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# Training Patterns of Tactical Athletes

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**Training Patterns of Tactical Athletes**

By

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# Training Patterns of Tactical Athletes

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## Abstract

An online survey was administered to determine what physical fitness training tactical athletes are currently participating in and determine training patterns among the tactical athlete community. One hundred two participants from law enforcement (n = 35), firefighting (n = 11), and military (n =54) participated in this study. The first portion of the survey determined the reported occupational requirements for physical fitness training. The second portion of the survey determined the reported frequency, type, and duration of participants' training within the last six months. Participants reported a common focus on cardiorespiratory training (87% of respondents) reportedly averaging 3 (±1.49) days per week for 34.2 (±19.2) minutes per session. Similarly, participants (87%) reportedly engaged in training focused on muscular strength, and muscular endurance for 3 (±1.33) days per week and 39.2 (±20.1) minutes per session. Training in balance and stability, flexibility and mobility, and speed and agility returned the lowest responses in engagement (31%), duration (19.4 (±13.9) minutes per session), and frequency (2 (±1.31) days per week), respectively. Responses reported that physical fitness testing is either never administered or only on an as needed basis. Tactical athletes may benefit from increasing training in balance and stability, flexibility and mobility, and speed and agility.

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## Introduction

Military, law enforcement, firefighting and rescue occupations, referred to as tactical athletes, have demonstrated a high demand of physical fitness. Typically, these professionals endure physically demanding occupational tasks, often in extreme conditions (32). At the start of these careers, tactical athletes endure physically intense initial training to build the foundations for the development of their tactical and technical skills. Throughout their careers, tactical athletes are often tested physically to assess their occupational performance (2,5,26).

Tactical athlete performance is often characterized by occupation-specific tasks and physical fitness standards. Firefighting tends to require the most specific occupational tasks such as: one-arm hose carry, ladder carry and raise, charged hose drag, ladder climbs, weighted sled pull, forcible entry, victim rescue, and equipment carry (4) Conversely, law enforcement and military personnel have similar occupational tasks and generally are required to execute their tasks quickly, often without warning. These tasks include maneuvering rigorous terrain, moving heavy objects, running, jumping, crawling, balancing, climbing, and engaging in combat (29,38) Although many tasks are different across the tactical athlete community, load carriage is a task all tactical athletes have in common. In law enforcement and military, load carriage is characterized by donning body armor or tactical gear and in firefighting wearing protective equipment and a self-contained breathing apparatus (SCBA) (4,18,30) Adding protective equipment has been shown to increase time to complete functional tasks, decrease physical fitness variables such as power and agility, decrease balance and stability, and increase ratings of perceived exertion (17,18,38)

Improving tactical athlete performance has been an area of increasing concern (32) In pursuit of this objective, identifying the physical fitness variables associated with success in performing these occupational tasks has been at the forefront of research to develop new fitness programs as well as evaluate the effectiveness of programs already in place. Many programs have been developed for tactical athletes to improve performance, but it is unclear if these programs are accessible and used by tactical athletes. Therefore, the purpose of this study is to determine what physical fitness training tactical athletes are currently participating in and if a specific occupation is more likely to engage in certain physical activities. Further this study would determine training patterns among the tactical athlete community and identify areas of physical fitness training that are lacking.

## Methods

### *Participants*

The study was reviewed and approved by the Internal Review Board (IRB) at Western Washington University. Out of the 102 surveys, 35 participants were law enforcement, 11 were firefighters, 54 were military, and two did not select an employer classification. Further, 54 of the 102 participants were full-time or active duty, two were part-time or volunteer, one was reserves, 33 were National Guard, 11 were veterans or retirees, and one did not provide their employment status. A total of 91 participants are, therefore, current tactical athletes (CTA) and out of those, 12 participants indicated they are qualified for special operations, 76 indicated they are not, and three participants did not provide an answer.

### *Protocol*

Surveys were disseminated electronically to various wellness coordinators, commanding officers, supervisors, and individual tactical athletes resulting in a total of 102 returned surveys. Participants were recruited through social media advertising, email, and word of mouth to firefighters, law enforcement, military personnel and wellness coordinators. An informed consent form was provided for each participant at on the first page of the survey. Responses were excluded if individuals were under 18 years of age or had experienced any musculoskeletal injury in the last six months that may have prevented them from participating in any physical activity. The survey was composed of several multiple-choice questions and fill in questions. Participants were asked to select their occupation and occupation status. The first portion of the survey determined the occupational requirements for physical fitness training. The second portion of the survey determined the frequency, type, and duration of training of participants within the last six months (Appendix D).

*Analysis*

Survey responses were analyzed in Microsoft Excel (Microsoft, Redmond WA, USA) and IBM SPSS Statistics version 28 (SPSS Inc., Chicago IL, USA). Descriptive statistics were calculated and reported regarding frequency of engagement in various training activities and availability of training opportunities afforded. Chi-square tests were conducted to determine if there military, law enforcement, or firefighting personnel are more likely to participate in running, walking, or lifting weights ($\alpha = .05$).

**Results**

Part one of the survey described employment demographics and employer requirements for physical fitness. See table one for employment demographics.

Table 1: Employment Demographics.[1]

| Employment / Status | Law Enforcement | Firefighter | Military | No Answer (Employer) | Total |
|---|---|---|---|---|---|
| Full-Time / Active Duty | 33 | 10 | 11 | 0 | 54 |
| Part-Time / Volunteer | 1 | 1 | 0 | 0 | 2 |
| Reserves | 0 | 0 | 1 | 0 | 1 |
| National Guard | 0 | 0 | 33 | 0 | 33 |
| Veteran / Retiree | 0 | 0 | 9 | 2 | 11 |
| Special Operations Qualified* | 4 | 2 | 6 | 0 | 12 |
| No Answer (Status) | 1 | 0 | 0 | 0 | 1 |
| Total | 35 | 11 | 54 | 2 | |

Forty-six percent of CTA reported that physical fitness testing is required and their career progression depends on physical fitness testing. Only 7% reported mandatory physical fitness training but also reported their career progression is not impacted on physical fitness tests. Additionally, 33% of CTA reported that physical fitness training is not required but highly encouraged and 14% reported physical fitness training or testing is not required or encouraged. Among the CTA, 25% indicated that physical fitness testing was required on an as needed basis

[1] *Number of Special Operations Qualified are not included in the bottom row total.

or upon initial entry of employment. The remaining responses reported the frequency of physical fitness testing with 14% biannually, 18% annually, 14% every 6 months, 1% quarterly, 3% monthly, 1% other, and the remaining 23% indicated physical fitness testing was never required.

Part two of the survey asked about access to physical activity, chosen physical activities, physical fitness training, frequency of training, type of training, and duration of training. Participants were provided multiple options of physical fitness training that may be available to them and then asked to select every option that applied to them. For 41% of participants, time is reportedly allotted in the workday to pursue physical fitness training. Different facilities are reportedly available for free for 31% of participants, while gym memberships or other resources are reportedly offered at a discounted cost for 22% participants. Twenty-five percent of participants reportedly engage in mandatory training, such as group fitness sessions in comparison to 11% participants who reportedly receive individualized training programs. Two percent of participants reported community involvement such as nonprofit organizations that provide physical fitness training at a discounted or no cost to them (Figure 1).

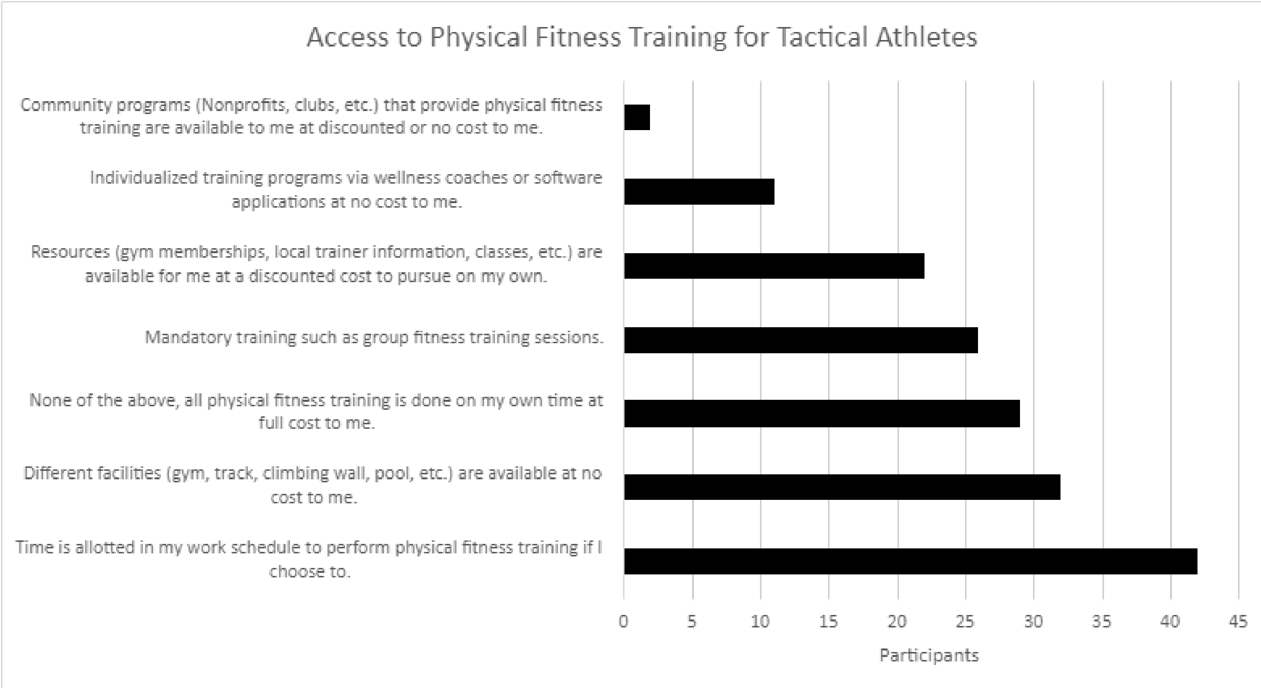


Figure 1: Access to physical fitness training for tactical athletes over the last six months.

Twenty-nine participants indicated no physical fitness training was provided for them and physical fitness training was done during their own time at no discounted cost. Additionally, participants were asked to select all activities they engaged in within the last six months. The six most commonly reported activities for physical fitness were lifting weights (n=76), running (n=69), walking (n=60), indoor cardio (n=51), hiking or rucking (n=44), and high intensity interval training (n=41) (Figure 2).

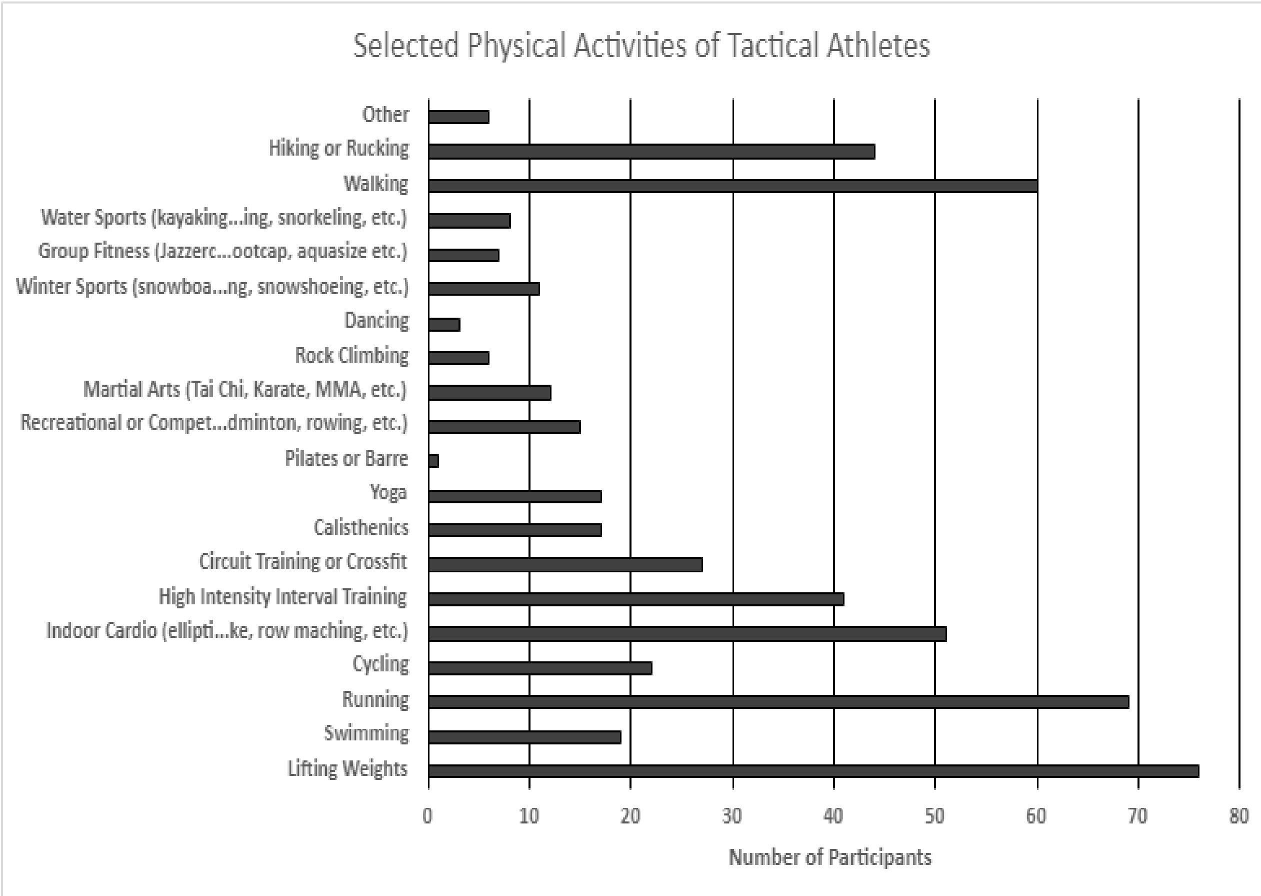

Figure 2: Selected physical activities of tactical athletes over the last six months.

A Chi-square test was executed to determine if employment in law enforcement, firefighting, or military was more likely to select one of the three most reported activities. Results demonstrated there was no statistical significance suggesting that participants were not more likely to select a specific physical activity based on their occupation (Table 3)

Table 2: Occupation by Selected Activities Chi-Square Test.[2]

| | | | Activity | | | |
|---|---|---|---|---|---|---|
| | | | Lifting Weights | Running | Walking | Total |
| Occupation | Firefighter | Count | 7 | 7 | 8 | 22 |
| | | % of Total | 3.40% | 3.40% | 3.90% | 10.70% |
| | Law Enforcement | Count | 30 | 22 | 22 | 74 |
| | | % of Total | 14.60% | 10.70% | 10.70% | 36.10% |
| | Military | Count | 39 | 40 | 30 | 109 |
| | | % of Total | 19.00% | 19.50% | 14.60% | 53.20% |
| | Total | Count | 76 | 69 | 60 | 205 |
| | | % of Total | 37.10% | 33.70% | 29.30% | 100.00% |

| Chi-Square Tests | | | |
|---|---|---|---|
| | Value | df | Asymptotic Significance (2-sided) |
| Pearson Chi-Square | 1.611a | 4 | 0.807 |
| Likelihood Ratio | 1.593 | 4 | 0.81 |
| N of Valid Cases | 205 | | |
| a 0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.44. | | | |

Participants were asked specific details about their physical fitness training over the last six months. This included the type of training, frequency, and duration. In the last six months, 96 participants engaged in physical fitness training an average of 4 (±1.32)-days per week for an average of 57.7 (±24.7) minutes per workout. Further, 39 participants engage in physical fitness

[2] Statistical significance is defined by an Asymptotic Significance of less than 0.05 ($p<0.05$).

training more than once a day an average of 3 (±1.62) -days per week for an average of 51.3 (±29.1) minutes per session. The remaining 63 respondents participated in physical fitness training only once a day within the last six months. Eighty-nine participants performed physical fitness training focusing on cardio an average of 3 (±1.49) days per week for an average of 34.2 (±19.2) minutes per session. For physical fitness training focusing on muscular strength and muscular endurance, 89 participants reported an average of 3 (±1.33) days per week for an average of 39.2 (±20.1) minutes per session. Only 42 performed physical fitness training focusing on explosive power an average of 2 (±1.42) days per week for an average of 28.6 (±17.0) minutes per session. For flexibility and mobility training 55 participated with an average of 3 (±1.53) days per week for an average of 19.4 (±13.9) minutes per session. The smallest participation was in physical fitness training focusing on balance and stability with 32 participants reportedly on average of 3 (±1.69) days per week for an average of 23.9 (±16.9) minutes per session. Fifty-one participants engaged in speed and agility training an average of 2-days per week for an average of 21.8 (±15.4) minutes per session (Table 3).

Table 3: Average current tactical athlete physical fitness training from the last six months.[3]

| Reported Activity | n | % Of Total Participation | Mean (Standard Deviation) of Days Per Week | Mean (Standard Deviation) Duration of Training (min) |
|---|---|---|---|---|
| Workouts Per Week | n = 96 | 94 | 4 (±1.32) | 57.7 (±24.7) |
| More than once a day | n = 39 | 38 | 3 (±1.62) | 51.4 (±51.4) |
| Cardio | n = 89 | 87 | 3 (±1.49) | 34.2 (±19.2) |
| Muscular Strength and Muscular Endurance | n = 89 | 87 | 3 (±1.33) | 39.2 (±20.1) |
| Explosive Power | n = 42 | 41 | 2 (±1.42) | 28.6 (±17.0) |
| Flexibility and Mobility | n = 55 | 54 | 3 (±1.53) | 19.4 (±13.9) |
| Balance and Stability | n = 32 | 31 | 3 (±1.69) | 23.9 (±16.9) |
| Speed and Agility | n = 51 | 50 | 2 (±1.31) | 21.8 (±15.4) |

[3] Percent of total responses, average frequency in days per week, and average duration in minutes for each type of training focus.

## Discussion

The purpose of this study was to determine what physical fitness training tactical athletes are currently participating in and if a specific occupation is more likely to select one of the most reported physical activities. Further, this study determined training patterns among the tactical athlete community and identified areas of physical fitness training that are lacking. Law enforcement officers, military servicemembers, and firefighters were all represented in this study, although not equally. Most participants came from law enforcement and the military, and a small number of participants were veterans or retirees. Few participants indicated they are special operations qualified which indicates the majority of respondents did not have higher physical training expectations. Tactical athletes that are qualified for special operations (i.e. US Army Ranger, SWAT) require high levels of fitness and continued fitness training to perform their occupational requirements (24). Since such a few number of participants were qualified for special operations this suggests the information from this study would be best applicable to the general tactical athlete population.

Physical fitness training and testing requirements were only considered for current tactical athletes. Nearly half of the participants reported that physical fitness testing is mandatory and passing a physical fitness test impacts their career. However, many participants reported physical fitness testing is not required which may decrease consistent participation in physical fitness training. A university study implemented physical fitness training in a health promotion class for criminal justice programs. The study demonstrated increased absenteeism and no attempt to increase fitness test scores by students, which researchers attributed to the inability to tie improved physical fitness test scores to a course grade (11) Twenty-five percent of CTA in the current study that reported physical fitness testing is held on an as needed basis or upon initial entry to their career. Although physical fitness testing upon initial entry may be an incentive to be physically active, it may also hinder recruitment. One solution for a US based law enforcement agency was to change the physical fitness test to facilitate testing more applicants and increase the numbers eligible for their academy(22) This solution may provide more opportunities to supply the hiring demand, but it may also suggest that physical fitness testing may be removed in order to increase eligibility. The reported absence of physical fitness testing is a surprising result of the current study as many organizations require physical fitness testing annually or biannually reported in this study by 18% and 14% of CTA, respectively. Yearly physical fitness testing is more in line with maintaining tactical athlete performance and can be adjusted to replicate occupational tasks. Firefighters in Norway are required to pass a standardized laboratory physical fitness test on a treadmill despite the lack of specificity to practical firefighting. However, a proposed physical fitness test utilized more functional exercises and exhibited energy demands comparable to the existing physical fitness test as well as ventilation and oxygen uptake similar to occupational tasks.(23)

Organizations that administer physical fitness tests, regardless of frequency, may benefit from providing test familiarization opportunities and access to physical fitness training (13) Access to physical fitness facilities, resources, programs, or mandatory trainings were provided for the majority of participants in the current study (Figure 1). The most common provision, for 42 participants, was allotted time in their work schedule to perform physical fitness training if they so choose. However, for 29 participants, physical fitness training was done on their own time with no facilities, resources, or programs available to them. A lack of resources for tactical athletes to pursue physical fitness training may be detrimental to the overall wellness of individuals. Evidence suggests an increased risk for premature death and morbidity due to unhealthy lifestyle behaviors in law enforcement officers. Prevention through wellness counseling enables healthy behaviors to improve physical fitness and nutrition (36)

Participants in this study identified several physical activities they participated in within the last six months (Figure 2). Lifting weights, running, walking, hiking or rucking, indoor cardio, and high intensity interval training were selected the most among participants.

The three most commonly reported activities were not associated to a specific occupation. However, the activities that this study identified fall in line with traditional military practices that focus training on muscular endurance and aerobic capacity (28) Additionally, these activities suggest individuals are receptive to research recommending physical fitness programs focusing on improving muscular strength, muscular endurance, muscular power, and aerobic-anaerobic endurance (13) While a difference separates the rest of the selected activities from the six most commonly reported activities, it is fair to say incorporating different physical fitness opportunities could be advantageous. A study examining burnout in a Mexican police department demonstrated a need for daily sport and recreational activities to diminish stress and burnout (12) Similarly, a martial arts-based high intensity interval training was found to have potential to improve existing physical performance, decrease risk of overuse injuries, and rehabilitate wounded servicemembers (27) Acknowledging individual well-being and providing physical fitness access through various activities to promote physical fitness can improve engagement, decrease exhaustion, and alleviate burnout (12)

Over the last six months, 96 participants engaged in physical fitness training an average of 4-days per week for an average of 57.7 minutes. Additionally, 39 participants reported they engage in physical activity more than once a day for an average of 51.3 minutes per session. This contradicts research that demonstrated firefighters performed physical activity for less than the recommended guidelines put out by the American College of Sports Medicine (ACSM) (1) The current recommendations by the ACSM for adults is engaging in physical activity for 150 – 300 minutes per week of moderate intensity or 75 – 150 minutes per week of vigorous intensity aerobic activity. Additionally, ACSM recommends muscle strengthening activities of moderate or greater intensity for two or more days per week (21)

The majority, of participants (87%), engaged in training that focused on cardiorespiratory fitness, muscular strength, and muscular endurance. A similar study demonstrated the highest rate of respondents participated in resistance training and aerobic activity (16) These findings indicate there is a general understanding that resistance training and aerobic training are related to occupational tasks which then impacts the pursuit or implementation of training (14,31)

When further examining occupational tasks, research has found that explosive power was predictive of performance or injury risk (10,15,30) The current results indicate that 46% of participants engaged in training that focused on explosive power with an average of 3-days per week and an average of 28.6 minutes per session. This lower percentage may be due to a lack of understanding of what types of training constitutes explosive power which could be mitigated through education or coaching.

With the lowest frequency, 50% of participants reported an average of 2-days per week for an average of 22.6 minutes per session, focusing on speed and agility. Despite the lower frequency of training, speed and agility may be impacted by different types of physical fitness activities. One study demonstrated agility was improved after six weeks of yoga practice, which supports the idea of implementing more creative physical fitness opportunities to improve performance (3,34)

Further, 54% of participants engaged in flexibility and mobility training with an average of 3-days per week. However, participants reported spending the least amount of time training in flexibility and mobility with a reported average of 19.3 minutes per session. Flexibility scores have often been used to assess injury risk and tactical performance (6,7,26,30) The results of this survey are encouraging as it demonstrates an understanding among more than half of the participants that there is a need for flexibility and mobility training. In contrast, results of the current study found that only 31% of participants, the least of responses, are engaging in training that focuses on balance and stability. The lower percentage could also be from a misunderstanding of what qualifies as balance and stability training. The average among this 31% was 3-days per week for 23.9 minutes per workout. Balance and stability have been assessed with the functional movement screen and the Y balance test in firefighters (35) Interestingly, it has been suggested that trauma exposure, from either personal experiences or combat exposure, is inversely associated with FMS and dynamic balance scores (37) The nature of these occupations can expose tactical athletes to traumatic experiences more frequently, so balance and stability training would be advantageous to decrease injury risk and improve FMS performance(7,8,19,20,35)

It is important to note that veterans and retirees were invited to participate in this survey as well and their responses were included in these results. While it is beyond the scope of this study, symptoms of post-traumatic stress disorder (PTSD) have been found to be impacted by cardiorespiratory fitness and yoga (9,40)

*Limitations*

As an online survey, the current study has several limitations. The first and foremost was social desirability bias. While participants may have had good intentions, they may have felt a need to bolster or underestimate their responses and increase the frequencies or durations of certain types of training. Similarly, the survey allowed participants to skip a question if they did not wish to, or could not, answer. This created some unknowns in the demographics. Numerical answers that were left blank were assumed to be zero. Another limitation of this survey is the number of respondents. Although all three tactical athlete occupations were represented, the numbers for each were unequal and relatively small. Further demographic information such as age, years in service, or gender could have been asked. These demographics were left out of this survey to ensure a participants identity could not be deduced or assumed from the collected data.

Interpretation of the question or directions of the survey may have altered the way a participant responded. Similarly, limiting multiple responses for their occupation could have altered how a participant responded. For example: a military veteran who may be working as, or training to be, law enforcement or firefighter but answered the survey as a veteran.

**Conclusion**

The results of this study reported a heavy focus on cardiorespiratory, muscular strength, and muscular endurance in tactical athletes. In contrast, training in balance and stability, flexibility and mobility, and speed and agility returned the lowest responses in engagement, duration, and frequency, respectively. Increasing training in these areas may mitigate negative effects on performance from wearing various personal protective equipment (25,33,39) . The most responses reported physical fitness testing is either never administered or only on an as needed basis. Since most participants are allotted time during their workday to pursue physical fitness training, providing greater access to individualized training may increase the use of that allotted time. It may be beneficial to incorporate creativity and personalization to provide training that can increase engagement and achieve transferability to occupational tasks to optimize performance.

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## Appendix A

### Review of Pertinent Literature

Tactical athletes are individuals in military, law enforcement, firefighting and rescue occupations. Typically, these professionals endure physically demanding occupational tasks, often in extreme conditions (36). At the start of these careers, tactical athletes endure physically intense initial training to build the foundations for the development of their tactical and technical skills.

Tactical athlete performance is often characterized by occupation specific tasks and physical fitness standards. Firefighting entails the most specific occupational tasks such as: one-arm hose carry, ladder carry and raise, charged hose drag, ladder climbs, and equipment carry (4). Conversely, law enforcement and military personnel have occupational tasks similar to each other and generally are required to execute their tasks quickly, often without warning. These tasks include maneuvering rigorous terrain, move heavy objects, running, jumping, crawling, balancing, climbing, and engaging in combat (29,40). Although some tasks are different across the tactical athlete community, a few are relatively universal such as forcible entry, victim rescue or body drags, and load carriage. In law enforcement and military, load carriage is characterized by donning body armor or tactical gear and in firefighting wearing protective equipment and a self-contained breathing apparatus (SCBA) (4,17,32). Adding personal protective equipment (PPE) has been shown to increase time to complete functional tasks, decrease physical fitness variables such as power and agility, decrease balance and stability, and increase ratings of perceived exertion (16,17,40).

Recognition of the physical demands on tactical athletes has led to increased interest in improving occupational performance over the last decade (36). Identifying the physical fitness variables associated with occupational tasks has been at the forefront of research. These efforts help to develop new fitness programs, evaluate the effectiveness of exercise programs already in place, and examine the effects of PPE.

*Tactical Athlete Performance Assessment*

The specificity of occupational tasks and the physical tax required demanded these occupations establish physical fitness standards. To uphold these standards, many tactical occupations rely on physical fitness testing to assess a person's ability to perform. Physical fitness testing is commonly comprised of field tests. To validate the use of physical fitness testing, one study aimed to determine whether assessments in a physical fitness test were redundant. A pushup test sit-up test, 75 m pursuit run, maximal revolutions on an arm ergometer, and a 2.4 km run were analyzed. Results from this study demonstrated limited relationships between the physical fitness tests. This suggests that the physical fitness tests are distinct from each other and therefore not a redundant assessment. It should be noted, this study only compared measurements within one specific physical fitness test and not in comparison with occupational tasks (6).

Since physical fitness testing is often used to assess and maintain standards, occupational performance is assessed through specific and separate tests. Measuring occupational performance specifically is achieved with occupational physical ability tests (OPATs) which are designed to mimic real life scenarios or tasks (24). To effectively improve performance elucidating the relationships between physical fitness parameters and OPATs was necessary. Identifying the physical fitness parameters that best predict OPAT performance has been studied frequently. In some cases, studies aimed to identify fitness variables predictive of performance for specific OPATs. An example of this, the work sample test battery (WSTB), a specific OPAT to the state of California, was examined in conjunction with a fitness test to identify variables predictive of performance. Aerobic capacity, muscular strength, muscular endurance, and anaerobic capacity were strong predictors of task performance in the WSTB (22). Similarly, a study examined the warrior task simulation test (WTST) for the United States Army (USAR). This study found nearly the same results but also identified body fat and agility as strong predictors of performance in the WTST (14).

Not every organization or location has a specific OPAT at their disposal. Studies have still demonstrated a relationship between physical fitness variables and occupational performance by designing OPATS to be completed for time and compared to physical fitness tests. One study designed a timed OPAT and found that aerobic capacity, trunk muscular endurance, and anaerobic power predicted OPAT performance. Additionally, subjects of this study with higher OPAT scores demonstrated higher physical fitness scores when compared to those with lower OPAT scores, further emphasizing the relationship between physical fitness variables and OPAT performance (11). Similarly, another study found muscular strength, anaerobic capacity, and muscular endurance were predictive of OPAT performance. Instead of traditional field tests this study used free weight exercises for maximal repetitions with weight associated to occupational tasks. Although the methodology differed, this study still found statistically significant results suggesting muscular endurance is a predictor of OPAT performance (34). Additionally, this study found that body composition had little relevance to occupational performance. Conversely, a separate study found body composition was correlated with OPAT performance in addition to the demonstrated relationship between muscular strength, muscular endurance, and OPAT performance 14 This study administered physical fitness testing and an OPAT consisting of six occupational tasks and found significant positive correlations between a high resting heart rate and body composition measurements. Body fat percentage was the strongest predictor of OPAT time, with the higher body fat percentages correlating with the slowest OPAT times suggesting excess body fat hinders occupational performance. Using a regression model to predict OPAT performance, another study unsurprisingly found muscular strength and endurance, and low body fat percentage as predictors of OPAT performance. Interestingly, this study also demonstrated that flexibility, body composition, and muscular strength improved the predictive power of the regression model used in that study. Improved scores in these variables were indicative of improved OPAT performance (27). In a separate study, body mass, waist circumference, and abdominal circumference positively correlated to specific OPAT tasks but not overall OPAT time. These findings were accompanied by significant correlations between agility, aerobic endurance, muscular strength, and muscular endurance with specific OPAT tasks. Interestingly this study found that age was positively correlated with slower OPAT times suggesting physical fitness maintenance is essential as tactical athletes age (2).

Physical fitness testing in the tactical athlete community lends itself to more than just performance evaluation. In a retrospective cohort study, 113 male soldiers participated in physical fitness testing and after baseline testing went on to develop injuries. After the regression analysis, low anaerobic power and poor static balance scores were strong predictors of injury (28). This study did not use an OPAT as part of the baseline assessments, however OPATs can also be used when assessing injury risk. An example of a specific OPAT is the Functional Movement Screen (FMS) used by firefighters. The FMS is a test designed to identify any dysfunction in movement via seven mobility tasks and can be used to evaluate performance and identify injury risk (1,7,8,39). As an example, one study examined the physical fitness variables and the FMS in firefighters to assess injury risk. This study found that scores less than 14 from the FMS along with sit and reach flexibility scores were predictive of injury, suggesting that low movement scores from the FMS indicated compensation during the movement. The specific movements in the FMS associated the most with injury were the deep squat and the pushup (5). While the FMS may be a practical test to determine injury risk, it may not be fully dependable. A meta-analysis reviewed the effectiveness of the FMS as a predictor of injury and found the magnitude of the effect was small. Due to this, the meta-analysis suggests not using it as a sole predictor (20). Physical fitness tests, therefore, could be a useful accompaniment with the FMS for predicting injury.

Further, to achieve injury prevention and optimal performance physical fitness, testing has been used to develop exercise prescription. Observation of Special Weapons and Tactics (SWAT) training implicated upper extremity strength, cardiovascular fitness, trunk rotation, explosive power, and flexibility were all physical demands of the officers (32). Physical fitness measures based on the observed attributes were measured to optimize fitness prescription. Results demonstrated the average physical fitness scores for the group compared to the average population placed them in the 60th percentile for $VO_2$max, over the 90th percentile in the leg press, and 85th percentile in the bench press. Within the group six of the eleven subjects reached the 50th percentile for in the vertical jump for power. The flexibility scores were varied among individuals with only six scoring a good or excellent in the sit and reach. This study recommended exercise prescriptions focusing on aerobic capacity, leg power, muscular strength, and flexibility to optimize performance. Despite the observational nature of this study, understanding how tactical athletes currently perform allows for more exercise prescriptions to form and develop.

*Load Carriage*

Tactical athletes may carry loads of up to 70% of body weight which can directly affect occupational capability (13). Physical fitness testing to assess occupational proficiency should therefore include load carriage. Investigating how load carriage affects physical fitness attributes associated with occupational performance has been the purpose of several studies. In one such study, nineteen law enforcement officers volunteered to perform physical fitness tests with and without PPE, a load difference of 8.3 kg, to determine the effect of PPE on physical fitness variables. Subjects performed a trunk isometric test, standing long jump, countermovement jump, fixed bar isometry test, the Illinois agility test, the Fletcher test, a maximal progressive treadmill test, and a squat jump in a crossover design. Although this study did not include an OPAT, subjects wearing PPE demonstrated a decrease in cardiorespiratory performance, muscular strength, power, and agility (23). A separate study also found decreased performance while wearing PPE. Eleven soldiers were tested in five different conditions of protective equipment, from no armor to full coverage of the extremities. Participants completed walking and running $VO_2$ testing as well as maximal performance tests consisting of box lifts, 30-m rushes, and obstacle course runs. The $VO_2$ measurements in this study were similar between armor and no armor conditions for both walking and running, however, adding extremity armor significantly decreased $VO_2$ measurements. Scores for the box lifts and obstacle course were significantly lower with PPE in comparison to no PPE and the worst scores occurring with the greatest amount of coverage (12). This suggests that with body armor alone there is not a significant impact, but the more PPE added to the body the more tactical performance is degraded.

Interestingly, one study found that predictors of performance changed when adding PPE. Thirteen police officers performed physical fitness tests and completed an OPAT for time with and without PPE. Without PPE, this study demonstrated agility and standing long jump were positively and negatively correlated with OPAT time respectively. Adding the PPE results indicated relative $VO_2$max, standing long jump and the counter movement jump were negatively correlated to OPAT time in addition to a positive correlation with agility (24). This suggests load carriage needs to be considered when selecting physical fitness tests to accurately predict occupational performance. Further examining the impact of PPE on occupational performance twenty-seven officers volunteered to take their OPAT in uniform with their PPE, a load difference of about 9.4 kg. Dutch police officers routinely take this specific OPAT, in plain gym clothes, to determine their physical fitness. Although familiar with the OPAT, participants were an average of 14 seconds slower and reported a higher RPE while wearing their uniform. This study inferred that while wearing the full uniform performance were potentially hindered by lower mobility, additional load, and heat strain (18). In a separate study, a sprint test was designed to mimic an explosive military task in order to determine the effects of wearing body armor on the task performance. Although not a full OPAT, the specificity of the test could lend support to occupational proficiency. Seventeen soldiers completed five 30-meter sprints with and without body armor. Participants began in a prone position and split times were taken during each sprint at the 5, 10, 15, and 20-m marks. Overall sprint times for the full 30 m increased by 31.5% with the addition of body armor. Results demonstrated that the body armor has the greatest impact within the first 5 m., when the participant must get up from the prone position suggesting a decrease in mobility and power (21).

In addition to decreasing performance, load carriage has demonstrated an impact on balance. A common laboratory assessment of balance and postural control is the measurement of center of pressure (COP) excursion. The COP is the center of distributed force on a surface; in the case of balance, those forces are the ground reaction forces of acting on the plantar surface foot (3,30). Common measurements of COP excursion include mean sway velocity, sway path, root-mean-square (RMS) amplitude and velocity, maximum and minimum sway amplitude and mean sway amplitude. A common field test for balance is the Star Excursion Balance Test (SEBT), a multidirectional dynamic balance test (35). The SEBT protocol requires the participant to balance on one leg and maximally reach with the other in eight separate directions for several recorded trials. Utilizing these measurements, the effects of load carriage was examined in twelve college students under three different conditions (41). The first was a control condition with no load carriage and two loaded conditions each with a different, but standard, sized SCBA as well as thermal protective clothing. Each condition measured antero-posterior and medio-lateral range, distance of COP travel, and mean velocity of COP for a baseline trial and after a fatiguing protocol. This study found no significant changes when comparing baseline measurements for all three conditions, however, significant results did occur after the fatiguing protocol. After the fatiguing task, both load conditions demonstrated significant increases in the medio-lateral range, while the larger SCBA resulted in significant increases in distance and velocity. Results also showed significant increases for both load conditions in the antero-posterior range and again the larger SCBA showed significant increases in distance and velocity. These results demonstrate increased postural sway and aggravated postural stability suggesting more rapid and frequent adjustments while stressed. However, the significance in the results could be due to the inexperience of the college students and their unfamiliarity with the load carriage that firefighters are accustomed to.

While stress has been shown to degrade capabilities, it is often overlooked (13). In many cases, fatigue is the common stressor, and one study demonstrated the cognitive repercussions. Using the NeuroCom Smart Balance Master (NC), twenty Army and Air Force ROTC cadets completed six separate conditions (25). Each condition was performed with a different sensory modification meant to disrupt balance as well as cognitive testing before, after, or during the balance tests. For the loaded condition, participants carried 30% of their body weight in a military style backpack. Results for each testing period returned lower balance scores and overall balance performance worsened over the entire testing periods. Adding the backpack significantly decreased postural stability scores and diminished select cognitive tasks. These results suggest that increased load may not only decrease postural stability but also situational awareness in tactical athletes. Although these results help to describe the challenges load carriage can invite, tactical athlete performance is often dynamic in nature. Thus, dynamic postural stability was assessed using a single leg jump in order to better replicate the dynamic military environment and tasks (38). Participants completed a single leg jump test with and without body armor. Participants were instructed to jump using both legs and land with the dominant leg onto a force plate, stabilize, and hold their position for 10 seconds. Stability indices were calculated for medial-lateral, antero-posterior, vertical, and dynamic postural stability with the worse stability indices indicating postural instability. After testing, the loaded condition returned significantly worse scores for each variable demonstrating diminished postural stability with the addition of body armor.

Although in the laboratory settings load carriage and fatigue demonstrated decrements in balance and postural stability, one study set to examine the impact during occupational tasks. In order to do so, this study used a novel functional balance test (FBT) designed to mimic occupational obstacles (15). Participants completed three conditions; in the first condition, participants completed the FBT without PPE, the second condition was completed with PPE before performing occupational tasks, and the third was completed with PPE after the occupational tasks. Major errors, minor errors, and performance time were recorded for each condition. Adding protective gear significantly increased the number of both major and minor errors and increased performance time. Further, after completing the occupational task, the number of major errors were significantly decreased, minor errors were unchanged, but performance time was significantly increased. This suggests that fatigued participants took more time to focus on their balance. Although these results are insightful, the novel testing procedures are problematic as they have not been tested for validity. In a more common and tried test, another study examined how load carriage specifically impacted performance on the Functional Movement Screen (FMS) and the SEBT (19). Participants in this study completed both the FMS and the SEBT with and without body armor. Overall, the FMS was impacted significantly with the loaded condition returning lower scores. Shoulder mobility in the FMS testing was shown to be impacted the most with the addition of body armor. The SEBT results were not significantly different suggesting that balance is not heavily impacted by body armor. The body armor used in this study added a mere 4.2-4.6 kg which may not have been enough to invoke significant results in the SEBT.

*Exercise Interventions*

Optimization of performance often relies on evaluating fitness programs to determine effectiveness. For example, a study determined the value of an existing physical fitness program of a police academy (10). The exercise program itself was 3 days a week for 1 hour and targeted cardiovascular endurance, absolute and dynamic strength, flexibility, and team building. For baseline measurements, participants completed skinfold tests, hand grip strength tests, vertical jump test, agility t-tests, sprint speed, 1RM bench press, upper-body power tests, and lower body power tests. In addition, participants completed the standard physical fitness test provided by the academy which included one-minute push-up test, one-minute sit-up test, vertical jump tests, and a half mile shuttle run. Measurements were taken at week 1, 8, and 16 to evaluate the program. The results of the study saw significant changes between weeks 1 and 8 and over the entire 16 weeks but there were no significant changes between weeks 8 and 16. Sprint speed improved significantly over the entire 16-weeks but was not significant between the separate 8-week blocks. Vertical jump height was the only variable that did not improve significantly between the 8-week blocks or the entire 16-weeks. The plateau at 8-weeks indicates that modifications to the training program would be necessary to optimize performance. Alternatively, a novel 12-week circuit training program was examined to determine its effectiveness in optimizing performance (31). To do this, nine firefighters were provided supervised training and compared to a control group of five firefighters who were instructed to maintain their current physical fitness routine. Physical fitness measurements of body composition, aerobic fitness, hand grip strength, and flexibility were taken at the beginning and end of the 12-weeks. Further, a simulated fire ground test was also administered and included tasks such as a tower climb, hose hoist, forcible entry, ladder raise, hose advance, and victim rescue. After the twelve weeks, the intervention group decreased their time to completion in four of six occupational tasks and had a significant change in body composition measurements. In comparison, the control group increased their time to complete all six tasks and had no significant changes in any of the physical fitness measurements. The significant difference between groups suggests that a specificity in training could lead to improved occupational performance.

Evaluating the efficacy of exercise programs is not limited to in person training but also branches into technology. A retrospective study evaluated the efficacy of a periodized 16-week functional training program for firefighters called O2X (33). The O2X program was implemented via a mobile app which allowed for each participant to receive daily coaching and participate when their schedule allowed. Participants were encouraged to adhere to 4-days a week for 90 minutes. Physical fitness measurements included bodyweight, bodyweight squats, push-ups, pull-ups, plank, and a 1.5-mile run and were taken in week 1 (baseline), 8, and 16. After the 16-week program, significant improvements were seen in each physical fitness measurement. Unlike the previous study, results also found improvements between weeks 8 and 16. The success of the O2X mobile app in this study inspires more training programs via technology. This would allow for more accessibility to training programs especially when the availability of strength and conditioning coaches or programs can be limited.

Similarly, a software program was evaluated for efficacy in optimizing FMS scores specifically (39). Unlike the previous study, this software is not through a mobile app, however it allows for subscribers to input baseline FMS scores and develops a progressive training program. The study utilized an 8-week program to assess the effect of a computer-generated exercise program on FMS scores. Sixty firefighters completed the FMS and entered their individual scores into the FMS Pro-360 to develop their 8-week program and then completed the FMS again after the 8-week program. Overall, results demonstrate a significant improvement in total

FMS scores as well as stability and advanced movement scores. There was no significant difference in mobility overall, however, 55% of participants improved their mobility scores. While the program was mostly a success furthering support for technology, the nonsignificant improvements in mobility question whether all physical fitness deficiencies can be solved utilizing digital platforms. To compare, yoga classes were provided in person, then examined as a potential way to improve FMS scores (9). Firefighters completed the FMS and flexibility tests before and after 10 sessions of yoga. Despite the limited number of yoga sessions, participants demonstrated improvement in overall FMS scores and trunk flexibility. Improvements in balance and the FMS demonstrate that yoga may have a positive impact on occupational tasks for tactical athlete performance.

Further, injury prevention is an important fact in maintaining tactical performance and implementing an exercise program has shown to help achieve that goal. A 10-month study was conducted to determine the effectiveness of the Eagle Tactical Athlete Program (ETAP) in reducing unintentional musculoskeletal injuries and demonstrate the need for physical training interventions for tactical demands (37). The ETAP was designed for the US Army's 101st Airborne Division for improving strength, flexibility, balance, anaerobic power, agility, and APFT scores. Injuries were tracked for 5 months prior to introducing the ETAP and for 5 months after the initiation of the training period. The ETAP was used for the training intervention for 5 months. In order to evaluate the effectiveness of ETAP, a control group was also tracked and during the intervention period was kept to the former Army physical fitness program (FM 21-20). The ETAP intervention demonstrated a significant reduction in musculoskeletal injuries and stress fractures and a downward trend, but not significant, in overuse injuries. The control group returned no significant changes in any of the evaluated injury categories.

Research of tactical athletes has demonstrated a valuable link to several physical fitness variables. The nature of their occupation demands a standard for physical fitness to not only improve or maintain performance but potentially prevent injury. While these findings are useful for prescribing and implementing physical fitness interventions, knowing how tactical athletes currently train may provide professionals with a place to start.

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## Appendix B

### Journal Guidelines

*International Journal of Exercise Science*

Journal Guidelines to the Author:

https://digitalcommons.wku.edu/ijes/styleguide.html

Citation example provided by International Journal of Exercise Science website:

Lyons S, Richardson M, Bishop P, Smith J, Giesen J. Excess post-exercise oxygen consumption in untrained males: effects of intermittent durations of arm ergometry. Appl Physiol Nutr Metab 31(3): 196-201, 2006.

# Appendix C

## IRB Approval

WESTERN
WASHINGTON UNIVERSITY

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www.wwu.edu/compliance

**To:** Emily Elliott
**From:** Stephanie Richey
**Subject:** Human Subjects Application
**Date:** 3/31/2021
**Action Taken:** Exemption Granted
**Principal Investigator:** Emily Elliott
**Faculty Advisor:** Dave Suprak
**Project Title:** Training Patterns of Tactical Athletes
**Protocol Number:** 4231EX21
**Funding:** None

The Western Washington University (WWU) Institutional Review Board (IRB) designee determined that your project meets the requirements outlined in §45 CFR 46 and WWU institutional procedures to receive the following exemption determination:

**Exempt Category 2**

This determination means that your research is valid indefinitely, as long as the nature of the research activity remains the same. You may begin recruitment and data collection. After 6 years, according to the University's retention schedule, this exemption file will be deleted. After this point, you will no longer be able to make modifications to this protocol.

This exemption is given under the following conditions:

1. The research will be conducted only according to the protocol.
2. The research will be conducted in accordance with the ethical principles of Justice, Beneficence, and Respect for Persons, as described in the Belmont Report, as well as with federal regulations and University policy and procedure.
3. PIs, Faculty Advisors, PI Proxies, and any individual interacting or intervening with human subjects or their identifiable data must be appropriately trained in human research subject protections (CITI Basic Social/Behavioral Research – Basic/Refresher course), research methods, and responsible conduct of research **prior to** initiating research activity.
4. The Principal Investigator will retain documentation of all past and present personnel, including documentation of their training(s).
5. The Principal Investigator will ensure that all personnel training(s) remain(s) up to date.

6. IRB approval will be obtained **prior to making any modifications** that affect the research study's eligibility for this exemption category or fundamentally change the research. This includes changes to the Principal Investigator (PI), PI Proxy, or Faculty Advisor (if applicable), subject population, recruitment methods, compensation amounts or methods, consent procedures or documents, or changes in study materials that deviate from the approved scope.

   The following types of changes can be made without submitting a modification: Adding or removing research personnel other than the PI, PI Proxy, or Faculty Advisor (if applicable), edits in spelling, punctuation, and grammar on study materials (not including consent forms), minor wording changes to study materials (not including consent forms) that do not change the overall content and resulting comprehension, and adding or editing questions in questionnaires that are within the scope of the questions currently approved.

7. All research records (the application determination packet, correspondence with the IRB, any other IRB-related determinations, signed consent forms, and documentation of research personnel trainings in human research subject protections) will be maintained in accordance with WWU's guidelines for document retention.

8. The IRB will be promptly informed of any issues that arise during the conduct of the research, such as adverse events, unanticipated problems, protocol deviations, or any issue that may increase the risk to research participants.

Thank you for your attention to these details. If you have questions at any point, please review our website (www.wwu.edu/compliance) or contact a Research Compliance Officer.

Research Compliance Officer: Stephanie Richey
Exemption timestamp: 3/31/2021

# Appendix D

## Survey Questions

Exclusion Criteria:

1. Are you 18 years or older?
    a. Yes
    b. No
2. Have you sustained any musculoskeletal injuries in the past 6 months that prevented you from participating in any physical fitness training?
    a. Yes
    b. No

Questions Part 1:

3. What is your occupation?
    a. Law enforcement (local, state, tribal, or federal)
    b. Firefighter
    c. Military
4. What is your occupational status? *Reserves and National Guard, please select Reserves or National Guard if you are on active duty orders (AGR, Title 10, Title 32, etc.)
    a. Full-time
    b. Part-Time/Volunteer
    c. Reserves
    d. National Guard
    e. Veteran/Retiree
5. Are you qualified in a specialized operations role within your occupation (SWAT/PTU, SF, SEAL, TACP etc.)? *If you are military, select no if you are attached to an SOF unit but have not been through the special operation courses to earn the tab or pin.
    a. Yes
    b. No
6. Is physical fitness training mandatory for your employer?
    a. Yes, my career progression requires passing physical fitness tests.
    b. Yes, physical fitness training is mandatory, but my career progression is not impacted by physical fitness tests.
    c. No, but physical fitness training is highly encouraged.
    d. No, my employer does not mandate or encourage physical fitness testing or training.
7. How often does your employer require physical fitness testing?
    a. Monthly
    b. Bimonthly
    c. Quarterly
    d. Every 6 months
    e. Once a year
    f. Biannually
    g. As needed/Per request/ Upon initial entry
    h. Never

i. Other

i. If other please describe:

8. In the last 6 months, how was physical fitness training provided for you? Select all that apply.

a. Mandatory training such as group fitness training sessions.
b. Individualized training programs via wellness coaches or software applications at no cost to me.
c. Different facilities (gym, track, climbing wall etc.) are available at no cost to me.
d. Community programs (Nonprofits, clubs, etc.) that provide physical fitness training are available to me at discounted or no cost to me.
e. Resources (discounted gym memberships, local personal trainer information, etc.) are available for me to pursue on my own.
f. Time is allotted in my work schedule to perform physical fitness training if I choose to.
g. None of the above, all physical fitness training is done on my own time at full cost to me.

Questions Part 2

1. In the last 6 months, on average how many days a week did you work out?
    a. 0
    b. 1
    c. 2
    d. 3
    e. 4
    f. 5
    g. 6
    h. 7
2. In the last 6 months, on average how many minutes did you work out each day?
    a. __________
3. In the last 6 months, on average how many days per week did you work out more than once?
    a. 0 (once a day only)
    b. 1
    c. 2
    d. 3
    e. 4
    f. 5
    g. 6
    h. 7
4. For days you worked out more than once, on average how many MINUTES was each workout?
    a. ________
5. In the last 6 months, what types of exercise did you participate in? Select all that apply.
    a. Lifting weights
    b. Swimming

c. Running
d. Cycling
e. Indoor Cardio (elliptical, stationary bike, row machine, etc.)
f. High Intensity Interval Training
g. Circuit Training or Crossfit
h. Calisthenics
i. Yoga
j. Pilates/Barre
k. Recreational/competitive sports (soccer, badminton, rowing, etc.)
l. Martial arts (tai chi, karate, MMA, etc.)
m. Rock Climbing
n. Dancing
o. Winter Sports (snowboarding, skiing, snowshoeing, etc.)
p. Group Fitness (Jazzercise, bootcamp, etc)
q. Water Sports (kayaking, surfing, snorkeling, etc.)
r. Other
    i. If other please describe:

6. In the last 6 months, on average how many days a week did your workouts focus on cardio (e.g., distance running, cycling, walking/rucking)?
    a. 0
    b. 1
    c. 2
    d. 3
    e. 4
    f. 5
    g. 6
    h. 7
7. On average how many MINUTES did you spend on cardio per session?
    a. ________
8. In the last 6 months, on average how many days a week did your workouts focus on muscular strength and muscular endurance (e.g.,calisthenics, power lifting)?
    a. 0
    b. 1
    c. 2
    d. 3
    e. 4
    f. 5
    g. 6
    h. 7
9. On average how many MINUTES did you spend on muscular strength and muscular endurance per session?
    a. _______
10. In the last 6 months, on average how many days a week did your workouts focus on explosive power (e.g., plyometrics, Olympic weightlifting)?
    a. 0

b. 1
c. 2
d. 3
e. 4
f. 5
g. 6
h. 7

11. On average how many MINUTES did you spend on explosive power per session?
    a. __________

12. In the last 6 months, on average how many days a week did your workouts focus on flexibility and mobility (e.g. yoga, dynamic stretching, foam rolling/myofascial release)?
    a. 0
    b. 1
    c. 2
    d. 3
    e. 4
    f. 5
    g. 6
    h. 7

13. On average how many MINUTES did you spend on flexibility per session?
    a. ______

14. In the last 6 months, on average how many days a week did your workouts focus on balance and stability?
    a. 0
    b. 1
    c. 2
    d. 3
    e. 4
    f. 5
    g. 6
    h. 7

15. On average how many MINUTES did you spend on balance and stability per session?
    a. _______

16. In the last 6 months, on average how many days a week did your workouts focus on speed and agility (e.g. sprints, interval running)?
    a. 0
    b. 1
    c. 2
    d. 3
    e. 4
    f. 5
    g. 6
    h. 7

17. On average how many MINUTES did you spend on speed and agility per session?
    a. _______