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Impact of an 11-Week Strength and Conditioning Program on Firefighter Trainee Fitness

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Abstract: Physical fitness is an important aspect of physical health and wellbeing. The aim of this study was to investigate the effects of 11-weeks of formal strength and conditioning training conducted during fire academy training on the physical fitness characteristics of firefighter trainees. Archived physical fitness data for 23 male fire academy trainees (age: 27.6 ± 4.3 y; height: 178.5 ± 6.9 cm; body mass [BM]: 83.9 ± 1.8 kg; BM index [BMI]: 26.8 ± 2.8 kg/m^2) were analyzed for this study. These data included vertical jump height, maximum pull-up repetitions, hand grip strength, lower-body strength (3RM Hexbar) and aerobic fitness. Trainees performed three sessions per week (two resistance training sessions and one aerobic conditioning session) in addition to fire academy training. A repeated measures ANOVA revealed significant ($p < 0.05$) pre-post decreases in BM and BMI and significant increases in upper- and lower-body strength, and aerobic fitness. Strength and conditioning programs are beneficial for improving firefighter trainees' physical fitness even when run concurrently with fire academy training and with limited space and equipment. This increased fitness may aid in mitigating known occupational injury risks to this population and improve task performance.

Keywords: wellbeing; tactical; fitness testing; health; exercise

1. Introduction

As part of their normal occupational duties, firefighters perform physically and cognitively demanding work while enduring extremely high temperatures (i.e., 155 °C or greater) [1]. These professionals must respond effectively and efficiently in these high-stress and austere working environments to preserve personal safety and protect life [2]. Many tasks performed by firefighters, such as carrying heavy tools, victim rescues, pulling objects upwards, and working with heavy objects that may exceed 60 kg, require adequate levels of strength and muscle endurance if they are to be performed safely and successfully [2–4]. While performing these tasks, firefighters must wear personal protective equipment (PPE) that can weigh upwards of 22 kg to maintain personal safety [1,2]. This load significantly increases their physiological burden, and as such aerobic fitness requirements, when performing these tasks [5]. Due to the complex demands and the dynamic physiological requirements of this occupation, attaining and maintaining an adequate level of physical fitness is of importance in firefighter populations [2,4,6,7]. This requirement is further made evident given that musculoskeletal injuries in the firefighter's workplace are most often caused by 'muscle bending, lifting and squatting, or muscle stressing' [8].

Relationships between physical fitness and firefighting performance have been reported in the literature. Rhea et al. [6] reported strong correlations between performance on firefighting specific tasks and upper body strength ($r = -0.66$), upper body muscular endurance ($r = 0.61$–0.71), lower-body strength endurance ($r = 0.47$) and anaerobic fitness ($r = 0.79$) [6]. In addition, Michaelides et al. [7] found that successful performance in simulated firefighting tasks was significantly related to vertical jump (VJ) height ($r = -0.44$, $p < 0.01$), isometric abdominal strength ($r = -0.53$, $p < 0.01$), upper-body and trunk muscular endurance (push-ups, $r = -0.27$, $p < 0.05$, sit-ups, $r = -0.41$, $p < 0.01$), and upper-body strength (1 repetition maximum (RM) bench press, $r = -0.41$, $p < 0.01$) [7]. These researchers also discovered that both fat mass and body mass index (BMI) were positively correlated to completion times on simulated firefighting tasks. In other words, as fat mass and BMI increased, firefighters required a longer duration of time to complete the measured tasks. In a profession where time literally can mean the difference between life and death, these findings are of significant importance to fire agency instructors responsible for developing training programs aimed at improving the health, fitness, and performance of firefighters.

While muscular (e.g., strength and endurance) and anaerobic fitness (i.e., short bouts of high-intensity activity) are critical components of performance, the need for aerobic fitness in firefighting cannot be overlooked. Previous research conducted by Gledhill and Jamnick [4] reported that, to successfully complete strenuous firefighting tasks, a mean oxygen uptake (VO_{2max}) value of 41.5 mL/kg/min was necessary [4]. This value equated to a cardiorespiratory demand of approximately 85% of maximal oxygen uptake (VO_{2max}) for the firefighters participating in their study, with the majority of work being performed at 23 mL/kg/min (approximately 50% VO_{2max}) [4]. Research by Johnson et al. [5] also provides further evidence on the need for aerobic fitness as they reported average maximum heart rates (MHR) ranging from 85 to 102% of the firefighter's age predicted MHR when performing training evolutions [5]. These values for cardiovascular fitness continue to serve as baseline fitness values by most fire agencies and support the need for aerobic fitness within firefighting populations.

Based on the aforementioned literature, it is evident that firefighting requires a unique combination of muscular, anaerobic, and aerobic fitness in order to have a sufficient work capacity and resistance to fatigue when performing essential job tasks. For example, a seminal study by Davis et al. [9] investigated the potential relationship between standard neuromuscular performance measures, physiological measures, and performance on firefighting tasks. The standard neuromuscular performance measures included grip strength, sit-up repetitions in 2-min, chin-ups and push-ups to exhaustion, standing long jump, and the Wells and Dillon hamstring flexibility test. The physiological measures included systolic and diastolic blood pressure, pulse pressure, fractional heart rate, 5-min step test, and the Balke treadmill test protocol. Lastly, the firefighting tasks included a ladder extension, standpipe carry, hose pull, simulated rescue, and simulated forcible entry. These authors reported that the average within-task heart rates indicated that near maximal aerobic efforts were required to perform these tasks. It was discovered that the main predictors of physical work capacity in the simulated firefighting tasks were MHR, sit-ups, grip strength, and submaximal oxygen pulse ($r^2 = 63$). Furthermore, the tests that best predicted ($r^2 = 39$) resistance to fatigue were lean body mass, MHR, final treadmill grade, and body fat. For these reasons, developing muscular strength, endurance, and aerobic fitness, as well as maintaining healthy body composition levels, are critical for improving work capacity within these populations.

There is a paucity of research that examines the ability of a structured strength and conditioning program to bring about changes in the aforementioned components of fitness among firefighter trainees. Cvorovic et al. (10) investigated the effects of a 4-week physical training program, emphasizing high-intensity intermittent training and high-intensity functional training, on the physical fitness and body composition of professional firefighters. Significant improvements in upper-body strength, as measured by chin-ups to failure, ($p = 0.021$) and estimated VO_2 max ($p = 0.012$) were reported. However, no significant changes were observed in body mass, BMI, standing long jump, 50 m speed performance, grip strength, lower-back and hamstring flexibility via the sit and reach test, or a 1 min push-up and sit-up test. While significant improvements were not observed in all aspects of fitness, the hort-term improvements observed in upper body strength and aerobic performance are encouraging when minimal blocks of training time are available, such as during fire academy.

Fire academy training provides an ideal environment to educate and train incumbent firefighters on proper exercise regimes as well as exploring their individual needs regarding their personal levels of fitness. This reinforces the purpose of fire training academy, which is to prepare trainees for the rigors of performing fire suppression tasks across the duration of their careers. While prior evidence suggests the importance of physical training programs and their effectiveness in improving trainee physical fitness in first responders [10,11], little research has investigated the effects of specific physical training programs among firefighter trainees [12]. Furthermore, often the limitations during academy training (e.g., time and access to strength and conditioning equipment) present challenges for both the trainer and trainee. Therefore, the primary aim of the present study was to determine baseline physical fitness in firefighter trainees and assess potential physiological changes throughout an 11-week firefighter academy training period. This information may be of value to agencies with limited resources (i.e., budgets, exercise equipment and time) in the development of physical training programs to improve health, fitness, and performance among firefighter trainees, as well as part–time and full-time firefighters.

2. Materials and Methods

A retrospective cohort analysis of fire academy trainees from a firefighting agency located in the USA was utilized for this analysis. In order to compare physical changes after 11-weeks of training in a 16 week fire training academy, various anthropometric and performance measures were assessed at weeks 4 and 15. Based on the structure of this academy, trainees performed only classwork for the first five weeks of training, and began physical training sessions at week 5. Academy training consisted of a 4-day per week schedule (three, twelve-hour days and one four-hour day) with trainees participating in formal physical conditioning twice per week under the supervision of at least one Certified Strength and Conditioning Specialist (CSCS) and one day per week focused on aerobic conditioning (i.e., long, slow distance running up to approximately 3 miles) with members of the cadre.

2.1. Subjects

Archived data for all 23 of the male fire academy trainees (age: 27.6 ± 4.3 y; height: 178.5 ± 6.9 cm; body mass: 83.9 ± 1.8 kg; BMI: 26.8 ± 2.8 kg/m^2) who completed training at the academy were analyzed for this study. Prior to the release of this data, all subjects signed an informed consent allowing release of this data to the senior investigator. Furthermore, prior to the commencement of this study ethics approval was granted by a university Institutional Research Board (IRB 17-227).

2.2. Procedures

For both pre- and post-testing, trainees reported to the firefighting training academy at 0730. All assessments were conducted at the same firefighter training academy location and were completed at the same time of day by the same testers. Anthropometric and performance measures were taken in the following order: height, body mass, BMI, vertical jump height and lower-body power with a VJ, upper-body muscular strength (pull-up), grip strength with a handgrip dynomometer, lower-back and leg strength with a leg/back dynomometer, and aerobic fitness with a 20 m multi-stage fitness test (20MSFT).

Height, Body Mass, and BMI—Height and body mass (BM) were measured using a portable stadiometer (Seca, Chino, CA, USA) and portable digital scale (Health-O-Meter, McCook, IL, USA).

All height measurements were rounded to the nearest centimeter, whereas all BM measures were rounded to the nearest tenth of a kg. Using this information, BMI was calculated using the following equation: BMI = body mass (kg)/[height (m)]^2. BMI classifications provided by the National Institutes of Health [13] were used to categorize trainees' potential health risk.

VJ—The VJ was conducted using a Just Jump electric contact system (ProBiotics Inc., Huntsville, AL, USA), which has been previously utilized in tactical populations [14]. The Just Jump Mat system (Probotics, Huntsville, AL, USA) calculates vertical displacement based on flight time. Trainees were instructed to step onto the center of the mat with their feet placed hip to shoulder width apart. Trainees then jumped as high as possible using a counter movement jump with arm swing. Trainees performed two jumps with approximately 10 s rest between each attempt. The best of the two jumps was recorded in inches then converted to metric units (i.e., centimeters) for analysis. During analysis, VJ height was converted to power using the following equation by Sayers et al. (PAPw = (60.7 × VJ Height (cm)) + (45.3 × Body Mass (kg)-2055) [15].

Maximal Pull-up Repetitions—A maximal pull-up repetition test was utilized to measure upper-body muscular strength among the trainees. Trainees began this test by hanging from the top bar of a quad pull-up station, with the arms extended, and the hands wrapped around the bar in an overhand position approximately shoulder width apart. Trainees were then instructed to flex their arms and pull their body upward until their chin was above the bar. After each pull-up was completed, the trainee was required to return to the starting position before performing the next repetition. The trainees' final score was the maximum number of pull-ups that could be completed with good technique and form (no swinging, kicking, or bending of the knees was allowed for the repetition to count). Trainees were allowed to rest at the beginning of this exercise movement, with the arms fully extended. The test was terminated when they were unable to maintain proper technique or reached volitional fatigue. The total number of repetitions performed with correct technique was recorded as the final score for this test.

Handgrip Dynomometer—Grip strength was measured for each trainee using a handgrip dynamometer (Takei Scientific Instruments, Niigata, Japan). All assessments were conducted in accordance with previously established guidelines [16]. Prior to the test, the dynanometer was adjusted for each trainee so that the second joint of the fingers of the hand being assessed fit under the handle. Trainees were then instructed to hold the instrument down to the side of, and in line with, their body without contacting their hip or thigh. The trainee then squeezed the dynamometer as hard as possible for up to three seconds. Two attempts were performed with each hand in alternating fashion, with approximately 60 s of rest between trials with the same hand. The best scores for both right and left hands were recorded to the nearest kilogram and used for analysis.

Lower-body strength—Lower-body strength was measured using a three-repetition maximum (3RM) high-handle hex bar deadlift using the multiple repetition max protocol as outlined by the National Strength and Conditioning Association (NSCA) [17]. Trainees were instructed to perform three warm-up sets of 3–5 repetitions, progressively increasing the load until they worked up to their first 3RM attempt. Additionally, trainees had a maximum of five attempts (or load increases) to reach their 3RM [17]. When ready to test, the trainees were instructed to lift the bar from the ground to a standing position, lowering the bar to lightly touch the ground between repetitions. The testing was observed by a CSCS who assisted with weight adjustments after each attempt. If any technique issues were observed during an attempt, such as rounding of the back, the test was terminated for safety reasons. During analysis, 1 RM estimations were calculated using the Brzycki equation (Weight ÷ (1.0278 − (0.0278 × Number of repetitions)) [18]. Relative strength was also calculated by dividing the trainees' estimated 1RM by their BM [13].

20MSFT—Aerobic capacity was measured using the 20MSFT. This test has been used to measure aerobic capacity in other tactical populations [19,20]. Trainees were instructed to run a 20-m shuttle keeping pace with a recorded audio track of beeps. The test started at 8.5 km/h and increased in speed by 0.5 km/h for every stage, with the beeps getting concomitantly quicker. If the trainee did not make it to the line two subsequent times before a beep, or they reached volitional fatigue, the test was terminated. The final shuttle stage and shuttle level (number of shuttles per stage) were converted to total number of shuttles completed for the purpose of data analysis. These scores were also used to estimate aerobic fitness (i.e., VO_{2max}) using the equation developed by Ramsbottom et al. [21].

Training Program—Two CSCSs and the firefighter training cadre collaborated to design and implement the training program. The training schedule for the academy consisted of three 12-h days and one 4-h day with 75 min of formal physical training on two of the days (Table 1). The formal training consisted of a dynamic warm-up (~10–12 min), agility training (~7–8 min), speed and power training (~3–4 min), hypertrophy/strength training (~30–35 min), trunk, mobility and conditioning (~5–10 min), and a cooldown (~5 min). The trainees also performed an aerobic fitness session, interspersed with callisthenic exercises, as a group, once per week for approximately one hour. It is important to note that the resources available for formal physical training were limited. This is a common challenge when working with tactical populations. For this study, only dumbbells and sandbags (weight range 4.5–29.5 kg), two TRX suspension training systems, and a quad pull-up station were available to provide external loading. Manual resistance (MR) provided by an exercise partner was also used to overload specific bodyweight exercises, such as the push-up. A metal picnic table with three benches and two weight benches were also used by the trainees to perform many of the single-leg) exercises (e.g., front and lateral, step-ups, Bulgarian squats, etc.) featured in this program (Table 1). An alternating push–pull, upper–lower body exercise rotation was used to ensure undue fatigue between stations was not a factor based on the design of the circuit.

Table 1. 11-Week Firefighter Strength and Conditioning Training Program Outline.

1. Basic Program Design							
Resistance Training				Aerobic Conditioning			
Duration	Frequency	Intensity	Volume	Duration	Frequency	Intensity	Distance
60 min	2×/week	67–83% of 1RM	3 sets 6–12 reps	45–60 min	1×/week	Low-High	~5 km
2. Organizational Structure							
4 trainees/group		7 stations		3 min/station	1 min transition	Total: 32 min	
3. Equipment							
Sand Bags		Dumbbells	TRX		Squat Rack	Weight Bench	Park Table
4. Basic Approach							
Unilateral Training		Manual Resistance		Focus on Strength/Power		Injury Prevention	
5. Exercise Stations with Sample Exercises							
Mobility	Lower-Body Pull	Lower-Body Push		Power	Upper-Body Pull	Upper-Body Push	Core
-Groiners -SL Balance w/Reaches -Goblet Squats	-DB RDL -SL DB RDL	-Bulgarian Squats -Step-up Variaitons		-DB Push Press -Vertical Jumps	-Chin-ups -TRX Rows -DB Rows	-MR Push-up Variations -Lat Raise	-Pikes -Flutter Kicks -Plank Variations

Exercise Abbreviation Key: DB: Dumbbells; MR: Manual Resistance; RDL: Romanian Dead Lift; SL = Single Leg.

2.3. Analysis

Following descriptive analysis, a repeated measures ANOVA was used to determine if significant changes in anthropometric and performance factors occurred over the 11-week academy period. Results were analyzed using the Statistics Package for Social Sciences (SPSS) (Version 26.0; IBM Corporation, New York, NY, USA). Effect sizes (*d*) were also calculated to determine the smallest worthwhile difference between the means. In accordance with Hopkins [22], a *d* less than 0.2 was considered a trivial effect; 0.2 to 0.6 a small effect; 0.6 to 1.2 a moderate effect; 1.2 to 2.0 a large effect; 2.0 to 4.0 a very large effect; 4.0 and above an extremely large effect. All statistical analyses for pre- and post-test measures were set at a priori $p \leq 0.05$.

3. Results

The results of the descriptive analysis (Mean ± SD) are presented in Table 2. The results of the repeated measures ANOVA identified significant changes from pre-to-post academy for BM, BMI, pull-up, lower-body absolute strength, lower-body relative strength, and 20MSFT. All other measures were not found to be significant. For significantly different changes, effect sizes ranged from small (BM, Pull-up and HexBar 1RM) through moderate (HexBar relative) to large (BMI and 20MSFT).

Table 2. Differences in selected fitness measures after 11-w training program.

Measure	Pretraining	Posttraining	*p* Value	*d*
Body Mass (kg)	85.9 ± 10.1	83.5 ± 9.3 **	<0.001	0.25
BMI	26.9 ± 2.7	23.3 ± 2.2 **	<0.001	1.46
VJ (cm)	61.2 ± 8.9	61.5 ± 7.1	0.825	0.04
Power (PAPW)	5546.2 ± 582.3	5445.9 ± 549.6	0.052	0.18
Pull-up (reps)	8.83 ± 4.9	11.7 ± 5.1 **	<0.001	0.57
R Hand Grip (kg)	55.8 ± 6.8	53.6 ± 7.8	0.109	0.30
L Hand Grip (kg)	54.3 ± 6.7	52.7 ± 6.9	0.227	0.24
Hex-bar 1RM (kg)	139.6 ± 49.2	159.2 ± 21.7 **	<0.001	0.52
Hex-bar Relative (1RM/Body Mass)	1.6 ± 0.3	1.9 ± 0.2 **	<0.001	1.17
20MSFT Shuttles (#)	41.0 ± 14.2	66.8 ± 16.3 **	<0.001	1.69

** $p \leq 0.01$.

4. Discussion

The aim of the present study was to investigate the impact of an 11-week formal strength and conditioning program, completed during fire academy training, on the anthropometric and physical performance characteristics of firefighter trainees. Significant improvements (e.g., reductions) in both BM and BMI were observed. Moreover, improvements in upper-body strength and endurance as well as lower-body maximal and relative strength were also found in the study. Furthermore, significant improvements were seen in aerobic fitness as measured by the 20MSFT. However, no significant changes were found for grip strength, VJ height, or lower-body power. These results provide evidence that an 11-week strength and conditioning program with minimal resistance training equipment, in conjunction with standard fire academy training, can elicit significant changes in physical fitness among firefighter trainees, and thus in turn prepare them for their careers as fire fighters.

While BMI is considered a crude method of determining health status, it may be useful in identifying trainees that require further exercise and nutrition interventions [20]. It was discovered that after only 11 weeks of participation, both BM and BMI significantly changed and large effect sizes were observed. In fact, the average BMI for trainees in this class dropped their overall classification from overweight (BMI = 25–29.9 kg/m^2) to healthy (BMI = 18.5–24.9 kg/m^2) [23]. These findings may be of significance when seeking to improve firefighter health and wellness, as prior evidence has suggested that the largest mortality event for firefighters was cardiac in nature and increased body mass may contribute to the physiological strain of the cardiovascular system [4,24]. Participation in a training program similar to the one presented in this investigation may help improve health status, thereby reducing a firefighter's risk of developing cardiovascular disease.

VJ height has been shown to correlate to job task performance within firefighting populations [6,7,22]. For example, Sell [25] found that VJ height had the strongest relationship ($r = -0.58$) with simulated firefighting task scenario (SFTS) completion times. In Sell's [25] research it was determined that firefighters able to achieve a VJ height of greater than 17 inches (43.18 cm) were more likely to achieve a passing rate (95.6%) on the SFTS than those that jumped less than 17 inches (46.2%).VJ height has also been associated with increased simulation performance of a rescue mannequin drag ($r = -0.31$, $p < 0.05$) and charged hose advance ($r = -0.28$, $p < 0.05$) [7]. While the present investigation found no significant changes in VJ height or power output, this may have been due to a relatively high initial VJ height score by this trainee class (61.2 cm) when compared to that reported by Sell [25]. This suggests that there may be ceiling effect in this measure and increasing VJ capability beyond a certain point may be more difficult to achieve as an individual approaches their genetic potential. Furthermore, it is also possible that neuromuscular fatigue accrued over the 11-week training program may have impacted acute performance in this test [26]. Future studies should seek to measure VJ height in the weeks following training academy to see if increased restitution from training may yield greater improvements in these measures post training.

Grip strength has been shown to be critical for performing numerous firefighting tasks including hydrant opening, carrying equipment, and hose deployment [27]. In this investigation, no changes in grip strength were observed over the 11-week training period. These findings support those of Roberts et al. [12], who likewise did not find significant changes in grip strength pre- to post-training program in firefighters ($p > 0.05$). Given that the results of this study (right hand grip strength = 55.8 kg) were notably higher than those of Roberts et al. [12] (best hand grip strength = 46.8 kg) who likewise did not find improvements, a ceiling effect may again have been present, whereby trainees, in general, presented with a level of grip strength above that required. Conversely, it is also possible that the training load utilized in this study may not have been sufficient to elicit a significant increase in grip strength given the high initial standards. Future studies should investigate the impact on grip strength when performing firefighter job tasks and attempt to set baseline recommendations for this measure.

Based on the physically demanding and uncertain nature of firefighting (e.g., victim rescue, hydrant removal, fire hose deployment, room breach), muscular strength is of importance within this population. Similar to the findings of Cvorovic et al. [10], significant improvements from pre- to post-test in upper-body strength (as measured by the pull-up to fatigue test) was observed among trainees. These findings are important, as performing heavy lifting and pulling tasks are inherent to this profession [9,21]. Additionally, significant improvements in both absolute and relative lower-body muscular strength in response to the program also occurred. With the limitations in strength and conditioning equipment, these findings are of value to fire departments and agencies with limited resources. These findings also suggest that the use of single-leg and unilateral lower-body strength training can significantly increase bilateral force production when performing lifting tasks. While the back and lower extremities are a leading site of non-fire-related injuries in firefighters and with the mechanism of these injuries often being reported as muscle bending, lifting and squatting or muscle stressing, improvements in absolute lower-body strength may reduce injury risk in this population [8]. This information may be used by firefighters, agencies, and administrators when determining the type of fitness equipment necessary in firehouses or when working with limited budgets.

Aerobic capacity is essential for successful job performance, as well as for reducing the risk of a firefighter experiencing a cardiac incident while on the job [2,4,6,7,12,24,25,28,29]. The present findings are in alignment with the recent meta-analyses conducted by Andrews et al. [24], who reported significant improvements in aerobic capacity ($\Delta = 1.20$, [0.52–1.87] $z = 3.48$, $p < 0.001$) amongst firefighters with exercise training. Based on the average age and number of shuttles completed on the 20MSFT by trainees in this study, the estimated $V0_2$ for this sample would be 42.2 mL/kg/min, respectively [21]. This level of aerobic fitness would meet the minimum recommendations of Gledhill and Jamnick (i.e., 41.5 mL/kg/min) [4]. The traditional focus of aerobic training in tactical occupations has primarily focused on longer, paced-based runs, which are aimed at enhancing aerobic capacity [27]. Prior evidence suggests that a focus on intensity-based interval training may elicit greater enhancements in both aerobic and anaerobic fitness [30] and supports the findings of this study. Trainees in this study only spent ~1 h per week performing long, slow distance training. Thus, a majority of the adaptations observed in this study may have been due to the circuit-based style of the strength and conditioning program that was implemented, as well as those imparted by the firefighting specific skills training performed as part of the academy curriculum [6]. Future research should explore the impact of participation in skills training alone on aerobic fitness among firefighter trainees.

This study was not without limitations. The nature of this study did not allow for a control group. However, based on the need to ensure that trainees are adequately prepared for the job of a firefighter, not training these individuals may be considered unethical. Additionally, the population size, while incorporating the entire completing cohort, is relatively small. However, this is the typical cohort size and as such the findings bear relevance. Further limitations also include the order of tests. While the order of tests was conducted based on best practice to reduce the impact of fatigue, performing all tests in a single session may have a negative effect on performance. Specifically, grip strength is an underlying component of both the pull-up and the hexbar deadlift assessment. It is possible that grip strength may have been impacted by performing the pull-up prior to the grip strength test, which in turn may have impacted on the hexbar deadlift. Additionally, performing the hexbar deadlift and fatiguing the legs prior to the 20MSFT may have impacted on shuttle run performance. Additionally, nutritional and dietary status was not controlled or tracked over the course of the academy, which could influence the rate of recovery for trainees and their training adaptations. However, the results reflect the practical nature of this intervention, as it is not practical to control these elements during fire academy training.

5. Conclusions

The results of this study highlight that fitness can be made in firefighter trainees attending fire academy, even with training academy specific requirements. Furthermore, these changes can be achieved with minimal equipment. Finally, it should be noted that not only was fitness increased but BMI, a measure associated with cardiovascular risk, was improved, thereby aiding in the mitigation of the leading cause of mortality in these future firefighters. These findings can be used by fire agency administration and staff to develop an evidence-based physical conditioning program to enhance fitness and occupational performance of firefighter trainees.

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