotted time, they failed the test.

## COST-EFFECTIVENESS OF WELLNESS PROGRAMS

It is encouraged that adults engage in a minimum of 150 minutes of moderate-to-vigorous physical activity per week. This is recommended by the authors of the Physical Activity Guidelines, but many Americans do not meet these physical activity recommendations. General worksite wellness programs are becoming more common in corporate America with many businesses promoting, incentivizing, and acknowledging the importance of physical activity for their employees in the workplace (Anderson et al., 2009; Baicker et al., 2010). Benefits from these programs include an increase in productivity and lower healthcare costs (CDC, 2013). It has been noted that workplace wellness programs can help generate savings for the employer. Baicker and colleagues reported that of the 32-original peer-reviewed publications twenty-two of those studies reported on the impact the wellness programs had on their employee healthcare costs. The average return on investment was $3.27 for every dollar that was spent on employee wellness programs for medical costs, and absentee cost falls by about $2.73 for every dollar spent (Baicker et al., 2010). While this evidence is particular to large corporate employers, there may be potential benefits of medical cost savings when initiating wellness programs in the fire service.

Work-related injuries are prevalent and costly in the fire service due to the hazardous conditions many firefighters are exposed to. Implementation of wellness programming can be a cost-effective way to save money for fire departments. In a physician, organized wellness regimen (POWR), a cohort of firefighters was compliant with the 2007 NFPA standard 1582. The initial wellness plan was simple. Firefighters performed at least 30 minutes of cardiovascular exercise at least 4 to 5 times per week, and there were individualized plans for each firefighter based individual goals and life circumstances. Each firefighter had an input in their program developed by the physician. Firefighters were encouraged to be involved in the wellness program to improve his or her health while achieving the yearly departmental requirement of a 12-metabolic equivalents stress test. This fire department strongly encouraged their employees to participate and went by the motto, "one weak link can put the firefighting team in peril" (Leffer & Grizzell, 2010). After the implementation of this wellness program, there was a 40% decrease in recordable injuries during year one of the intervention, and 60% reduction after the second year. The average cost for this department was $13,420 per work-related injury, and the average time away from work was 8.8 days. In 2007, there were 19 fewer injuries and the cost-saving was $254,980 which was 171 days of regular duty preserved. During year two, 216 regular duty days were saved and cost savings were $322,080. The return on investment was a 4:6:1 by the second year of the intervention (Leffer & Grizzell, 2010).

Economic benefits after implementation of workplace health promotion programs have been shown to be beneficial and a cost-effective means to improve firefighter injury and illness rates (Kuehl et al., 2013). One study evaluated the effectiveness of the PHLAME (Promoting Healthy Lifestyles: Alternative Models' Effects) on workers' compensation claims and overall medical costs from one urban fire department. Researchers evaluated total annual workers' compensation claims, total medical costs before and after implementation of the PHLAME health promotion program, and return on investment. Results showed that during the time period that the PHLAME program took place, there was a significant reduction in claim rates in the fire departments that took place in the PHLAME program compared to the

fire departments that did not take place in the PHLAME program. There was a 1% decrease in the mean total number of worker's compensation claims in departments that took place in the PHLAME program compared to a 30% increase in claims of the fire departments that did not take place in the health promotion programs. Over the time period of the were the health promotion program took place the PHLAME fire departments increased their cost per firefighter by $312 (7%) whereas other departments increased by $1026 per firefighter (24%). This represents that the fire department that implemented the wellness program cost was about one third less than the fire departments that did not implement a health promotion program (Kuehl et al., 2013).

**EFFECTIVENESS OF WELLNESS PROGRAMS ON NUTRITION AND EXERCISE**

When implementing workplace wellness programs in the fire service, it is important to consider the leadership differences, living situations, work schedule, and their military-like structure in the firehouse. Overall culture in the firehouse is also consistently better in departments that had a wellness program in place. Departments that implemented the WFI programs were more likely to report greater optimism, job satisfaction, and have a greater sense of accomplishment than firefighters that were a part of a wellness program that did not have a wellness program in place (Poston et al., 2013).

Nutrition plays a major role in the overall health and wellness of a firefighter, and the overall dietary patterns can be used as markers of the health status for the individual. By improving one's diet, it has been shown to produce positive effects on health outcomes (Leighton et al., 2009). It has been demonstrated that career firefighters that have dietary habits in line with the Mediterranean Diet showed more positive health outcomes, less CVD risks, inverse associations of metabolic syndrome prevalence, and lower weight gain over the course of five years compared to those who ate primarily fast food or takeout (Yang et al., 2014). Approximately 68% of firefighters responded to a survey reporting that they have not received adequate information regarding proper nutrition from the fire service (Yang et al., 2015). One effective method in improving overall health and wellness of firefighters is to include firefighters in the development of the wellness programs that will be established in the firehouse. This is

important to gain trust and to get buy-in from the firefighters involved in wellness programming (Frattaroli et al., 2013). Researchers learned that from forming focus groups and incorporating the feedback from firefighters they were able to implement a variety of interventions in the firehouse. Researchers were able to include several education sessions on how to cook and eat healthy, began a weight loss program in the fire department, and had peer health advocates in the department (Frattaroli et al., 2013). The intervention was established by having the buy-in of the fire department by incorporating the feedback from the firefighters, and by combining the feedback from experts in wellness fields.

The PHLAME study was a large, multisite investigation aimed to help improve overall wellness in the fire service with the main goal of examining the effects of the implementation of the program in the workplace between 2002 and 2004 (Elliot et al., 2007). It was broken up into three phases. Throughout this multiphase investigation, the focus was to reduce the calories from fat in firefighters to less than 30%, increase physical activity, increase energy levels, and to increase consumption of fruits and vegetables to at least 5 servings per day (Elliot et al., 2004). During the initial PHLAME study, interventions included both team and one-on-one formats which both delivered positive results. After the one year follow-up, all groups gained weight, but the intervention group gained less than. While the intervention group did result in less gained weight, there were no significant improvements in cardiorespiratory fitness levels or physical activity behavior (Elliot et al., 2007).

It is common knowledge that regular exercise can help with weight management, increasing strength, increasing cardiovascular endurance, and improving overall wellness. Being able to perform the tasks necessary in a safe and effective manner is crucial. Firefighters must be able to carry load up to 70 pounds worth of gear such as boots, jackets, and supplemental air tanks (Bjerke, 2011). They also must be able to carry equipment such as hoses and axes upstairs, which can be roughly another 30 pounds, added to the total load that they are carrying. During this time, the physiological responses can quickly approach near-maximal levels, and the exposure to heat stress can cause excess strain on both the musculoskeletal and cardiovascular systems of the firefighters (Michaelides et al., 2011; Bos et al., 2004; Bugajska et al.,

2007). The need for appropriate fitness levels is very important to lessen the risk of sudden cardiovascular events from occurring. Firefighters that engage in regular exercise while on-duty have nearly half the odds of suffering an injury compared to those that do not exercise regularly while on-duty (Jahnke et al., 2013). Furthermore, firefighters that train regularly and possess higher fitness levels tend to perform their job-specific tasks more efficiently firefighters that do not engage in regular physical activity (Hollerbach et al.,2019; Dennison et al., 2012). Research has shown that firefighters that worked in departments with a strong wellness program has been noted to have exercised more regularly than firefighters that work in departments that do not have an established wellness program (Poston et al., 2013). In departments that implemented the WFI, only 4.4% of firefighters claimed to never exercise at the station compared to 12.9% of firefighters at departments that did not implement the WFI. The same thing occurred for exercising every day that they are on-duty. In departments that implemented the WFI, 29% claimed that they exercised every day while on duty whereas firefighters that worked for departments that did not implement the WFI only 12.9% reported that they exercised every day while on-duty (Poston et al., 2013).

While current research discusses some of the benefits of incorporating a wellness program in the fire service to increase the amount of exercise and nutritional knowledge among firefighters, there is a limited amount of research on how these wellness programs can improve the NFPA's health and fitness components. Since there are no requirements in the fire service for exercise that firefighters are required to have, it is important to gain knowledge if wellness programming can improve the health and fitness recommendations from organizations such as the NFPA.

# REFERENCES

Anderson, L. M., Quinn, T. A., Glanz, K., Ramirez, G., Kahwati, L. C., Johnson, D. B., ... & Katz, D. L. (2009). The effectiveness of worksite nutrition and physical activity interventions for controlling employee overweight and obesity: a systematic review. *American Journal of Preventive Medicine*, *37*(4), 340-357.

Baicker, K., Cutler, D., & Song, Z. (2010). Workplace wellness programs can generate savings. *Health Affairs*, *29*(2), 304-311.

Bjerke, W. (2011). Health and fitness programs for firefighters. *Strength & Conditioning Journal*, *33*(2), 55-57.

Bos, J., Mol, E., Visser, B., & Frings-Dresen, M. H. (2004). The physical demands upon (Dutch) fire-fighters in relation to the maximum acceptable energetic workload. *Ergonomics*, *47*(4), 446-460.

Bugajska, J., Zużewicz, K., Szmauz-Dybko, M., & Konarska, M. (2007). Cardiovascular stress, energy expenditure and subjective perceived ratings of fire fighters during typical fire suppression and rescue tasks. *International Journal of Occupational Safety and Ergonomics*, *13*(3), 323-331.

CDC - Workplace Health - Implementation - Physical Activity (2013)

Dennison, K. J., Mullineaux, D. R., Yates, J. W., & Abel, M. G. (2012). The effect of fatigue and training status on firefighter performance. *The Journal of Strength & Conditioning Research*, *26*(4), 1101-1109.

Deutsch, J. (2005). “Please pass the chicken tits”: rethinking men and cooking at an urban firehouse. *Food and Foodways*, *13*(1-2), 91-114.

Duffey, K. J., Steffen, L. M., Van Horn, L., Jacobs Jr, D. R., & Popkin, B. M. (2012). Dietary patterns matter: diet beverages and cardiometabolic risks in the longitudinal Coronary Artery Risk Development in Young Adults (CARDIA) Study. *The American Journal of Clinical Nutrition, 95(*4), 909-915.

Elliot, D. L., Goldberg, L., Duncan, T. E., Kuehl, K. S., Moe, E. L., Breger, R. K., ... & Stevens, V. J. (2004). The PHLAME firefighters' study: feasibility and findings. *American Journal of Health Behavior, 28(*1), 13-23.

Elliot, D. L., Goldberg, L., Kuehl, K. S., Moe, E. L., Breger, R. K., & Pickering, M. A. (2007). The PHLAME (Promoting Healthy Lifestyles: Alternative Models' Effects) firefighter study: outcomes of two models of behavior change. *Journal of Occupational and Environmental Medicine, 49*(2), 204-213.

Fahs, C. A., Smith, D. L., Horn, G. P., Agiovlasitis, S., Rossow, L. M., Echols, G., ... & Fernhall, B. (2009). Impact of excess body weight on arterial structure, function, and blood pressure in firefighters. *The American Journal of Cardiology, 104*(10), 1441-1445.

Faught, B. E. (2017). Does the pre-employment screening process influence health status of probationary firefighters?. *Medical Research Archives*, *5*(9).

Frattaroli, S., Pollack, K. M., Bailey, M., Schafer, H., Cheskin, L. J., & Holtgrave, D. R. (2013). Working inside the firehouse: developing a participant-driven intervention to enhance health-promoting behaviors. *Health Promotion Practice, 14*(3), 451-458.

Fujii, H., Takiuchi, S., Kawano, Y., & Fukagawa, M. (2008). Putative role of asymmetric dimethylarginine in microvascular disease of kidney and heart in hypertensive patients. *American Journal of Hypertension, 21*(6), 650-656.

Hertz, R. P., Unger, A. N., McDonald, M., Lustik, M. B., & Biddulph-Krentar, J. (2004). The impact of obesity on work limitations and cardiovascular risk factors in the US workforce. *Journal of Occupational and Environmental Medicine, 46*(12), 1196-1203.

Hollerbach, B. S., Jahnke, S. A., Poston, W. S., Harms, C. A., & Heinrich, K. M. (2019). Examining a novel firefighter exercise training program on simulated fire ground test performance, cardiorespiratory endurance, and strength: a pilot investigation. *Journal of Occupational Medicine and Toxicology, 14*(1), 12.

Hunter, A. L., Shah, A. S., Langrish, J. P., Raftis, J. B., Lucking, A. J., Brittan, M., ... & Graveling, R. (2017). Fire simulation and cardiovascular health in firefighters. *Circulation, 135*(14), 1284-1295.

International Association of Fire Fighters. (2008). The Fire Service Joint Labor Management Wellness-Fitness Initiative.

Jahnke, S. A., Poston, W. S., Jitnarin, N., & Haddock, C. K. (2012). Health concerns of the US fire service: perspectives from the firehouse. *American Journal of Health Promotion, 27*(2), 111-118.

Jahnke, S. A., Poston, W. S. C., Haddock, C. K., & Jitnarin, N. (2013). Injury among a population based sample of career firefighters in the central USA. *Injury Prevention, 19*(6), 393-398.

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, 21*(8), 1505-1508.

Kahn, S. A., Woods, J., & Rae, L. (2015). Line of duty firefighter fatalities: an evolving trend over time. *Journal of Burn Care & Research, 36*(1), 218-224.

Kales, S. N., Soteriades, E. S., Christoudias, S. G., & Christiani, D. C. (2003). Firefighters and on-duty deaths from coronary heart disease: a case control study. *Environmental Health, 2*(1), 14.

Kniffin, K. M., Wansink, B., Devine, C. M., & Sobal, J. (2015). Eating together at the firehouse: how workplace commensality relates to the performance of firefighters. *Human Performance, 28*(4), 281-306.

Korre, M., Sotos-Prieto, M., & Kales, S. N. (2017). Survival Mediterranean style: lifestyle changes to improve the health of the US fire service. *Frontiers in Public Health, 5*, 331.

Kuehl, K. S., Elliot, D. L., Goldberg, L., Moe, E. L., Perrier, E., & Smith, J. (2013). Economic benefit of the PHLAME wellness programme on firefighter injury. *Occupational Medicine, 63*(3), 203-209.

Leffer, M., & Grizzell, T. (2010). Implementation of a physician-organized wellness regime (POWR) enforcing the 2007 NFPA standard 1582: injury rate reduction and associated cost savings. *Journal of Occupational and Environmental Medicine, 52*(3), 336-339.

Leighton, F., Polic, G., Strobel, P., Pérez, D., Martinez, C., Vásquez, L., ... & Mezzano, D. (2009). Health impact of Mediterranean diets in food at work. *Public Health Nutrition, 12*(9A), 1635-1643.

Lowden, A., Moreno, C., Holmbäck, U., Lennernäs, M., & Tucker, P. (2010). Eating and shift work—effects on habits, metabolism, and performance. *Scandinavian Journal of Work, Environment & Health*, 150-162.

Mabry, L., Elliot, D. L., MacKinnon, D. P., Thoemmes, F., & Kuehl, K. S. (2013). Understanding the durability of a fire department wellness program. *American Journal of Health Behavior, 37*(5), 693-702.

Michaelides, M. A., Parpa, K. M., Henry, L. J., Thompson, G. B., & Brown, B. S. (2011). Assessment of physical fitness aspects and their relationship to firefighters' job abilities. *The Journal of Strength & Conditioning Research*, *25*(4), 956-965.

National Fire Protection Association. (2015). NFPA 1583: standard on health-related fitness programs for Fire Department members. National Fire Protection Association.

National Fire Protection Association. (2018). NFPA 1582, Standard on comprehensive occupational medical program for fire departments. National Fire Protection Association.

Pereira, M. A., Kartashov, A. I., Ebbeling, C. B., Van Horn, L., Slattery, M. L., Jacobs Jr, D. R., & Ludwig, D. S. (2005). Fast-food habits, weight gain, and insulin resistance (the CARDIA study): 15-year prospective analysis. *The Lancet*, *365*(9453), 36-42.

Physical activity guidelines for Americans (2008). Washington, DC.

Poston, W. S., Jitnarin, N., Haddock, C. K., Jahnke, S. A., & Tuley, B. C. (2012). The impact of surveillance on weight change and predictors of change in a population-based firefighter cohort. *Journal of Occupational and Environmental Medicine, 54*(8), 961-968.

Poston, W. S., 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, 53*(3), 266.

Poston, W. S., Haddock, C. K., Jahnke, S. A., Jitnarin, N., & Day, R. S. (2013). An examination of the benefits of health promotion programs for the national fire service. *BMC Public Health, 13*(1), 805.

Rita, F., Fahy, R. F., & Molis, J. L. (2019). Firefighter Fatalities in the US- 2018.

Smith, D. L., DeBlois, J. P., Kales, S. N., & Horn, G. P. (2016). Cardiovascular strain of firefighting and the risk of sudden cardiac events. *Exercise and Sport Sciences Reviews, 44*(3), 90-97.

Soteriades, E. S., Hauser, R., Kawachi, I., Liarokapis, D., Christiani, D. C., & Kales, S. N. (2005). Obesity and cardiovascular disease risk factors in firefighters: a prospective cohort study. *Obesity Research, 13*(10), 1756-1763.

Soteriades, E. S., Smith, D. L., Tsismenakis, A. J., Baur, D. M., & Kales, S. N. (2011). Cardiovascular disease in US firefighters: a systematic review. *Cardiology in Review, 19*(4), 202-215.

Tsismenakis, A. J., Christophi, C. A., Burress, J. W., Kinney, A. M., Kim, M., & Kales, S. N. (2009). The obesity epidemic and future emergency responders. *Obesity, 17*(8), 1648-1650.

Williams-Bell, F. M., Villar, R., Sharratt, M. T., & Hughson, R. L. (2009). Physiological demands of the firefighter candidate physical ability test. *Medicine & Science in Sports & Exercise, 41*(3), 653-662.

Wilkinson, M. L., Brown, A. L., Poston, W. S., Haddock, C. K., Jahnke, S. A., & Day, R. S. (2014). Physician weight recommendations for overweight and obese firefighters, United States, 2011-2012. *Preventing Chronic Disease, 11*, E116. doi:10.5888/pcd11.140091

Yang, J., Farioli, A., Korre, M., & Kales, S. N. (2014). Modified Mediterranean diet score and cardiovascular risk in a North American working population. *PLoS One, 9*(2), e87539.

Yang, J., Teehan, D., Farioli, A., Baur, D. M., Smith, D., & Kales, S. N. (2013). Sudden cardiac death among firefighters≤ 45 years of age in the United States. *The American Journal of Cardiology, 112*(12), 1962-1967.

Yang, J., Farioli, A., Korre, M., & Kales, S. N. (2015). Dietary preferences and nutritional information needs among career firefighters in the United States. *Global Advances in Health and Medicine*, 4(4), 16-23.