Original Research

Tactical Athletes: An Integrated Approach to Understanding and Enhancing the Health and Performance of Firefighters-In-Training

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ABSTRACT

International Journal of Exercise Science 8(4): 341-357, 2015. In an effort to reduce the rates of firefighter fatality, injury, and workplace stress, there has been a call for research to advance knowledge of firefighting performance and injury prevention. Physical and psychological variables important to firefighter health and performance have been identified, yet the interrelated nature of these variables has been overlooked. Given the overlap between the physical and psychological demands of firefighting and sport, and given that an integrated framework has been used in the sport domain to guide athlete health and performance research and practice, firefighter organizations could benefit from adopting a sport-based, integrated model of firefighter training and performance management. Guided by the Meyer Athlete Performance Management Model (MAPM), the purposes of the current study were to: (a) describe the physical and psychological characteristics of firefighters-in-training (i.e., cadets and recruits), and (b) explore relationships between the physical and psychological variables associated with health and performance. Firefighters-in-training employed by a Midwestern area fire department in the United States (N = 34) completed a battery of physical and psychological assessments at the department's Fire and Safety Academy building. Results of the current study revealed significant correlations between several of the physical and psychological characteristics of firefighters-in-training. These results, along with the multidimensional data set that was also established in the current study, provide preliminary evidence for the use of a sport-based integrated performance model such as the MAPM to guide training and performance research in firefighter populations.

KEY WORDS: tactical performance, occupational health, firefighter performance management, firefighter injury management, Meyer Athlete Performance Management Model

INTRODUCTION

Across the United States (U.S.), approximately 1.1 million career and volunteer firefighters (51) work in extremely demanding and dangerous conditions to save citizen lives (81). According to the U.S. Bureau of Labor Force Statistics (83), a firefighter may be required to perform any of the following tasks on the job: fire prevention, hazardous material response, disaster assistance, search and rescue, and emergency medical service. Although a firefighter's job is to protect the safety of citizens, the stressful and dynamic conditions in which a firefighter must

perform also pose risks to his/her own safety. In 2012 alone, 64 U.S. firefighters lost their lives and another 69,400 firefighters incurred non-fatal injuries on the job (84, 85). Given the demands of the job mentioned above, it is no surprise that the leading cause of both fatal and non-fatal (83) injuries among U.S. firefighters is stress, overexertion, and strain associated with performance. Consequently, injuries to firefighters often result in time lost from work and rehabilitation expenses (31), which combined, cost U.S. fire departments upwards of $7.8 billion per year (89).

To reduce the rates of fatality, injury, and workplace stress, organizations such as the National Fire Protection Association (NFPA) have proposed that physical fitness programs be implemented into fire training and safety programs (51). In accordance, 30% of U.S. fire departments have launched preventive fitness initiatives and implemented programs to improve firefighter health and physical fitness (81). Although some fire departments have implemented fitness programs, the majority have not, and little if any evidence exists to support the effectiveness of the programs that are in place. In an effort to improve firefighter health and performance, firefighter associations have called for research that would advance the knowledge of firefighting performance (i.e., technical performance, physical fitness, psychological health) and injury prevention, and researchers have called on health and fitness professionals to lend their expertise for the design and delivery of programs that will better prepare firefighters for the demands of the job (78). Specifically, Storer et al. (78) prompted scholars to consider the need for formal collaborations between the fire service and sport-based organizations such as the National Strength and Conditioning Association (NSCA) and American College of Sports Medicine (ACSM).

To date, a majority of the performance-related research has focused on the physical aspects of firefighting, supporting links between performance and the following variables: (a) aerobic fitness (13, 59, 69, 90), (b) body composition (46, 49, 90), (c) muscular strength and endurance (25, 47), and (d) muscular power (46, 69). Research has also identified relationships between a firefighter's risk of injury and functional movement patterns (57). Taken together, these findings provide a foundational base of knowledge regarding the physical aspects of firefighting performance. However, in contrast to the robust body of literature on the physical aspects of firefighting performance, far less research has focused on the psychological aspects of firefighting performance.

The psychological research which has been conducted has revealed links between firefighter health, an indirect component of firefighting performance, and several psychological variables. Specifically, research findings have demonstrated potential links between: (a) personality characteristics (i.e., extraversion, openness) and firefighting performance (14); (b) self-efficacy and traumatic stress, depressive symptomatology (61), and quality of life (60); (c) prosocial and intrinsic motivation and number of volunteer overtime hours worked (21); and (d) trait anxiety and tense arousal (i.e., responses to physical stress) when completing live firefighting drills (74). Furthermore, former fire officials have reported that a firefighter's mental error on

the job could result in loss of life or injury, thereby suggesting that psychological skills training should be integrated into firefighter training programs in order to maximize safety and performance (9). While the mental demands of firefighting are apparent, and the psychological characteristics of firefighters have been identified, much research is still needed to understand the influence of psychological aspects on firefighting performance and/or on other aspects (e.g., physical) of firefighting performance.

While links to firefighting performance have been identified, no research to date has concurrently examined the physical and psychological aspects of firefighting within the same sample. Similarly, no research has been conducted to examine the relationships between the physical and psychological aspects of firefighting performance. These data would be valuable to health and performance professionals who work with active duty firefighters and/or are involved with the design and delivery of fire training programs. In order to gain a more comprehensive understanding of firefighting performance, scholars and firefighters alike might benefit from viewing firefighting performance through a more holistic and multidimensional lens.

The physical and psychological links to firefighting performance noted above have long been recognized as interrelated aspects of health and performance for sport athletes. That the physical and psychological aspects of firefighting performance may be similar if not identical to those of sport performance (17) supports the notion that firefighters may benefit from being evaluated and trained as *tactical athletes*. The overlap between variables associated with both firefighting and sport performance, along with the need for programs that enhance firefighter health and performance (81), prompt the suggestion that firefighter organizations consider adopting a sport-based approach to conceptualizing firefighter health and performance.

In sport, numerous models have been used to conceptualize the interrelated variables that influence an athlete's performance (e.g., Bronfenbrenner's Ecological Model [5, 16, 41]; Wheel of Excellence [55]). Unique to other models of sport performance, the Meyer Athlete Performance Management Model (MAPM [43]) provides both a framework for conceptualizing the multiple, interrelated performance demands made upon an athlete and a framework for structuring interdisciplinary collaborations between professionals involved in the athlete's training (see Figure 1). The authors of the MAPM further suggest that the use of such an integrated model to structure performance enhancement efforts naturally allows for the concurrent management and protection of the athlete's health (e.g., reduced risk of injury, improved recovery, etc.). Thus, rather than utilizing distinct models to study and manage health and performance, both outcomes can and should be concurrently managed when professionals operate within an integrated systems approach.

In light of the similarities between the performance demands of firefighting and sport, and considering the need to better understand the multidimensional nature of firefighting performance, a model such as the MAPM could provide an integrated framework for performance research and

training programs aimed at reducing the rates of fatality, injury, and stress among firefighters. To explore the applicability of sport-based, integrated health and performance models like the MAPM to firefighter populations, the purposes of the current study were to: (a) describe the physical and psychological characteristics of firefighters-in-training, and (b) explore relationships between the physical and psychological variables associated with firefighting performance.

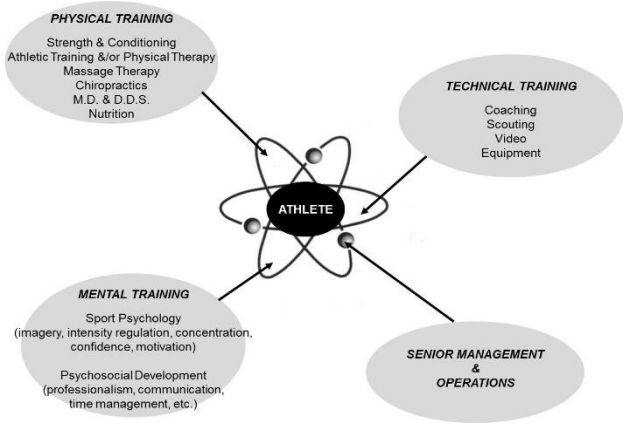

Figure 1. Meyer Athlete Performance Management Model (Source—[43] modified with permission).

METHODS

Participants

Through an existing collaboration between the researchers and a fire department in the Midwestern section of the U.S., all cadets from an incoming class of the cadet training program, and all recruits from an incoming class of the recruit training program were invited to participate in the current study. For the purposes of the study, all participants will be referred to as firefighters-in-training, since age was the only major demographic difference between cadets and recruits. As age was not significantly related to any of the measured variables in the study ($p > .05$), the decision to condense the cadets and recruits into one sample was supported. To be eligible for participation, firefighters-in-training were required to meet the following criteria: (a) male; (b) between the ages of 18 and 50 years; (c) speak and write English fluently; (d) pass all previous department-required physical and psychological screenings; (e) no prescription medications taken for symptomatic illness; (f) no injuries, surgeries, or bone abnormalities to their knees, hips, or ankles within one year of data collection; (g) no existing heart conditions; and (h) no chest pain or dizziness. Of the 45 individuals who volunteered to participate, four were determined to be ineligible for participation. After the screening process, 41 firefighters-in-training provided their informed consent to participate.

Prior to completing any of the physical tests, the height (m) and weight (kg) of the participant was measured and recorded. To examine the physical aspects of firefighting performance, the participant completed a battery of physical tests, all of which were previously utilized in sport or firefighting performance research. All physical measures utilized in the current study were already being implemented by the participating fire department as part of a wellness-fitness initiative (28). Each physical measure utilized in the current study is described below.

To assess aerobic fitness (i.e., VO_{2max}), a submaximal, 5-minute step test was used (67, 68). After the test was completed, the participant stopped and sat down on the step. After resting for 15 seconds, the participant's heart rate was assessed and

recorded. From a published table of VO_{2max} estimations (67, 68), the recorded 15-second heart rate value was then used to determine an estimated VO_{2max} value. Polar T31i heart rate monitor straps and watches were used to assess heart rate (Polar Electro, Lake Success, NY). The estimated VO_{2max} value was expressed in relative terms or milliliters of oxygen consumed per kilogram of body weight per minute (mL/kg/min). When compared with a directly measured VO_{2max} protocol intended for laboratory research, this submaximal protocol intended for field research has demonstrated adequate reliability (r = .46 - .66) and validity (SEM = 12-15%) (12, 30).

To assess body composition, body density was calculated using the Jackson & Pollock Three Skinfold Site method (29) and percent body fat was calculated using Siri's body fat percentage equation (71). To ensure reliability, all skinfold measures were taken twice by the same researcher for all participants. If the two skinfold measures differed by more than 1 mm, a third skinfold measure was obtained. All skinfolds were recorded to the nearest 0.1 mm. Prior reports in the literature indicate that skinfold assessments for the prediction of body composition demonstrate very good reliability and good validity (19).

To determine muscular strength, indirect one repetition maximum (1 RM) squat and bench press tests were administered (2). To complete the test, using a bar loaded to 85% perceived 1 RM, the participant completed repetitions until failure. If the participant completed fewer than 8 repetitions, the test was complete and the weight lifted was recorded. If the participant completed more than 8 repetitions, the participant rested for 3 to 4 minutes and completed the indirect test once more with additional load (i.e., greater than the testing load used previously). The 1 RM was estimated using the following equation (35): 1 RM estimate = (100 * weight lifted) / (101.3 – (2.67123 * #reps)). The reliability and validity of this protocol has been confirmed in previous research (35).

To determine muscular endurance, two different tests were administered. First, the participant performed push-ups to exhaustion (2). The number of push-ups that were completed, to the beat of the metronome (i.e., 80 beats per minute) without losing proper form or resting between repetitions, was recorded. This push-up test was administered for no longer than 2 minutes or for no more than 80 consecutive repetitions. Second, the participant performed as many sit-ups as possible in 60 seconds. From the starting position (i.e., shoulders, hips, and knees in contact with the ground; hands behind the head), the participant lifted the entire torso up and touched his right elbow to his left knee followed by his left elbow to his right knee. Each elbow to knee touch was considered one sit-up repetition. While a variety of push-up and sit-up tests are commonly used to assess muscular endurance (22), the specific muscular endurance tests utilized in the current study were adopted from the fire department's wellness-fitness initiative protocol already in place (28).

To assess muscular power, the participant completed a counter movement jump (CMJ). A Myotest Sport unit (Myotest Inc., Durango, CO), a small accelerometer-based device which measures height, force output,

work output, and velocity of the jump, was used to assess CMJ performance (53). The participant completed two trials and the power (W/kg) produced during the highest jump of the two trials was recorded. Previous research has indicated the reliability and validity of the CMJ protocol used (6, 7).

To assess functional movement, the participant was evaluated using the Functional Movement Screen™ (FMS™ [10]). Each of the seven tasks of the FMS™ is subjectively scored on a 3-point scale, for a total of 21 possible points. The seven tasks include: deep squat, hurdle step, in-line lunge, straight-leg raise, measure of shoulder mobility, push-up, and measure of rotary stability. To maximize data collection efficiency, all participants were rated by seven total raters, one rater for each of the seven tasks. All raters in the current study were FMS™ certified at the time of data collection. Previous research has indicated a moderate to high level of interrater and intersession reliability of the FMS (72, 79).

To examine the psychological aspects of firefighting performance, the participant completed a battery of online psychological questionnaires which have been used previously in sport or firefighting research. Research has demonstrated the equivalence between the online and the paper-pencil methods of psychological data collection (34, 40, 45). To ensure the internal consistency of each questionnaire used, Cronbach's alpha reliability coefficients were calculated and reported for all subscales. Per acceptability standards, reliability coefficients greater than .70 were considered minimally acceptable (54). Any subscale that fell below the standards of acceptability were excluded from any of the inferential analyses. The psychological questionnaires used in the current study are described in detail below.

To assess the Big Five personality characteristics (i.e., extraversion, openness, conscientiousness, agreeableness, emotional stability), Saucier's 40-item Mini-Markers scale was used (65). Saucier's Mini-Markers scale is a personality scale which has been used among university students and adult populations (65, 66). Calculated Cronbach's alphas confirmed the reliability of the subscales used (αs = .72 - .86), with the exception of the agreeableness subscale (α = .43). As such, agreeableness was not used in any inferential analyses. The validity of this scale has been confirmed in previous research (56).

To assess self-efficacy, or belief in ability to competently perform across a variety of performance tasks, the participant completed the 17-item general self-efficacy subscale of the Self-Efficacy Scale (70). The general self-efficacy subscale has been used previously among firefighters (61), demonstrating external validity. The calculated Cronbach's alpha confirmed the reliability of the subscale used (α = .70).

To assess intrinsic motivation, the participant completed the three intrinsic motivation subscales (i.e., intrinsic motivation to know, intrinsic motivatation to accomplish, intrinsic motivation for stimulation) from the 28-item Sport Motivation Scale (SMS [58]). The SMS has been used previously in both firefighting (36) and sport (11, 23) populations. Calculated Cronbach's alphas confirmed the reliability of the subscales used (αs = .76 - .89). The validity of this measure, and the

validity of the intrinsic motivation subscales used in the current study specifically, has been confirmed in previous research (37).

To assess trait anxiety, the 20-item Trait Anxiety Scale (Form Y-2) from the State-Trait Anxiety Inventory was used (76). This scale has been utilized in research across a variety of adult populations (i.e., working adults, college students, military recruits [77]). The calculated Cronbach's alpha confirmed the reliability of the subscale used (α = .83). The construct validity of this measure has been demonstrated in previous research (86).

Procedures

A human subjects approval form was submitted to and approved by the Institutional Review Board (IRB) at the principal investigator's affiliate university. Testing dates were mutually agreed upon by the researchers and representatives of the department. Each testing session was held at a Fire and Safety Academy building. During each testing session, the participant: (1) was screened for inclusion eligibility, (2) completed the informed consent documents, (3) was provided a unique identification code (e.g., FF1) to link all data, (4) completed a brief demographic questionnaire, (5) completed all physical and psychological tests described in the sections above. The screening, informed consent, and coding processes were completed in a classroom within the Academy building. All physical tests were completed in the gymnasium within the Academy building. All psychological tests were completed in a computer laboratory within the Academy building.

As indicated above, at the onset of data collection, each participant was provided a unique identification code (e.g., FF1) to link the physical and psychological data collected. To ensure the confidentiality of each participant and his data, a single key containing participants' names, contact information, and unique identification codes were stored in a locked file. All physical and psychological data collected were transferred into an Excel file and stored on a password-protected computer. To maintain accurate snapshot depictions of the physical and psychological characteristics of firefighters-in-training, incomplete data sets (i.e., the participant could not complete all physical tests and/or the participant missed responding to items in a psychological questionnaire) were omitted from the data analyses. Due to incomplete data sets, seven participants were omitted from data analyses, resulting in a final sample size of 34 participants.

Statistical Analysis

All data were analyzed using Microsoft Excel® (Redmond, WA) and IBM® Statistical Package for the Social Sciences (SPSS®) Statistics 20.0 software (IBM Corporation, Armonk, New York). To describe the physical and psychological characteristics of firefighters-in-training, descriptive statistics were calculated. To examine the relationships between the physical and psychological variables associated with firefighting performance, Pearson product-moment correlation coefficients were calculated. Statistical significance was determined using an alpha level of .05.

RESULTS

The 34 study participants (9 cadets and 25 recruits) ranged in age from 18.0 – 37.0 years (M = 26.6 years, SD = 5.6 years) and in firefighting experience from 0.0 – 10.0 years (M = 1.6 years, SD = 2.7 years). Participants reporter their ethnicities as White/Caucasian (n = 26, 76.4%), African American (n = 2, 5.9%), Hispanic (n = 2, 5.9%), or "other" (n = 4, 11.8%).

To describe the physical and psychological characteristics of firefighters-in-training, the mean, standard deviation, and range of all measured variables were calculated and reported in Table 1. To the extent of the authors' knowledge, the information presented in Table 1 represents the first multidimensional depiction of firefighters-in-training to date.

To examine the relationships between the physical and psychological variables associated with firefighting performance, Pearson product-moment correlation coefficients were calculated and reported in Table 2. Significant findings include the

Table 1. Physical and psychological characteristics of firefighters-in-training.

N = 34			
Physical Characteristics	M	SD	Range
Height (m)	1.8	0.1	1.7 – 1.9
Weight (kg)	85.6	9.8	70.8 – 106.6
Aerobic Fitness - VO_{2max} (mL/kg/min)	46.9	4.5	41.0 – 61.0
Body Composition - Body Fat %	12.5	3.6	5.8 – 20.0
Musc. Strength – 1 RM Squat (kg)	112.9	21.1	77.0 –156.0
Musc. Strength – 1 RM Bench (kg)	96.5	19.8	65.0 – 141.0
Musc. Endurance Push-ups (reps)	38.1	11.6	20.0 – 67.0
Musc. Endurance - Sit-ups (reps)	43.9	6.7	30.0 – 58.0
Musc. Power – CMJ (W/kg)	40.8	12.5	17.0 – 74.0
Functional Movement - FMS™ (out of 21)	12.4	1.7	9.0 – 17.0
Psychological Characteristics	M	SD	Range
Extraversion (out of 9)	6.9	1.0	4.9 – 8.3
Conscientiousness (out of 9)	7.4	0.8	5.5 – 8.8
*Agreeableness (out of 9)	7.7	0.9	3.5 – 8.8
Openness (out of 9)	6.6	1.3	2.4 – 8.6
Emotional Stability (out of 9)	6.9	1.1	4.4 – 8.9
Self-Efficacy (out of 238)	215.1	15.1	182.0 – 238.0
IM to Know (out of 7)	5.8	1.0	3.3 – 7.0
IM to Accomplish (out of 7)	5.6	0.9	3.5 – 7.0
IM for Stimulation (out of 7)	5.6	1.0	3.8 – 7.0
Trait Anxiety (20-80)	27.6	5.1	20.0 – 37.0

* Agreeableness subscale did not demonstrate adequate reliability (α = .43).

Table 2. Correlations between the physical and psychological variables associated with firefighting performance.

N = 34	EX	CON	OP	ES	SE	IM-K	IM-A	IM-S	TA
1. Aerobic Fitness-VO_{2max}	.041	.164	.216	.173	.079	.103	-.038	-.014	.022
2. Body Comp-BF %	.195	-.038	-.106	.081	-.022	-.043	-.306	.098	.149
3. Strength-1 RM Squat	.063	**.417***	.304	.204	**.402***	.087	-.010	-.118	.-.224
4. Strength-1 RM Bench	-.062	**.401***	**.371***	.117	**.395***	.059	-.087	-.083	-.070
5. Endurance-Push-ups	-.283	**.397***	**.361***	.111	**.354***	.035	.025	.003	-.187
6. Endurance-Sit-ups	-.208	.234	.281	.186	.086	.029	.014	.121	-.253
7. Power-CMJ	.105	-.070	-.019	-.103	-.154	-.177	.004	-.258	.089
8. Functional Movement	**-.419***	.249	.139	-.076	.288	-.232	-.139	-.307	-.119

Note: EX = extraversion, CON = conscientiousness, OP = openness, ES = emotional stability, SE = self-efficacy, IM-K = intrinsic motivation to know, IM-A = intrinsic motivation to accomplish, IM-S = intrinsic motivation for stimulation, TA = trait anxiety.

* Correlation is significant at the .05 level (2-tailed).

** Correlation is significant at the .01 level (2-tailed).

relationships identified between: muscular strength (via 1 RM squat) and conscientiousness and self-efficacy (ps < .05); muscular strength (via 1 RM bench) and conscientiousness, openness, and self-efficacy; muscular endurance (via push-ups) and conscientiousness, openness, and self-efficacy; as well as between functional movement and extraversion ($p < .05$). Collectively, it is apparent that the psychological characteristics of conscientiousness and self-efficacy share the greatest overlap with the physical variables included in the current study, notably muscular strength (via 1 RM squat and bench) and muscular endurance (via push-ups). These weak to moderaterelationships identified between the physical and psychological performance-related characteristics of firefighters-in-training in the current study provide, albeit indirect, preliminary evidence for the interrelated nature of the physical and psychological aspects of firefighting.

DISCUSSION

In an effort to explore the applicability of a sport-based model of performance to the firefighting domain, the purposes of the current study were to: (a) describe the physical and psychological characteristics of firefighters-in-training, and (b) explore relationships between the physical and psychological variables associated with firefighting performance. From the results emerged the first comprehensive, multidimensional data set reported in any firefighter population as well as evidence to support the interrelatedness of the physical and psychological characteristics of firefighters-in-training. Results of the physical and psychological measures will be further discussed within the contexts of the existing literature in the paragraphs below.

The physical characteristics of the firefighters-in-training in the current study were consistent with those reported in previous firefighting research (13, 46, 50), with the exception of muscular power which was higher than that reported previously (46) and functional movement which was lower than that reported previously (57). The discrepancy in muscular power is likely due to the different measurement protocols used to determine muscular power (i.e., Vertec and Myotest Sport Unit).

The FMS™ Total Scores of firefighters-in-training in the current study were lower than those reported in previous firefighting research (57). While this discrepancy may be due to the subjective nature of FMS™ scoring, acceptable levels of FMS™ interrater reliability (54, 72, 80) prompt the suggestion that the participants in the current study do in fact have lower scores than firefighters in previous research. Since 79% of the participants in the current sample received an FMS™ Total Score of less than 14, and since an FMS™ Total Score of less than 14 indicates an increased risk for injury (8, 33, 57), it appears that these firefighters-in-training may be at an increased risk for injury. Prompted by the results of previous injury prevention research, implementation of a firefighter functional training program designed to improve FMS™ Total Score (i.e., core strength, flexibility, proper body mechanics) may result in reductions of workplace injuries and work time lost due to injury (57).

Firefighters-in-training in the current study reported higher levels of extraversion,

conscientiousness, emotional stability, self-efficacy, intrinsic motivation, and lower levels of trait anxiety than individuals in the general population (1, 56, 70, 74), a finding consistent with comparisons made in the existing firefighter literature (64, 74, 87). This psychological profile of firefighters-in-training is also consistent with that of successful athletes (3, 27, 39, 42, 48), a finding which provides preliminary support for the consideration of firefighters as *tactical athletes*. Sport psychologists acknowledge that an athlete's psychological characteristics may have an influence on his/her learning style, and therefore should be considered when designing and implementing their fire or psychological training programs (20, 91). In addition, the sport performance literature is replete with evidence to support psychological training interventions aimed at performance enhancement (24, 26, 38, 44). Given the similarities between athletes and firefighters, and informed by the sport performance literature, the psychological characteristics of firefighters-in-training should also be considered when designing and delivering their training programs.

Results of the current study indicated several significant correlations between the physical and psychological variables associated with firefighting performance. These results are consistent with those reported in the sport domain (17, 63, 88) and are not surprising given that firefighting, like sport, is a job in which multiple variables concurrently influence performance. It makes sense, therefore, that an integrated model of sport performance like the MAPM be used to inform the study and application of intervention programs aimed at firefighter health (e.g., injury prevention) and performance enhancement. As we know from decades of establishing best practices in sport, and per the previous recommendations of Compton and Mack (9), integration of psychological skills training interventions such as confidence-building into a physical training program designed to improve the muscular strength of firefighters-in-training may result in achievement of a more cost-efficient, expeditious, and long-term result than that achieved by psychological or physical training alone.

The descriptive statistics reported in the current study serve as a much needed multidimensional baseline assessment of the physical and psychological characteristics of firefighters-in-training, filling a gap in the firefighting health and performance literature. These data could be used by fire and/or health and sport professionals looking to enhance baseline measures of health and performance among U.S. firefighters and/or firefighters-in-training. As anecdotal evidence for the value of these baseline data, and as part of the ongoing collaboration between the researchers and this particular department, fire training officials have used these data and other assessments to inform evidence-based modifications to active-duty firefighter health assessments and fire training programs. For example, informed by consistently poor FMS™ shoulder mobility scores among fire cadets and recruits, fire training programs now include specific drills and exercises to facilitate the protection of shoulder mobility after long periods of chopping-related training. As part of a larger effort in the ongoing partnership, such research outcomes have led to the implementation of injury

prevention strategies that have successfully reduced the total number of work time lost due to injuries by 62% since 2012.

The correlational data reported challenge the unidimensional approach to studying firefighting health and performance, whereby fire experts and scholars alike have focused almost exclusively on either the physical aspects *or* psychological aspects of firefighting health and performance. The psychological demands of firefighting reported anecdotally by firefighters-in-training, in conjunction with the identified overlap between the physical and psychological aspects of firefighting emerging in the current study, provide preliminary evidence for the consideration of a multidimensional approach to firefighting performance enhancement in future research and practice. Active duty firefighters have reported to the authors of the current study that some firefighters possess psychological characteristics or strategies that they use to increase performance and/or cope with the demands of the job. By default, other firefighters lack certain psychological characteristics and strategies (e.g., conscientiousness, compartmentalization skills, etc.) which place them at risk of personal injury and/or poor performance. Consistent with practice-based models like the MAPM and the recommendations of previous researchers (78), the aforementioned results prompt authors of the current study to recommend that fire departments and organizations pursue collaborations with health and sport professionals in order to accommodate the multidimensional health and performance needs of firefighters. Such collaborations could be conceptualized and structured based on a modified MAPM for tactical athletes (see Figure 2).

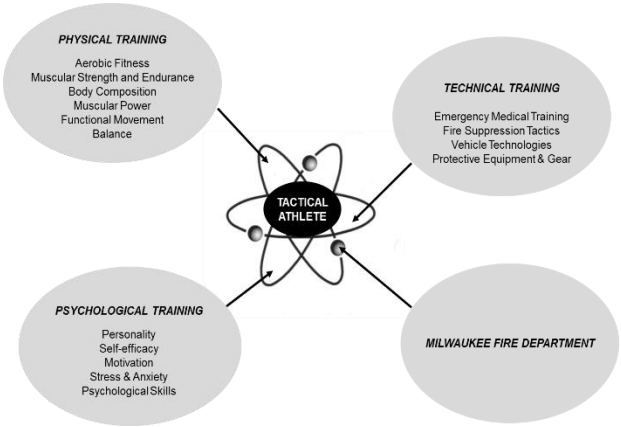

Figure 2. Meyer Athlete Performance Management Model for Tactical Athletes (Source—[43] modified with permission).

Several limitations exist in the current study which may inform interpretation of results as well as directions for future research. The low alpha reliability coefficients reported for the agreeableness subscale prompt caution in the use of this particular personality measures among firefighter populations. Given the substantial support in the literature for using a Big Five framework to guide personality research in firefighter populations (14, 87), additional investigations should be conducted to identify the most valid and reliable Big Five-based measure to use in firefighter research moving forward. In addition, and considering the small homogenous sample, the results of the current study may only be generalizable to the next generations of firefighters-in-training in the Midwestern area of the U.S. Additional research is warranted to further investigate the validity of all measures used in the current study among larger and more diverse samples of cadets, recruits, and active-duty firefighters. Finally, informed by the overlap between the variables linked to performance in

firefighting and sport, an assumption was made that the psychological variables assessed in the current study are directly related to firefighting performance. While these psychological variables have been repeatedly linked to performance in sport, only weak associations between personality and firefighting performance have been established in the literature (14). Therefore, statistical modeling should be utilized in future research to explore the main and interaction effects of physical and psychological variables on measures of firefighting performance (e.g., Candidate Physical Ability Test, etc.).

Until the current study, research had neither examined the physical and psychological aspects of firefighting within the same sample of firefighters-in-training nor the relationships between the physical and psychological variables associated with firefighting health or performance. The results of the current study provide a multidimensional data set that can be used as a starting point for health and performance comparisons by researchers and fire organizations. Although the results of the current study may lack generalizability beyond firefighters-in-training employed within the Midwestern areas of the U.S., the results do fill an important gap in the literature given that previous research has never viewed firefighter health and performance through a multidimensional lens. Collectively, results of the current study generally and the relationships identified between the physical and psychological characteristics of firefighters-in-training specifically, provide preliminary support for the use of an integrated approach such as the MAPM to better understand and enhance firefighter health and performance. To that end, research is still needed to gain a thorough understanding of the injury prevention and performance needs of firefighters and how sport research and professional practice knowledge can be used to further advance the understanding of health and performance among a unique population of tactical athletes.

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CONFLICT-OF-INTEREST STATEMENT

The authors of the current study report that there are no conflicts of interest.

REFERENCES

1. Alexandris K, Tsorbatzoudis C, Grouios G. Perceived constraints on recreational sport participation: Investigating their relationship with intrinsic motivation, extrinsic motivation, and amotivation. J Leisure Res 34(3): 233-252, 2002.

2. Baechle RW, Earle RW. Administration, Scoring, and Interpretation of Selected Tests. Essentials of

strength training and conditioning, 3rd ed. Human Kinetics, Champaign, 2008.

3. Beauchamp PH, Halliwell WR, Fournier JF, Koestner R. Effects of cognitive-behavioral psychological skills training on the motivation, preparation, and putting performance of novice golfers. Sport Psychol 10(2): 157-170, 1996.

4. Berry M, Matic T. Professional firefighter profiles: Physical ability evaluation. Power-Up USA, Inc., Milwaukee, 2002.

5. Bronfenbrenner U. Development ecology through space and time: A future perspective. In: Moen P, Elder GH, Luscher K (eds) Examining lives in context. Washington, DC, pp 619-649, 1995.

6. Casartelli N, Müller R, Maffiuletti NA. Validity and reliability of the Myotest accelerometric system for the assessment of vertical jump height. J Strength Cond Res 24(11): 3186-3193, 2010.

7. Castagna C, Ganzetti M, Ditroilo M, Giovannelli M, Rocchetti A, Manzi V. Concurrent validity of vertical jump performance assessment systems. J Strenth Cond Res 27: 761-768.

8. Chorba RS, Chorba DJ, Bouillon LE, Overmyer CA, Landis JA. Use of a functional movement screening tool to determine injury risk in female collegiate athletes. N Am J Sports Phys Ther 5(2): 47-54, 2010.

9. Compton D, Mack G. The mental aspects of performance for firefighters and fire officers (The M.A.P.). Fire Protection Publications, Oklahoma State University, 2004.

10. Cook G, Burton L, Fields K, Kiesel K. The Functional Movement Screen. Athletic Testing Services, Inc., Danville, 1998.

11. Curran T, Appleton PR, Hill AP, Hall HK. Passion and burnout in elite junior soccer players: The mediating role of self-determined motivation. Psychol Sport Exerc 12(6): 655-661, 2011.

12. deVries HA. Lab experiments in exercise physiology. Dubuque, IA: Wm C. Brown, 1971.

13. Elsner KL, Kolkhorst FW. Metabolic demands of simulated firefighting tasks. Ergonomics 51(9): 1418-1425, 2008.

14. Fannin N, Dabbs JM. Testosterone and the work of firefighters: Firefighting fires and delivering medical care. J Res Pers 37(2): 107-115, 2003.

15. Firefighter injuries. Summary incidence report. U.S. Fire Administration, Federal Emergency Management Agency, 2013. Available from: http://apps.usfa.fema.gov/firefighter-fatalities/.

16. Gilbert, J. N. Teaching sport psychology to high school student-athletes: The Psychological UNIFORM and the Game Plan Format. Journal of Sport Psychology in Action, 2, 1-9, 2011.

17. Gilson TA, Chow GM, Feltz DL. Self-efficacy and athletic squat performance: Positive or negative influences at the within-and between-levels of analysis. J Appl Sport Psychol 42(6): 1467-1485, 2012.

18. Gnacinski SL, Meyer BB, Ebersole KT. Backdraft: The use of applied sport psychology to characterize firefighter performance. Performance Excellence Movement Newsletter. https://www.appliedsportpsych.org/files/2012PEMFinal.pdf, 2012.

19. Going S, Davis R. Body composition. In: Roitman JL (ed) ACSM Resource Manual for Exercise Testing and Prescription. 4th Edition. Lippincott Williams and Wilkins, Baltimore, 2001.

20. Gould D, Dieffenbach K, Moffett A. Psychological characteristics and their development in Olympic champions. J Appl Sport Psychol 14: 172-204, 2002.

21. Grant AM. Does intrinsic motivation fuel the prosocial fire? Motivational synergy in predicting persistence, performance, and productivity. J Appl Psychol 93(1): 48-58, 2008.

22. Graves JE, Pollock ML, Bryant CX. Assessment of muscular strength and endurance. In: Roitman JL (ed) ACSM Resource Manual for Exercise Testing and Prescription. 4th Edition. Lippincott Williams and Wilkins, Baltimore, 2001.

23. Halbrook M, Blom LC, Hurley K, Bell RJ, Holden JE. Relationships among motivation, gender, and cohesion in a sample of collegiate athletes. J Sport Behav 35(1): 61-77, 2012.

24. Harmison RJ. Peak performance in sport: Identifying ideal performance states in developing athletes' psychological skills.

25. Sport Exerc Perform Psychol 1: 3-18, 2011.

26. Harvey DG, Kraemer JL, Sharratt MT, Hughson RL. Respiratory gas exchange and physiological demands during a fire fighter evaluation circuit in men and women. Eur J Appl Physiol 103: 89-98, 2008.

27. Hatzigeorgiadis A, Zourbanos N, Galanis E, Theodorakis Y. Self-talk and sports performance: A meta-analysis. Perspect Psychol Sci 6(4): 348-356, 2011.

28. Hayslip B, Petrie TA, MacIntire MM, Jones GM. The influences of skill level, anxiety, and psychological skills use on amateur golfers' performances. J Appl Sport Psychol 22: 123-133, 2010.

29. International Association of Fire Fighters (IAFF). The Fire Service Joint Labor Management Wellness-Fitness Initiative. 3rd Edition. Washington, 2008.

30. Jackson AS, Pollock ML. Practical assessment of body composition. Physician Sport Med 13:76-80, 82-90, 1985.

31. Johnson J, Siegel D. The use of selected submaximal step tests in predicting change in the maximal oxygen intake of college women. J Sport Med Phys Fit 21: 259-264,1981.

32. Karter MJ Jr, Stein GP. U.S. fire department profile through 2012, National Fire Protection Association, Quincy, 2012.

33. Karter MJ Jr, Molis JL. U.S. firefighter injuries-2012. National Fire Protection Association, Quincy, 2013.

34. Kiesel K, Plisky PJ, Voight ML. Can serious injury in professional football be predicted by a preseason functional movement screen? N Am J Sports Phys Ther 2(3): 147-158, 2007.

35. Krantz JH, Ballard J, Scher J. Comparing the results of laboratory and World-Wide Web samples on the determinants of female attractiveness. Behav Res Meth Instrum Comput 29(2): 264-269, 1997.

36. LeSuer DA, McCormick JH, Mayhew JL, Wasserstein RL, Arnold MD. The accuracy of prediction equations for estimating 1-RM performance in the bench press, squat, and deadlift. J Strength Cond Res 11(4): 211-213, 1997.

37. Long, N, Readdy T, Raabe, J. What motivates firefighters to exercise? A mixed-methods investigation of Self-Determination Theory constructs and exercise behavior. Sport Exerc Perform Psychol 3(3): 203-218, 2014.

38. Martens MP, Webber SN. Psychometric properties of the sport motivation scale: An evaluation with college varsity athletes from the U.S. J Sport Exerc 24: 254-270, 2002.

39. Martin GL, Vause T, Schwartzman L. Experimental studies of psychological interventions with athletes in competition: Why so few? Behav Modif 29(4): 616-641, 2005.

40. McKelvie SJ, Lemieux P, Stout D. Extraversion and neuroticism in contact athletes, no contact athletes, and non-athletes: A research note. Athl Insight 5(3): 19-27, 2003.

41. Meyer BB, Cashin SE, Massey WV. The equivalence of online and paper-pencil measures of emotional intelligence. In: DiFabio A (ed), Emotional intelligence: New perspectives and applications, InTech, Rijeka, pp 183-194, 2012.

42. Meyer BB, Fletcher TB. A systems approach to applied sport psychology. Annual meeting of the

Association for Applied Sport Psychology, Salt Lake City, 2009.

43. Meyer BB, Massey WV, Gnacinski SL. Operationalizing the symbiotic relationship between talent identification and talent development in elite sport. Workshop presented at the annual meeting of the Association of Applied Sport Psychology, Atlanta, 2012.

44. Meyer BB, Merkur A, Ebersole KT, Massey WV. The realities of working in elite sport. What they didn't teach you in graduate school. In: Lane AM, Godfrey RJ, Loosemore M, Whyte GP (eds) Case studies in sport science and medicine. CreateSpace, 2014.

45. Meyers AW, Whelan JP, Murphy SM. Cognitive behavioral strategies in athletic performance enhancement. Prog Behav Modif 30: 137-164, 1996.

46. Meyerson P, Tryon, WW. Validating Internet research: A test of the psychometric equivalence of Internet and in-person samples. Behav Res Meth Instrum Comput 35(4): 614-620, 2003.

47. Michaelides MA, Parpa KM, Henry LJ, Thompson GB, Brown BS. Assessment of physical fitness aspects and their relationship to firefighters' job abilities. J Strength Cond Res 25(4): 956-965, 2011.

48. Michaelides MA, Parpa KM, Thompson J, Brown B. Predicting performance on a firefighter's ability test from fitness parameters. Res Q Exerc Sport 79(4): 468-475, 2008.

49. Moritz SE, Feltz DL, Fahrbach KR, Mack DE. The relation of self-efficacy measures to sport performance: A meta-analytic review. Res Q Exerc Sport 71(3): 280-294, 2000.

50. Myhre LG, Tucker DM, Bauer DH, Fischer JR. Relationship between selected measures of physical fitness and performance of a simulated fire fighting emergency task. Alexandria, VA: Texas, Crew Systems Directorate, AL/CFT Systems Research Branch, Brooks AFB, 1997.

51. National Institute of Standards and Technology. The economic consequences of firefighter injuries and their prevention. Final report. TriData Corporation, Arlington, 2004.

52. NFPA 1500: Standard on Fire Department Occupational Safety and Health Program. National Fire Protection Association, Quincy, 2013.

53. Nunnally JC. Psychometric Theory. McGraw-Hill, New York, 1978.

54. Nuzzo JL, Anning JH, Scharfenberg JM. The reliability of three devices used for measuring vertical jump height. J Strength Cond Res 25(9): 2580-2590, 2011.

55. Onate JA et al. Real-time intersession and interrater reliability of the functional movement screen. J Strength Cond Res 26(2): 408-415, 2012.

56. Orlick T. The psychology of personal excellence. Contemp Thought on Perform Enhance 1(1): 109-122, 1992.

57. Palmer JK, Loveland JM. Further investigation of the psychometric properties of Saucier's big five "mini-markers:"

58. Evidence for criterion and construct validity. Individ Differ Res 2(3): 231-238, 2004.

59. Peate WF, Bates G, Lunda K, Francis S, Bellamy K. Core strength: A new model for injury prediction and prevention. J Occup Med Toxicol. doi: 10.1186/1745-6673-2-3, 2007.

60. Pelletier LG et al. Toward a new measure of intrinsic motivation, extrinsic motivation, and amotivation in sports: The sport motivation scale (SMS). J Sport Exerc Psychol 17(1): 35–53, 1995.

61. Perroni F et al. Energy cost and energy sources during a simulated firefighting activity. J Strength Cond Res 24(12): 3457-3463, 2010.

62. Prati G, Pietrantoni L, Cicognani E. Self-efficacy moderates the relationship between stress appraisal

and quality of life among rescue workers. Anxiety Stress Coping 23(4): 463-470, 2010.

63. Regehr C, Hill J, Knott T, Sault B. Social support, self-efficacy and trauma in new recruits and experienced firefighters. Stress Health 19: 189-193, 2003.

64. Rhea MR, Alvar BA, Gray R. Physical fitness and job performance of firefighters. J Strength Cond Res 18(2): 348-352, 2004.

65. Richter J, Gilbert J, Baldis M. Maximizing strength training performance using mental imagery. Strength Cond J 34: 65-70, 2012.

66. Salters-Pedneault K, Ruef AM, Orr SP (2010) Personality and psychophysiological profiles of police officer and firefighter recruits. Pers Individ Dif 49(3): 210-215

67. Saucier G. Mini-markers: A brief version of Goldberg's unipolar big-five markers. J Pers Assess 63(3): 506-516, 1994.

68. Seibert SE, Kraimer ML. The five-factor model of personality and career success. J Vocat Behav 58(1): 1-21, 2001.

69. Sharkey BJ. Fitness and work capacity. Report FS-315, Washington DC, 1997.

70. Sharkey BJ. Physiology of Fitness: Prescribing Exercise for Fitness Weight Control and Health. Human Kinetics Publishers, Champaign, 1979.

71. Sheaff AK et al. Physiological determinants of the candidate physical ability test in firefighters. J Strength Cond Res 24(11): 3112-3122, 2010.

72. Sherer M et al. The Self-Efficacy Scale: Construction and validation. Psychol Rep 51: 663-671, 1982.

73. Siri WE. Body composition from fluid space and density. In Brozek J & Hanschel A(eds) Techniques for measuring body composition. Washington, DC, pp 223-244, 1961.

74. Smith CA, Chimera NJ, Wright NJ, Warren M. Interrater and intrarater reliability of the functional movement screen. J Strength Cond Res 27(4), 982-987, 2013.

75. Smith DL. Firefighter fitness: Improving performance and preventing injuries and fatalities. Curr Sports Med Rep 10(3): 167-172, 2011.

76. Smith DL, Petruzzello SJ, Kramer JM, Misner JE. Physiological, psychophysical, and psychological responses of firefighters to firefighting training drills. Aviat Spac Environ Med 67(11): 1063-1068, 1996.

77. Sothmann MS, Gebhardt DL, Baker TA, Kastello GM, Sheppard VA. Performance requirements of physically strenuous occupations: validating minimum standards for muscular strength and endurance. Ergonomics 47(8): 864-875, 2004.

78. Spielberger CD, Gorsuch RL, Lushene RE. Manual for the State-Trait Anxiety Inventory (Self-Evaluation Questionnaire). Consulting Psychologists Press, Palo Alto, 1970.

79. Spielberger CD. State-Trait Anxiety Inventory for Adults. Consulting Psychologists Press, Palo Alto, 1983.

80. Storer, TW et al. Firefighter health and fitness assessment: A call to action. J Strength Cond Res, 28(3): 661-671, 2014.

81. Taylor A, Plisky P, Butler RJ. Interrater reliability of the functional movement screen. J Strength Cond Res 24(2): 479-486, 2010.

82. Teyhen DS et al. The Functional Movement Screen: A reliability study. J Orthop Sports Phys Ther, 42(6): 530-540, 2012.

83. The Fire Service Joint Labor Management Wellness-Fitness Initiative, 3rd edn. International Association of Fire Fighters. Department of Occupational Health and Safety, Washington, DC, 2008.

84. Third Needs Assessment of the U.S. Fire Service. Conducted in 2010 and including comparisons to the

2001 and 2005 needs assessment surveys. National Fire Protection Association, Quincy, 2011.

85. United States Bureau of Labor Statistics. Occupational outlook handbook 2012-13 edition. United States Department of Labor, Washington DC, 2013.

86. United States Department of Homeland Security. Fire-related firefighter injuries reported to the NFIRS. National Fire Data Center, Emmitsburg, 2011.

87. United States Fire Administration. Firefighter fatalities in the United States in 2012. National Fire Data Center, Emmitsburg, 2013.

88. Vautier S, Pohl S. Do balanced scales assess bipolar constructs? The case of the STAI scales. Psychol Assessment 21: 187-193, 2009.

89. Wagner SL, Martin CA, McFee JA. Investigating the "rescue personality". Traumatology 15(3): 5-12, 2009.

90. Weinberg R, Gould D, Jackson A. Expectations and performance: An empirical test of Bandura's self-efficacy theory. J Sport Psychol 1(4): 320-331, 1980.

91. West P. NIST: Firefighter injuries cost billions per year. Fire Chief. http://firechief.com/health_safety/ firefighter-injuries-cost032505, 2005.

92. Williams-Bell FM, Villar R, Sharratt MT, Hughson RL. Physiological demands of the firefighter candidate physical ability test. Med Sci Sports Exerc 41(3): 653-662, 2009.

93. Woodman T, Zourbanos N, Hardy L, Beattie S, McQuillan A. Do performance strategies moderate the relationship between personality and training behaviors? An
exploratory study. J Appl Sport Psychol 22:183-197, 2010.