ORIGINAL RESEARCH

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Fitness Policies Within the Fire Service: A Pilot Investigation of Exercise Adherence on Fitness Outcomes Among Rural Firefighters

Abstract: *The purpose of this study was to investigate the adherence to departmental fitness policies and to evaluate the impact of on-duty firefighters' adherence to fitness outcomes. This cross-sectional designed study utilized a convenience sample of 40 career firefighters from one department in rural southeast Georgia. Onsite gym attendance logs were recorded during a 10-month period. Firefighters were classified as lowest (0-16 sessions), low (17-30 sessions), moderate (31-44 sessions), or high (45+ sessions) adherence for analyses based on gym attendance. The fitness outcomes were retrieved from required annual fitness testing, including measurements of muscular strength (1RM$_{est}$ leg press and 1RM$_{est}$ bench press), muscular endurance (pushup), muscle power (vertical jump), cardiovascular fitness (submaximal treadmill), mobility (functional movement screen), and flexibility (shoulder elevation). Only 12.5% (n = 5) of firefighters complied with the department's fitness policy of a minimum 75% adherence rate. Furthermore, there were significant differences (P ≤ .05) between various muscular strength, endurance, and flexibility between adherence rates. This study indicated that firefighters that complied more with the fitness policies were more physically fit than those that did not. Considerations should be made to promote and enforce departmental fitness policies to*

> Higher levels of physical fitness aid firefighters in performing occupational tasks such as pulling hoses, forcibly entering structures, carrying equipment up and down ladders, and carrying victims to safety, all while decreasing the risk of injury.

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ensure that firefighters can physically perform their responsibilities.

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Firefighting is a hazardous occupation that requires specific tasks to be performed to protect life and property. It is well documented that cardiorespiratory fitness and muscular strength are crucial to firefighters in order to carry heavy equipment, victims, and supplies for extended periods of time.[1-3] Firefighters who do not perform regular physical activity are at a higher risk for injury and a potential loss of life during training and occupational duties requiring substantial physical work compared to their more physically active peers.[4] Higher levels of physical fitness aid firefighters in performing occupational tasks such as pulling hoses, forcibly entering structures, carrying equipment up and down ladders, and carrying victims to safety, all while decreasing the risk of injury.[5] Specifically, a maximum aerobic capacity (VO_{2max}) greater than 44.0 mL/kg/min has been recommended to be able to successfully complete on-duty tasks.[6]

There is emerging research on the impact of evidence-based fitness programming for the fire service. The effectiveness of fitness programming in the fire service, both with recruit training programs and active firefighters, highlights the positive impacts fitness programming has on key performance indicator for firefighters.[6-8] A high number of job-related injuries each year has led organizations,[9] such as the National Fire Protection Agency (NFPA) and the International Association of Fire Chiefs, to set forth fitness training recommendations for firefighters. The NFPA recognizes that fire departments implementing a fitness program can encourage firefighters to perform occupational tasks with vigor, which are associated with lower rates of injury, morbidity, and mortality.[10]

Table 1.

Descriptive Statistics of Rural Firefighters in Southeast Georgia (N = 40).

	Mean ± SD	Max	Min
Age (years)	34.18 ± 8.86	56	21
Service (years)	9.95 ± 8.87	38	1
Height (cm)	178.90 ± 5.81	193.04	167.64
Weight (kg)	93.16 ± 14.98	133.17	68.49

NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members*, elaborates on injury prevention, stressors of the job, overall healthy lifestyle habits, and the importance of health and wellness programs among fire departments.[10] Furthermore, these guidelines recommend that health-related fitness programs include the following components: (1) qualified health and fitness coordinator; (2) annual fitness assessment; (3) exercise training programs; (4) health promotion education and counseling; and (5) established process for collecting and maintaining health-related data.[10] While these recommendations have been established, it is estimated that only approximately one quarter (~27%) of fire departments offer programs that meet these guidelines for their firefighters to maintain essential health and wellness.[11]

To our knowledge, there are no studies that evaluate the effects of fitness policies on individual firefighters' health and fitness outcomes. Additionally, little evidence exists on the effectiveness of departmental fitness policies' impact on firefighters' health and fitness, especially in rural fire departments. Therefore, the purpose of this study was to examine the impact of adherence to departmental fitness policies on firefighters' fitness outcomes in a rural fire department.

Method

Design and Participants

This retrospective study utilized a convenience sample of 40 career male firefighters from one department in rural southeast Georgia. This fire department works the industry standard of 24/48 hour (1 day on and 2 days off) shifts and have primary responsibilities of fire suppression with limited medical calls. All descriptive statistics are provided in Table 1. Participants were contacted through the Deputy Chief, who was previously informed of the study's benefits, risks, and purpose. Those who expressed interest and met the inclusion criteria of being over 18 years and a full-time active firefighter in the local department were considered eligible for the study. The firefighters were asked to consent to release their fitness and physical assessment information from their most recent physicals in a coded format to the research team. This study was approved by the university institutional review board, and written informed consent was obtained from each participant prior to accessing the existing data sets.

This department has a nonpunitive fitness policy requiring 45 minutes of physical activity per 24 hours shift in place at the time of the study. The fire department's exercise policy was encouraged and advocated by the administration, including Fire Chief, Deputy Chief, Assistant Chief, and Battalion Chief/Health and Safety Officer. Daily commanding officers were encouraged to make time for the on-shift firefighters to attend the onsite gym and asked to use their best judgment as to when they would integrate this requirement. However, no formal penal or reward system was in

place for the individual or shift that adhered to the policy.

Participants were provided with an onsite gym and access to certified personal trainers free of charge. The onsite gym had been in existence for 2 years prior to the data collection and was recently renovated to meet fitness industry standards, approximately 1 year before data collection. At the time of this study, a minimally structured fitness program consisted of a shift training workout every 3 weeks (Friday mornings on shift) and a departmental requirement of 45 minutes of self-guided exercise for every 24-hour shift.

Measurements

Demographics. Personnel records for years of service were deidentified and submitted by the Health and Safety Officer to the research team. Age was self-reported by participants. Height and weight data were retrieved from the annual fitness assessment described below.

Attendance/Adherence. Onsite gym attendance logs were requested from a 9-month period, August 2018 through May 2019. The 9-month period was selected based on the timing of the kinesiology student's fitness programming and maintenance of attendance logs during the academic year. A student intern was responsible for entering the attendance logs, coding the participants, and pulling their data to protect the participants' identity. Based on the 9-month data collected, it was estimated that firefighters would have worked 10 shifts per month for a total of 90 shifts during the data collection period, and 90 visits to the onsite fitness facility would equate to a 100% adherence rate. Participants were placed into quartiles following completion of the data collection period by the test administrators into 1 of 4 attendance classifications (Table 2): lowest (0-16 sessions; n = 10, 25%), low (17-30 sessions; n = 10, 25%), moderate (31-44 sessions; n = 11, 27.5%), or high (45-104 sessions; n = 11, 22.5%).

Table 2.

Gym Attendance Quartiles as Determined by Frequencies.

Quartiles	Visits	N	Percentage
Lowest	0-16	10	25.0
Low	17-30	10	25.0
Moderate	31-44	11	27.5
High	45-104	9	22.5

Health and Fitness Outcomes. As a part of a community partnership, this fire department outsourced its health and fitness annual assessment partly to the local university's Health Sciences and Kinesiology Department. Participants reported to the university's laboratory to measure their anthropometrics, including height, weight, 3-site skinfold body composition (BF%). Fasted blood markers of blood glucose (BG), triglycerides (TG), high-density lipoprotein (HDL), low-density lipoprotein (LDL), and total cholesterol (TC) were also collected by a qualified health professional from the fire department's onsite health center, and the results were provided to the researchers in a coded format for analysis.

Fitness outcomes were retrieved from the required annual fitness testing from the university recorders, including muscular strength (estimated 1-repetition maximum [$1RM_{est}$] leg press and bench press), muscular endurance (pushups and isometric plank), lower body muscular power (vertical jump), cardiovascular fitness (estimated VO_{2max} using the Gerkin treadmill protocol), mobility (functional movement screen), mobility (Functional Movement Screen), and flexibility (sit-and-reach, trunk extension, and shoulder flexion). All fitness tests were conducted in accordance with Wellness-Fitness Initiative (WFI) guidelines (IAFF, 2008) adopted by the NFPA and/or the National Strength and Conditioning Association (NSCA) guidelines and under the supervision of certified trained exercise personnel.[11,12]

Statistical Analysis

Data were analyzed and reported as mean ± SD using IBM SPSS Statistics 25.0 (IBM Corp). Prior to all data analyses, data were assessed for normality using skewness, kurtosis, histogram analyses, Shapiro-Wilks, and box and whisker plots. Frequencies and quartiles were calculated for categorical data, including the number of gym visits. Differences in fitness and health outcomes between adherence classifications were analyzed using one-way analysis of variance (ANOVA). Post hoc analysis on all significant main effect findings was conducted via LSD comparisons. Practical significance was assessed using Cohen's *d* statistics using Hopkin's scale of magnitude.[13,14] The scale utilized for all practical significance was 0 to <0.2 for trivial, 0.2 to <0.6 for small, 0.6 to <1.2 for moderate, 1.2 to <2.0 for large, and ≥2.0 for very large. All significance was set a priori with an α level of .05.

Results

It was found that less than 12.5% (n = 5) of firefighters met the threshold of 75% adherence rate to the 1 hour of exercise for every 24-hour shift per the departmental policy.

A significant main effect difference was noted for the following tested variables: $1RM_{est}$ leg press ($P = .04$); $1RM_{est}$ bench press ($P < .01$); pushups ($P = .04$); and shoulder flexion ($P < .01$). Post hoc

Table 3.

Statistical Significance of Adherence and Health and Fitness Outcomes[a].

	Total	High	Moderate	Low	Lowest
TC (mg/dL)	175.4 ± 32.2	184.8 ± 32.3	175.0 ± 32.0	175.7 ± 36.5	167.2 ± 30.0
HDL (mg/dL)	44.1 ± 12.1	41.4 ± 6.7	44.8 ± 11.3	45.9 ± 19.5	44.1 ± 8.1
LDL (mg/dL)	110.3 ± 30.2	122.6 ± 30.1	110.1 ± 31.7	102.7 ± 31.7	106.2 ± 28.8
TG (mg/dL)	95.7 ± 63.8	105.3 ± 64.7	107.5 ± 95.3	91.9 ± 48.2	77.6 ± 26.8
BG (mg/dL)	88.9 ± 7.8	88.0 ± 5.8	85.9 ± 7.6	89.4 ± 7.7	92.6 ± 9.1
BF%	26.4 ± 7.8	27.0 ± 8.0	24.6 ± 5.4	24.3 ± 6.6	29.9 ± 10.1
Isometric plank (seconds)	102.6 ± 58.4	118.8 ± 66.9	118.4 ± 62.6	92.7 ± 55.9	80.6 ± 46.1
Pushups (#)	23.0 ± 10.2	28.0 ± 10.8	26.0 ± 9.9	22.8 ± 5.9	15.7 ± 10.7*
Leg press $1RM_{est}$ (kg)	511.8 ± 161.5	291.9 ± 83.8†	223.7 ± 55.0	207.7 ± 39.8	214.3 ± 86.7
Bench press $1RM_{est}$ (kg)	197.3 ± 53.4	108.0 ± 20.1‡	96.5 ± 26.8	81.0 ± 18.8	74.4 ± 17.7
VJ (cm)	48.2 ± 11.5	50.9 ± 11.4	51.3 ± 10.0	51.0 ± 7.3	40.0 ± 13.7
Estimated VO_{2max} (mL/kg/min)	41.4 ± 4.6	41.5 ± 4.4	42.9 ± 2.6	42.9 ± 4.2	37.9 ± 6.0
Sit and reach (cm)	28.5 ± 9.5	31.3 ± 7.1	28.4 ± 11.1	29.4 ± 8.3	25.4 ± 11.2
Shoulder flexion (cm)	40.7 ± 10.9	50.6 ± 7.3§	33.8 ± 8.7	38.5 ± 11.8	41.7 ± 9.6
Trunk extension (cm)	29.3 ± 6.2	29.7 ± 7.3	28.9 ± 6.3	28.1 ± 5.5	30.9 ± 6.3

Abbreviations: TC, total cholesterol; HDL, high-density lipoprotein; LDL, low-density lipoprotein; TG, triglycerides; BG, blood glucose; BF%, body fat percentage; $1RM_{est}$, estimated one-repetition maximum; VJ, vertical jump; VO_{2max}, maximum aerobic capacity.
[a]Mean ± SD of all tested variables separated by exercise adherence group.
*Denotes significant difference between Lowest and Moderate and High groups at $P \leq .05$.
†Denotes significant difference between High group and all other groups at $P \leq .05$.
‡Denotes significant difference between High group and Lowest and Low groups at $P \leq .05$.
§Denotes significant difference between High group and all other groups at $P \leq .05$.

analysis revealed that the high adherence group had significantly greater $1RM_{est}$ leg press compared to lowest ($P < .01$; $d = 0.91$), low ($P < .01$, $d = 1.29$), and moderate ($P = .03$; $d = 0.96$). High adherence group also had significantly greater $1RM_{est}$ bench press compared to lowest ($P < .01$; $d = 1.78$) and low ($P < .01$, $d = 1.39$) groups. Additionally, high adherence group had significantly greater shoulder flexion compared to lowest ($P = .05$; $d = 1.05$), low ($P < .01$, $d = 1.24$), and moderate ($P < .01$; $d = 2.09$). Last, the lowest exercise adherence group performed significantly fewer pushups compared to the moderate ($P = .02$; $d = 0.96$) and high ($P < .01$; $d = 1.09$) adherence groups.

No significant differences were found between adherence groups and the following variables: TC ($P = .72$); HDL ($P = .88$); LDL ($P = .55$); TG ($P = .72$); BG ($P = .25$); BF% ($P = .34$); isometric plank ($P = .38$); sit-and-reach ($P = .61$); trunk extension ($P = .79$); vertical jump ($P = .06$); and estimated VO_{2max} ($P = .06$). See Table 3 for complete information on all tested variables.

Discussion

The purpose of this study was to investigate the impact of adherence to departmental fitness policies on firefighters' fitness outcomes in a rural fire department. There are no published adherence rates to the exercise policy among rural firefighters in departments that recommend or require mandatory exercise training with each shift. While the NFPA does not have a policy requiring exercise while on duty,[11] the studied department recommends that all firefighters obtain 45 minutes of exercise per 24-hour shift. This policy falls in line with existing research that confirms the positive effects of exercise on improving health and fitness outcomes associated with superior job performance and reduced risk of injury and cardiovascular disease among firefighters.[15] While the studied department has an exercise policy, very few (12.5%; n = 5) of firefighters studied complied with the

department's fitness policy of a minimum 75% adherence rate.

Although a lack of support from administration may inhibit the success of physical fitness initiatives,[16,17] it is important to note in this sample fire department the exercise policy was encouraged and advocated by administration, including Fire Chief, Deputy Chief, Assistant Chief, and Battalion Chief/Health and Safety Officer. Additionally, the administration staff advocated for physical activity time on-duty and, anecdotally, were consistent gym users. Physical activity benefits are well documented, and even as little as 30 minutes of moderate-intensity exercise can have a cascade of positive health impacts.[18]

Based on the finding of a low adherence rate across the department, it is suggested to incorporate a reward system at the individual and team levels to encourage making physical fitness a priority while on shift. Commanding officers should consider providing the flexibility of required physical activity time, which may help increase adherence among on-duty personnel. Additionally, commanding officers may need to incorporate personal fitness into annual performance reviews for the firefighters, again highlighting the importance of the individual and the mission of the fire department.

Since the field of fire science has a hierarchical role of leadership, it may be key to propose that commanding officers actively engage as change agents, who frame and make sense of the change with on-duty firefighters, which can reduce resistance to implementation or enforcement of an exercise program.[19] Furthermore, Putman suggests a multilevel approach to workplace wellness, including support at the top levels and mid-level and entry levels to promote wellness.[16] The key to change health behaviors is to make exercise an easy choice and not a perceived barrier to their health. Although many firehouses are not outfitted with a gym or fitness center, it is more feasible to equip bays with fitness equipment that individuals or small groups can easily utilize.[19]

Although several outside risks come with firefighting, leading causes of death and injury may be preventable with the proper exercise training. High levels of muscular strength are required in conditions where firefighters are expected to carry heavy loads (upwards of 68 kg).[20] It was evident from this study that those who engaged in routine exercise had significantly better fitness outcomes than their less active peers. Most of the differences in muscular strength and endurance were seen in the upper body. Traditionally, firefighters have exhibit natural lower body strength due activities job tasks of lifting, stair climbing, pulling hose, and other activities, which may explain why there were limited differences in lower body values, despite increased exercise adherence.

Along with muscular fitness, the increased demand on the cardiovascular system during active fire suppression can strain the body and be a precursor for injury if the firefighter is not properly conditioned for action.[21] While no significant differences were noted between adherence groups in the current study, the average VO_{2max} of the firefighters tested was ~41.0 mL/kg/min. This average falls ~7% under the NFPA recommendation for ideal firefighter cardiorespiratory fitness (44.0 mL/kg/min). Additionally, only 27.5% (11 of 40) of the firefighters in the tested population had an estimated VO_{2max} that met NFPA recommendations. The average firefighter in the sample population fell into the fitness consultation recommendation under NFPA guidelines.[11] The importance of cardiovascular fitness is critical for successfully completing job-related tasks,[22] and it appears that increased emphasis on cardiovascular fitness may be of benefit for the firefighters tested.[23] While this may indicate that this department is lacking proper cardiorespiratory fitness, it is worth noting that previous research revealed that the Gerkin protocol overestimated VO_2 among firefighters.[21] This methodology for estimating VO_{2max} was chosen as it is the preferred method of the NFPA. Furthermore, this firefighter sample had an average body fat percentage of 26.4%. This percentage indicates that a majority of this population were overweight or obese, according to NSCA guidelines.[12] Cardiovascular training can decrease body fat and improve health variables such as resting heart rate, blood lipid profiles, and blood pressure. Physical activity requirements and policies could be an advantage to help firefighters maintain and improve their cardiovascular fitness.

Finally, this study's sample department did adhere to all the NFPA wellness guidelines plus added a required 45-minute physical activity policy for on-duty firefighters. The policy might not have been received as a requirement, but it may be perceived as a protected time for those who wanted to engage in physical activity.[24] Although fire departments may have physical activity time for on-duty firefighters, no evidence was found regarding the repercussions of not meeting that requirement. Why firefighters did or did not participate was not explored in this study; however, it is recommended for future research to delineate through qualitative research the barriers and motives with departmental policies.

Limitations of the Study

There were several limitations to this study. First, the attendance records were based on a self-reported sign-in sheet posted in the gym area. It is possible that firefighters chose not to or forgot to sign in and out on each occasion. Some firefights may have taken time off or worked additional shifts during the 9-month period, which may have decreased or increased their true adherence rates. Additionally, just because the firefighter did sign in, there was no guarantee they engaged in an appropriate workout. However, despite these concerns, the investigators maintain confidence in using these attendance records. Second, the fitness data were collected on a single day of testing, in which a firefighter might not

have given a maximal effort. However, proper instruction and motivation were provided during all physical tests to minimize the chance that firefighters did not give a maximal effort during testing.

Implications of the Findings

This study was the first to document the adherence rates of an individual rural fire department's fitness policies. Results from this study indicated that firefighters who complied with the fitness policies were more physically fit than those that did not. However, despite full support from the administration, only 12.5% (n = 5) of firefighters from this study adhered to the fitness requirements. Wellness professionals working with fire departments might also include some internal rewards to an incentive exercise program for the employees.

Declaration of Conflicting Interests

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Ethical Approval

This study was approved by the Georiga Southern University's institutional review board, H19098.

Informed Consent

Not applicable, because this article does not contain any studies with human or animal subjects.

Trial Registration

Not applicable, because this article does not contain any clinical trials.

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