EFFECTIVENESS OF THE FITTEST FORCE CHALLENGE: A 12-WEEK ONLINE THEORY-BASED NUTRITION AND PHYSICAL ACTIVITY INTERVENTION FOR FIRST RESPONDERS

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Abstract: **Background**: Firefighters and law enforcement officers (LEO) are at increased risk of cardiovascular disease (CVD) due to their current occupation and lifestyle practices. Highlighting this risk, 45% of on duty firefighter deaths are CVD related. The purpose of this study was to determine the effectiveness of a 12-week online nutrition and physical activity intervention based on group dynamics, Kohler effect, self-determination theory, and social cognitive theory for LEO and firefighters across the US. **Methods**: Program effectiveness was tested using a quasi-experimental, pre-/ post-test design with a convenience sample of current firefighters or law enforcement officers over the age of 18 years recruited via social media and personal email contacts in the professions. Assessments included demographics, International Physical Activity Questionnaire (IPAQ), Behavioral Regulation in Exercise Questionnaire (BREQ-2), Exercise Self-Efficacy Scale (ESES), 24-hour food recall and Healthy Eating Index (HEI-2015) scores, body mass index (BMI), perceived knowledge of program topics, and program engagement. Chi-square and paired t-test were used to determine difference from pre- to post-program. **Results**: Ninety-two participants completed the pre-program assessment, while 13 individuals completed the post-program assessment and were matched. There were significant increases between pre- and post-program assessment for matched participants in perceived knowledge for nutrition literacy ($p=0.002$), increasing fruit and vegetable intake ($p<0.001$), incorporating whole grains ($p=0.005$), setting up social supports ($p=0.023$), creating food environments for dietary change ($p=0.008$), safe and effective supplement use ($p=0.009$), safe caffeine consumption ($p=0.003$), and eating healthy while eating out ($p=0.009$). There was also a significant decrease in sedentary time from pre- to post-program ($p=0.001$). **Discussion**: This online challenge program was effective in increasing perceived knowledge and decreasing sedentary time. This pilot provides guidance for future programming with this population, in addition to serving as an immediate, inexpensive, high reach, and evidence-based resource.

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CHAPTER I

INTRODUCTION

Some public safety workers and first responders, specifically firefighters and law enforcement officers, can be categorized as tactical athletes due to occupational activities which require periods of rigorous physical performance under extreme stress, in heavy gear and equipment, and sometimes in life threatening conditions (Sefton & Burkhardt, 2016). While these hazardous occupational activities are dangerous, they are not the leading cause of death in this population. The leading cause of on-duty death for firefighters is cardiovascular disease (CVD), not hazards, such as smoke inhalation or burn injuries (Fahy, 2020). CVD is also prevalent in and detrimental to law enforcement officers (Varvarigou et al., 2014).

This population of tactical athletes is exposed to extreme occupational risk factors, such as sudden rigorous physical activity, stress, smoke inhalation, and shift work that puts them at greater risk for developing CVD or aggravating existing CVD (Brook et al., 2010; Eastlake et al., 2015; Esquirol et al., 2009; Franke et al., 1998; Gaines et al., 1993; Gan et al., 2012; Guidotti, 1992; Puttonen et al., 2010; Soteriades, Smith, et al., 2011). Additionally, this population does not escape the lifestyle risk factors for CVD the general population faces, such as poor diet, lack of regular physical activity, and obesity (Brook et al., 2010; Gan et al., 2012; Kales et al., 2003b; NIOSH, 2007; Soteriades, Smith, et al., 2011). While occupational risk factors for CVD do exist, it has been shown that CVD fatality in this population is more so attributed to excess lifestyle risk factors, or underlying CVD, than to occupational risk factors (Kales et al., 2003b; Soteriades, Smith, et al., 2011).

When looking at reducing CVD risk, both poor diet and obesity are modifiable risk factors (Gendron et al., 2019; Poston et al., 2011; Ramey et al., 2008; Soteriades, Smith, et al., 2011). In a five year cohort study on obesity and CVD risk for firefighters, researchers found the prevalence of obesity increased from 35% to 40% (Soteriades et al., 2005). Similarly, the obesity prevalence in law enforcement officers is estimated to be 40%, which was greater than the obesity rate, 35%, of the general population at the time (Can & Hendy, 2014). In law enforcement officers, it was found individuals from the overweight and obese categories had a greater prevalence of modifiable CVD risk factors, such as hypertension and dyslipidemia, both of which can be influenced by diet, compared to those in the normal BMI category (Gendron et al., 2019). In firefighters, a cross sectional study found individuals in the normal weight BMI category had higher quality diets compared to individuals who were in the overweight and obese BMI categories (Yang et al., 2014). Shift work can also greatly impact diet and is a risk factor for poor diet in firefighters and law enforcement officers (Esquirol et al., 2009; Lowden et al., 2010; Soteriades, Smith, et al., 2011).

Despite diet and lifestyle modification as a feasible means to reduce CVD risk among tactical athletes, there is a lack of health education requirements and programs available related to nutrition and CVD risk factors tailored to this unique population (Kales et al., 2003a; NIOSH, 2007; Soteriades, Targino, et al., 2011). With so many tactical athletes dying needlessly from a preventable cause, health promotion and disease prevention programs are needed. With diet and physical activity as leading modifiable risk factors, programs focusing on improving nutrition and physical activity may be especially impactful. Thus, the Fittest Force Challenge program was developed to begin to fill the gap in available programs. The Challenge was developed based on behavior change theories to promote effective and continued risk reduction practices following program completion. The purpose of this study was to determine the effectiveness of the Fittest Force Challenge in improving dietary quality, physical activity levels, and weight status in

firefighters and law enforcement officers by comparing pre-program survey results to post-program survey results.

Research Questions

1. How will a 12-week online theory-based wellness program for firefighters and law enforcement officers impact their dietary quality?
2. How will a 12-week online theory-based wellness program for firefighters and law enforcement officers impact their physical activity levels?
3. How will a 12-week online theory-based wellness program for firefighters and law enforcement officers impact their weight status?

Hypotheses

1. A 12-week online theory-based wellness program for firefighters and law enforcement officers will improve dietary quality as measured by Healthy Eating Index (HEI) scores.
2. A 12-week online theory-based wellness program for firefighters and law enforcement officers will improve physical activity levels as measured by International Physical Activity Questionnaire (IPAQ) scores.
3. A 12-week online theory-based wellness program for firefighters and law enforcement officers will improve weight status by decreasing the percentage of participants in the overweight and obese BMI categories.

CHAPTER II

LITERATURE REVIEW

Tactical Athletes

In 2018, there was an estimated 1.1 million firefighters stationed at over 29,000 fire departments across the US (Evarts, 2020). The majority of firefighters are between the ages of 30 and 49 years of age and are predominately male with females only making up 8% of this group (Evarts, 2020). A recent estimate of the number of US law enforcement officers has reached peak at roughly 800,000 officers, 12% of whom are female (National Law Enforcement Officers Memorial Fund, 2020). Firefighters and law enforcement officers can be considered tactical athletes because both occupations require periods of rigorous physical performance in which extreme stress, heavy gear and equipment, and life threatening conditions are involved (Sefton & Burkhardt, 2016). As tactical athletes, firefighters and law enforcement officers are often thought of as a fit and healthy population however, there is evidence to show the health status of this population may not be as good as we assume it is.

CVD and its associated risk factors are highly prevalent in firefighters, law enforcement officers, and other tactical athletes such as military personnel (Brook et al., 2010; Gan et al., 2012; NIOSH, 2007; Soteriades, Smith, et al., 2011). Mortality due to CVD accounts for the greatest percentage of on-duty firefighter deaths (Fahy, 2020). The number of deaths due to CVD in firefighters is greater than the number of deaths due to smoke inhalation with over 45% of

on-duty fatalities related to CVD in this population (Kales et al., 2007; Soteriades, Smith, et al., 2011). These CVD related fatalities typically occur in firefighters who have underlying CVD or excessive prevalence of modifiable risk factors (Kales et al., 2003b; Soteriades, Smith, et al., 2011). In law enforcement officers, a case distribution study on sudden cardiac death using data from the National Law Enforcement Officers Memorial fund found of the 4,553 on-duty deaths, 331 were sudden cardiac deaths (Varvarigou et al., 2014). Also reported in this study was data from the Officer Down Memorial Page which similarly revealed 359 sudden cardiac deaths out of 4,661 on-duty deaths of law enforcement officers.

In addition to high prevalence of CVD, the rates of overweight and obesity in both career and volunteer firefighter differ only slightly compared to the rates of the US population (Poston et al., 2011). In a sample of 154 midwestern firefighters, 53% were overweight with a BMI of 25-29.9 and 33% were obese with a BMI greater than 30 (Eastlake et al., 2015). In 2014, the obesity rate of the general population was 35.5% at the time of the study (Can & Hendy, 2014). Similarly, in a study population of 968 firefighters, 51% were overweight and 37% were obese, leaving only 12% in the normal BMI category of 18.5-24.9 (Baur et al., 2011). From this study, 88% of firefighters had a BMI greater than 25 which is similar to the overweight/obesity rate in law enforcement officers according to Ramey (2003). In a cross-sectional study from 2003 with 672 law enforcement officers, the incidence of individuals categorized as overweight by BMI was 82.6% compared to 74.4% in the 1999 BRFSS general population (Ramey, 2003). In a 2014 study, obesity prevalence in a sample of 172 police officers was around 42% (Can & Hendy, 2014).

Risk Factors of Cardiovascular Disease and Obesity in Tactical Athletes

In this group of tactical athletes, CVD risk factors are extremely prevalent due to the presence of occupational risk factors in addition to the typical lifestyle risk factors faced by the general population (Brook et al., 2010; Gan et al., 2012; Kales et al., 2003b; NIOSH, 2007;

Soteriades, Smith, et al., 2011). Occupational risk factors for CVD in firefighters include exposure to high noise levels (Gan et al., 2012), physical demand related to heat dissipation, physiological stress, and energy demands (Eastlake et al., 2015; Guidotti, 1992), environmental toxins such as carbon monoxide, hydrogen cyanide, aerosolized chemicals, and airborne particulate matter (Brook et al., 2010; Eastlake et al., 2015), psychological stress (Puttonen et al., 2010), shift work (Esquirol et al., 2009), fire station food environment (Soteriades, Smith, et al., 2011), little to no warm up time prior to strenuous activity (Guidotti, 1992), and no mandated physical fitness requirement post hire (Soteriades, Smith, et al., 2011). Similarly, in police officers, shift work (Franke et al., 1998; Violanti et al., 2009), critical incident activities (Weiss et al., 2010), stress, poor eating habits (Franke et al., 1998), and sudden strenuous activity (Gaines et al., 1993) contribute to CVD risk.

Tactical athletes are exposed to lifestyle risk factors similar to individuals in the general population. These risk factors include excessive body weight or high BMI (Soteriades et al., 2005), elevated blood pressure (Eastlake et al., 2015; Kales et al., 2009; Ramey, 2003), elevated blood lipids (Esquirol et al., 2009), poor work-life balance (Puttonen et al., 2010), family history of CVD (NIOSH, 2007), over consumption of high energy convenience foods (Lowden et al., 2010), and smoking (Eastlake et al., 2015; Ramey, 2003). In a study predicting death due to cardiac events in male firefighters, the presence of hypertension or smoking each resulted in a four-fold greater risk of death (Geibe et al., 2008). In this study, obesity was near significant with risk of a similar magnitude as hypertension and smoking. Additionally, 90% of the firefighters who had a fatal on-duty cardiac event were overweight. In firefighters without typical CVD risk factors, on-duty fatalities due to CVD are unlikely (Kales et al., 2003a).

The majority of occupational hazards are nonmodifiable, especially by public health practitioners, but many lifestyle risk factors are modifiable. In a case control study, Kales et al. (2003b) found the majority of major CVD risk factors in firefighters were not only modifiable,

but detectible in regular physical exams. Yet 75% of the firefighters who died from CVD in this study had not had a recent medical exam. In a cross-sectional study by Eastlake et al. (2015) assessing the lifestyle and safety practices of firefighters and their relation to cardiovascular risk factors, it was found that lifestyle factors, particularly BMI, had a greater impact on CVD risk compared to occupational hazards. The author's concluded CVD risk factors related to lifestyle could be combated with appropriate education.

Obesity is not only a health concern for tactical athletes in and of itself, but also a risk factor for CVD. In a five year cohort study on obesity and CVD risk for firefighters, researchers found the prevalence of obesity in participants ranged from 35% to 40% (Soteriades et al., 2005). Poston et al. found the age-standardized overweight and obesity rates in firefighters from their cohort study were greater than the rates of the US population (Poston et al., 2011). Similarly, the obesity prevalence in law enforcement officers is estimated to be 40% which is also greater than that of the general population (Can & Hendy, 2014). In a 2,000-participant study with law enforcement officers, the average BMI was 27.4 ± 3.4 which is categorized as overweight (Gendron et al., 2019). Before discussing how it is a risk factor, the accuracy of BMI in assessing obesity for this population must be addressed. One could argue in physically active groups BMI is not always an accurate estimation of body composition because it cannot distinguish between fat mass and muscle mass (Poston et al., 2011). In a cohort of firefighters, BMI, waist circumference, and body fat percentage were taken to assess the accuracy of BMI in categorizing firefighters as normal weight, overweight, or obese (Poston et al., 2011). In this group, an example of a false positive would be an individual with a high BMI categorizing them as obese but a low waist circumference and a low body fat percentage. This study found low rates of misclassification when using BMI and concluded BMI was an adequate classification measure in firefighters. An investigation on the accuracy of BMI classification in police officers was also done by Alasagheirin et al. (2011). Researchers in this study compared BMI classification to results from

dual energy X-ray absorptiometry and found BMI was actually under classifying participants in this study when compared to the classification based on body fat percentage. Of the 84 participants in this study, 70.2% were classified as obese using body fat percentage whereas only 39.3% were classified as obese using BMI classifications.

There is strong evidence to suggest obesity has negative impacts on health, particularly related to CVD (Poston et al., 2011; Ramey et al., 2008; Soteriades, Smith, et al., 2011). In male law enforcement officers, it was found the presence of modifiable CVD risk factors increased significantly from those in the normal weight BMI category to the overweight and the obese categories (Gendron et al., 2019). Poston et al. found over half of the firefighters categorized as obese in their study had elevated blood pressure leading to poor cardiovascular health profiles (Poston et al., 2011). Soteriades, Targino et al. (2011) conducted a four year, 340-participant cohort study and determined obese firefighters are twice as likely to develop electrocardiographic abnormalities and left ventricular hypertrophy, which increases the risk of CVD related morbidity and mortality, compared to normal weight firefighters. These researchers also concluded their results may be applicable to other tactical athletes, such as military and law enforcement officers. In a study assessing the relationship between CVD risk factors and lifestyle and safety practices, it was found that BMI significantly contributed to the risk of developing high cholesterol (Eastlake et al., 2015).

In the firefighting population, which is at high risk for CVD, there are no regulatory guidelines for maintaining a certain BMI or physical fitness level once an individual is accepted into the profession (Baur et al., 2011; New York State Division of Criminal Justice Services, 2016; Soteriades, Smith, et al., 2011). Weight and fitness requirements are rarely implemented for firefighters and law enforcement officers because it can be considered discriminatory if disciplinary action is taken as brought up in several lawsuits (McNicholas and McNicholas LLP, n.d.; Moore, 1996; New York State Division of Criminal Justice Services, 2016; Rollins, 2021).

In fact, it was previously proposed that fitness standards be used in place of a mandatory retirement age for firefighters due to diversity in age related physical decline (Saupe et al., 1991). This proposal was rejected in fear of legal implications and the impact fitness standard requirements would have on the eligibility of the current workforce, regardless of age (Saupe et al., 1991). However, this lack of regulation, just as it may be, could have negative impacts on the health of this population because high BMI and low physical fitness are associated with CVD risk factors and increased occupational safety risks (Baur et al., 2011; Orr et al., 2021; Soteriades, Smith, et al., 2011). Baur et al. (2011) found improvements in cardiorespiratory fitness in career firefighters had positive impacts on CVD risk factors such as BMI, blood pressure, HLD cholesterol, and fasting blood glucose levels. Increasing cardiorespiratory fitness of an obese firefighter to greater than 12 METS not only increases their physical fitness, but it could lead to a decrease in BMI of up to 1.6 units (Baur et al., 2011).

Poor Diet as a Major Risk Factor for CVD and Obesity

A cross sectional study by Yang et al. (2014) used the modified Mediterranean Diet Score system (mMDS) to evaluate diet quality in firefighters. The Mediterranean Diet Score is assessed based on ten food domains including olive oil, fruits and vegetables, sweet desserts, breads and starches, fried food, wine, alcohol consumption, drink with meals, ocean fish, and fast food or takeout food. Findings from this study showed normal weight firefighters had a higher (better) mMDS compared to overweight/obese firefighters. In addition, they found for every single unit increase in mMDS, blood lipid levels improved with a 0.4% decrease in LDL cholesterol and a 0.4% increase in HDL cholesterol. Yang et al. (2014) concluded the main reason overweight/obese participants had lower scores was due to greater intake of sugar sweetened drinks and a greater likelihood of consuming fast-food meals. In a 2,905 sample of law enforcement officers, it was found individuals in the obese BMI category had higher intake of soft drinks compared to the overweight and normal weight groups (Gendron et al., 2019).

This population is also subject to chronic shift work due to their occupation (Esquirol et al., 2009; Franke et al., 1998; Violanti et al., 2009). Shifts may include morning, afternoon or night timeframes, rotating shifts, or particularly in the case of firefighters, 48 hours on-duty followed by 96 hours off-duty (Violanti et al., 2009; *Work schedule*, n.d.). Circadian rhythm, which is disrupted by shift work, is linked to both sleep and eating patterns and the activity of hunger and satiety hormones (Lowden et al., 2010). It has been shown shift work negatively effects an individual's nutritional intake related to the timing and content of their meals which impacts diet quality (Esquirol et al., 2009; Lowden et al., 2010; Soteriades, Smith, et al., 2011). In a review, Lowden et al. (2010) summarized main differences in eating patterns between day and shift workers and found energy intake in a 24-hour period is similar, but the sources and timing of calorie intake differed. Broadly, shift workers had lower quality diets (less fiber, vitamins, and minerals, more simple carbohydrates and fats) compared to day workers. The emergency work done by firefighters and law enforcement officers is unpredictable and can disrupt regular meal patterns (Soteriades, Smith, et al., 2011). Uncertainty in when they will be called out limits the amount of time that can be spent cooking and eating which leads to the habitual intake of fast-foods which tend to be high in saturated fats, simple carbohydrates, and calories, and low in fruits and vegetables (Soteriades, Smith, et al., 2011). A study assessing the relationship between lifestyle practices and CVD risk factors of firefighters found 90% of participants consumed fast-food at least 1-3 times per week and 10% responded they consumed fast-food at least 4-5 times per week (Eastlake et al., 2015). In addition to high intake of fast-foods, foods that are high in fat and simple carbohydrates are part of the "firehouse culture" and are often consumed on-duty (Soteriades, Smith, et al., 2011). In addition, Esquirol et al. (2009) found shift workers consumed more fat that was high in cholesterol and saturated fatty acids compared to day workers. These researchers also found the proportion of shift workers who had elevated triglyceride levels was one and a half times greater compared to day workers. In a case control study, there was over a four-fold increase in the likelihood of an on-duty death due to coronary heart disease (CHD) in

firefighters who's total cholesterol was greater than 200 mg/dL (Kales et al., 2003b). A survey-based study found 94% of the 28% in the study population with high cholesterol incorrectly thought one lowered their cholesterol by eating foods that are low in cholesterol (Kay et al., 2001). In a cross-sectional study on shift work in police officers, it was found the midnight shift officers had lower HDL cholesterol compared to the day shift officers which could be attributable, in part, to a difference in food choices, sleep cycles, and physical activity levels (Violanti et al., 2009). This study also assessed the presence of components for metabolic syndrome and reveled the midnight shift officers had four-fold greater prevalence of hypertension, elevated waist circumference, and low HDL cholesterol. A systematic review on CVD in US firefighters concluded exercise and diet changes in this population would greatly help the lower several CVD risk factors (Soteriades, Smith, et al., 2011).

Need for Intervention

Even as firefighter health is being negatively impacted by modifiable risk behaviors, individual units or departments are not adjusting or addressing these risks. Through the Fire Fighter Fatality and Prevention Program, the National Institute for Occupational Safety and Health (NIOSH) has found fire departments in which an on-duty cardiac death has occurred have made few to no changes to prevent further fatality (NIOSH, 2007). Areas such as physical evaluation and wellness programs are not being established or encouraged by fire departments for their firefighters (NIOSH, 2007). From 1998-2004, NIOSH investigated 131 fire departments in which a fatality related to CVD occurred. The investigation found 39% of departments had a department fitness program, but only 8% of those departments had mandatory participation requirements. To encourage healthier work environments, professional governing bodies must take the lead in promoting a healthy workforce. The National Fire Protection Association (NFPA) establishes voluntary standards such as the Standard on Comprehensive Occupational Medical Program and the Standard on Health-related Fitness Programs for Fire Fighters (NIOSH, 2007).

The International Association of Fire Fighters (IAFF) and the International Association of Fire Chiefs (IAFC) have also published voluntary guidance, such as the Fire Service Joint Labor Management Wellness-Fitness Initiative, to help protect firefighter health and safety (NIOSH, 2007). The Fire Fighter Fatality and Prevention Program acknowledges the need for a mandatory comprehensive wellness/fitness program to help decrease and prevent CVD incidence and fatalities in firefighters (NIOSH, 2007). Several studies have called for medical evaluation guidelines for this population that include assessment of BMI, blood lipid levels, and blood pressure, all of which are indicators of CVD risk (Kales et al., 2003a; NIOSH, 2007; Soteriades, Targino, et al., 2011).

The SHIELD program was developed for use in an intervention trial for law enforcement officers to promote improvements in health related to diet, physical activity, body weight, stress, sleep, tobacco use, and alcohol use (Kuehl et al., 2014). The program was designed to incorporate individuals into teams because the organizational structure and culture of law enforcement is naturally team based. In this program, teams were formed based on job descriptions and job location as officers who work together are a tight knit group because they rely on each other for safety on-duty. Participants in this program completed a baseline medical assessment and a preprogram survey assessing nutrition, sleep, health perceptions, musculo-skeletal discomfort, stress, healthy eating, and physical activity, and burnout using validated scales. The program intervention consisted of a team box containing a scripted team leader manual, 12 scripted, peer-led, team-based sessions and individual workbooks. Participants were assessed using the same survey at a 6-month follow up. This team-based program resulted in improved health in the following areas, fruit and vegetable intake, sleep quality and quantity, tobacco use, and alcohol use. The researchers in this study stated there are few law enforcement departments with programs related to health promotion and disease prevention.

Behavior change must be voluntary, so it is encouraging that in a survey-based study, firefighters expressed interest in learning about the prevention of CVD (Scanlon & Ablah, 2008). The respondents also reported they believed their departments should assist in modifying CVD risk factors. In another study assessing the knowledge and behaviors of firefighters related to CVD, 79% of the firefighters felt their employer was not addressing overall health adequately (Kay et al., 2001). Ninety seven percent of those who felt their health was not being adequately addressed desired more health related information be provided by their employers. Almost identical reports were given in a study 15 years later (Yang et al., 2015). The later study also found firefighters with an obese BMI had less self-efficacy related to nutritional knowledge when compared to firefighters with a normal BMI (Yang et al., 2015).

In a study conducted to inform interventions targeted at reducing morbidity from CVD among law enforcement officers, the following identified barriers to lifestyle changes included peers, lack of administrative support, lack of adequate exercise equipment, fatigue, irregular hours/lack of time, limited food choices, and no personal motivation (Ramey et al., 2008). Specifically related to dietary intake, a survey based cross-sectional study in law enforcement officers revealed the following perceived barriers to healthy eating in order of greatest responses, busy lifestyle, irregular hours, lengthy food preparation time, the price of healthy foods, and cooking skills (MacKenzie-Shalders et al., 2020). Participants in this study reported health and convenience were the most important factors influencing their food choice. When asked how willing they were to adopt healthier eating habits, participants 80% of participants in this study said they were very willing and 14% said they were willing. The authors of this study recommended nutrition programs for this population focus on how to change eating habits in addition to providing information on what foods should be incorporated into a nutritious diet.

Behavior Modification Theories to Ensure Program Effectiveness

The intervention in this study uses several behavior modification theories including self-determination theory (SDT), social cognitive theory (SCT), the Köhler effect, and group dynamics. Including these behavior modification theories in the design of the intervention increases the likelihood of its effectiveness in encouraging sustainable positive change related to risky behaviors.

SDT posits biological, social, and cultural conditions have an influence on self-determination factors, such as engagements, wellness, and psychological growth (Deci, 2016). SDT defines both intrinsic and extrinsic sources of motivation in individuals and how outside factors influence their motivation. SDT incorporates social aspects of behavior change with the construct of relatedness, which is defined as one's sense of belonging, connectedness, and need for close relationship with others. SDT also consists of constructs that are internally based, such as autonomy and competence, which are defined as one's internal perceived locust of control in which they feel they are the cause of their behaviors and confidence in one's ability to successfully perform knowledge, skills, or behaviors, respectively. These constructs help explain the personal and social components of behavior change. The constructs of STD (autonomy, competence, and relatedness) are defined in Table 1 in addition to their application within the program and their assessment measurement (Patrick & Williams, 2012; Ryan & Deci, 2000). In a quasi-experimental study, SDT was applied in an educational intervention to promote physical and mental health in military spouses (Mailey et al., 2019). The team-based intervention allowed for relatedness between participants, competency by education, promotion of small behavior changes, and autonomy by allowing participants to select the behavior changes they wanted to emphasize based on their personal health goals. Both groups completed a health intervention, but the intervention group received more materials and had more to do than the control group. While the intervention group was not more effective than the control group, a positive change in both

mental and physical health was seen in participants. Researchers speculated the lack of a difference between the groups was related to the stage of change participants in the control group were in. This study did not include measures to assess the effect of the SDT constructs.

SCT uses a reciprocal model to explain behavior, understanding personal factors, environmental influences, and behavior consistently interact. Verbal/social persuasion, vicarious experience, and reinforcement are constructs that can be considered environmental influences. Verbal/social persuasion is the dynamic interaction of the person, behavior, and the environment in which the behavior is performed (Rimer et al., 2012). Vicarious experience, also referred to as modeling or observational learning, is behavioral acquisition that occurs by watching the actions and outcomes of others' behavior. Reinforcements are responses to a person's behavior that increase or decrease the likelihood of reoccurrence. Reinforcements can be both external from environmental influences and internal from personal factors. Constructs more closely tied to personal factors include mastery experience and self-efficacy. Mastery experience, also referred to as behavioral capability, is the knowledge and skills needed to perform a given behavior, whereas self-efficacy is confidence in one's ability to take action and overcome barriers to perform a behavior. The constructs of SCT (vicarious experience, verbal/social persuasion, reinforcement, and self-efficacy) are further defined in Table 1 in addition to their application within the program and their assessment measurement (Bandura, 1994; LaMorte, 2018). SCT has previously been used in a nutrition behavior study assessing self-regulation, self-efficacy, outcome expectations, and social support (Anderson et al., 2007). Participants in this study with high family (social) support had overall healthier diets, less fat, more fiber, and more fruits and vegetables, compared to those who had less support.

The Köhler effect occurs when an individual works harder in a group setting involving competition than they would in an individual setting (Kerr & Hertel, 2011; Osborn et al., 2012). Competition is the main construct of the Köhler effect and is built on the observation of weaker

performers putting forth more effort to achieve the same level of performance as the stronger performers. This construct is defined in Table 1 in addition to its application within the program and its assessment measurement. The Köhler effect has been strongest in conjunctive task conditions in which the productivity of the group is impacted by the lowest performing team member (Feltz et al., 2011). A study by Osborn et al. (2012) found individuals had faster times in the relay swim than they did in individual swims and attributed this to the Köhler effect. In a study titled Buddy Up: The Köhler Effect Applied to Health Games, participants were partnered with a virtual teammate whose performance was manipulated to always be better than the participant's performance in exercise games on a PlayStation (Feltz et al., 2011). Researchers concluded participants had increased task persistence when virtually working out with a superior partner compared to when they did so alone.

Group dynamics is made up of several constructs that create cohesion within a group and promote engagement, encouragement, and improve the effectiveness of intervention programs (Mailey et al., 2019; Martin et al., 2009). Constructs include identity, size, role, and norms. Identity is when group members see themselves as team members rather than individuals. The size of a group contributes to group dynamics because it impacts the degree to which each group member feels their contribution matters to the group (*Group Structure*, n.d.). A role within a group refers to the attitude and behavior of individuals in accordance with the expectations from each other and are shaped and developed according to the needs and preference of both the individual and the group (Gençer, 2019). Norms contribute to group dynamics because they define rules that specify what kind of behavior is appropriate or unwanted within the group (Gençer, 2019). The constructs work together to create a sense of cohesion within the group and may promote engagement, encouragement, and improve the effectiveness of the program (Mailey et al., 2019; Martin et al., 2009).The constructs of group dynamics are further defined in Table 1 in addition to their application within the program and their assessment measurement. In an

intervention study on weight loss, Nackers et al. (2015) assessed the association between group dynamics and weight loss in 125 women who were obese. Participants who had strong group cohesion attended more of the intervention sessions which is critical for success in weight loss programs. Less weight loss was achieved in groups that experienced more conflict. From this study, group dynamics was shown to have both positive and negative impact on this obesity treatment intervention (Nackers et al., 2015).

Purpose

The Fittest Force Challenge is a comprehensive online nutrition and physical activity intervention, based on group dynamics, the Köhler effect, self-determination theory, and social cognitive theory, among a diverse group of US fire and law enforcement departments, to improve diet and physical activity behaviors, as leading modifiable obesity and CVD risk factors. The present study aims to determine the effectiveness of the Fittest Force Challenge in improving modifiable lifestyle-related risk factors, mainly diet and physical activity, related to obesity and CVD following the completion of the Challenge.

CHAPTER III

METHODS

This study uses a quasi-experimental pre-/post-test design to determine the effectiveness of an online theory-based intervention, the Fittest Force Challenge, in improving the health profile of participants. This team challenge program began on January 4th, 2020 and ended 12 weeks later on March 28th. The Challenge was designed to last 12 weeks, in order to allow behavior change to take place by the participants (Lally et al., 2010).

Participants

All participants in this study, hereafter referred to as the Challenge, were active firefighters, volunteer or career, or law enforcement officers. Past the requirement of being an active member in one of the above professions, inclusion criteria were limited to being greater than 18 years of age and willing and healthy/able to participate in this Challenge. Participants in this study were recruited using a convenience sample by directly emailing local departments and departments who have been in contact with the Tactical Fitness and Nutrition Lab at Oklahoma State University (OSU) and via social media accounts of the lab. Originally, participant recruitment was only directed to departments in Oklahoma due to internal OSU funding source. Low interest in Oklahoma lead to national recruitment using the same strategy of direct emailing and social media accounts of the lab. Snowball sampling also occurred, as participants accepted at the beginning of the recruitment period were encouraged to invite other firefighters and law enforcement officers. In the emails and social media posts, a short flyer describing the program

was provided. The flyer instructed interested individuals to contact the PI of the study and to attempt to form a group of 4-5 members consisting of other qualifying first responders from their department. The PI created teams of 4-5 with individuals from the same department. In the case that there was not enough interest in their department, individuals were placed on teams with individuals from other departments to make a full 4–5-member team. Recruitment ended on January 6, 2020, half-way through the first week of the program. All participants provided informed consent, and study procedures were approved by the Institutional Review Board in November 2020 (IRB-20-492-STW).

Procedures

Once accepted to the Challenge, participants were provided logins to an online learning management platform, Canvas (Instructure, Inc., Salt Lake City, UT), where they could access challenge materials. Challenge features and materials were created to incorporate four behavior modification theories (i.e., SDT, SCT, Köhler Effect, and Group Dynamics), increasing likelihood of program effectiveness in changing health behaviors, by kinesiology and nutrition experts on the research team (JD and JJ, respectively). Application of these theories as components of the Challenge can be found in Table 1. Components of the Challenge included weekly nutrition and physical activity videos, weekly nutrition and physical activity assignments associated with the videos, daily individual and team weekly point tracking, bonus point opportunities and leaderboard standings.

For each of the 12 weeks, each participant was tasked with completely watching that week's nutrition video and physical activity video, completing the nutrition assignment and the physical activity assignment associated with that week's video, recording their individual points, and checking the leaderboard. In addition to the individual responsibilities, teams were instructed to assign the following roles within their groups: team captain, point keeper, motivator, video compliance officer, and assignment compliance officer. These roles enhanced group cohesion and

promoted further engagement with the program. The roles of motivator, video compliance officer and assignment compliance officer were left up to the teams for interpretation on their team contributions. The point keeper role was tasked with receiving and/or collecting weekly individual point totals from team members and reporting them to the team captain by Sunday evenings. The team captain was then tasked with leading their team however they see fit, determining if all team members watched all videos and completed all assignments for bonus point eligibility, which will be discussed below, and reporting their team's weekly point total by posting it on the weekly leaderboard (i.e., a Canvas Discussion Board).

Individuals earned points to contribute to the total team score by completing three daily SMART goals related to their overarching, long-term health goals. Participants were responsible for tracking their daily SMART goal achievement throughout the week. Participants then communicated their weekly point total of up to 21 points maximum per week to the point keeper for their team. Point keepers collected points and reported the team's weekly total to the team captain, who then posted this total to the weekly leaderboard on Canvas. In addition to the total points from each team member's daily SMART goal achievement, teams could earn four bonus points if all team members fully watched the nutrition and physical activity videos and completed the nutrition and physical activity assignments for the week. Study coordinators averaged the total weekly team points posted by the team captain on the weekly leaderboard, due to the fact that teams had varying numbers of members, added 4 bonus points if eligible, to the average score, and posted all teams' weekly average scores with bonus to the overall program leaderboard.

Intervention Theory-based Components and Construct Assessments

The three constructs of SDT an intervention should focus on to ensure effectiveness related to SDT by shifting individuals from extrinsic to intrinsic motivation are competence, relatedness, and autonomy. These three constructs are defined as follows and are highlighted in Table 1. (Patrick & Williams, 2012; Ryan & Deci, 2000). Autonomy is the internal perceived

locus of control/causality of behavior. Competence is one's efficacy and confidence in their knowledge, skills, and ability to successfully perform a behavior. Relatedness is one's sense of belonging and connectedness to others. In the present study, the construct of autonomy was incorporated by allowing participants to create their own SMART goals so they could feel internal control over their behaviors. Competence was promoted by participants repeatedly completing their SMART goals which enhanced efficacy and confidence in behavior change. The team aspect of the Challenge fulfills the relatedness construct by providing a sense of connectedness in a shared experience among team members. These constructs were assessed via the BREQ-2, which has previously been used in education intervention programs (Markland & Tobin, 2004; Teixeira et al., 2012; Wilson et al., 2006). Previous studies have shown the BREQ-2 is valid and reliable in assessing stages of the self-determination continuum with respect to motivation to exercise in the following populations, Spanish adults, future healthcare professionals, and adults with chronic musculoskeletal pain (Brooks et al., 2018; Mahony et al., 2019; Murcia et al., 2007). However, this assessment was modified to assess SDT stages as related nutrition and exercise and used in a different population. The following is an example question from our adapted BREQ-2 questionnaire: Using the scale below, how true do you feel the following statement currently is for you: I value the benefits of a healthy lifestyle. (1 (not true for me), 2, 3 (sometimes true for me), 4, 5 (very true for me)).

The SCT constructs vicarious experience (also known as modeling), mastery experience, verbal persuasion, reinforcement (also known as reciprocal determinism and expectations), increase self-efficacy and the likelihood of behavior change. The constructs of SCT are defined as follows and are highlighted in Table 1 (Bandura, 1994; LaMorte, 2018). Vicarious experience is defined as the observation of others successfully performing a behavior whereas mastery experience is defined as the opportunity for an individual to practice that behavior. The construct verbal/social persuasion, also referred to as expectations and reciprocal determinism, states when

an individual is persuaded, they have the ability to perform a behavior successfully. Reinforcement is defined as both the internal and external feedback that will influence an individual performing a behavior again. Finally, self-efficacy is defined as one's confidence in their ability to successfully perform a behavior. In the present study, the construct vicarious experience was applied when participants visualized the expert researchers provide example behaviors in the videos and when participants observed their team members making lifestyle changes to achieve their SMART goals. Mastery experience was incorporated when participants practiced the behaviors they learned from the videos, assignments, and from other team members. By learning the benefits, risks and having expectations set for accomplishing behavior change, verbal/social persuasion was endorsed in this study. Behavior change was externally reinforced by earning points and internally reinforced by individuals achieving goals they set for themselves. Finally, the construct of self-efficacy was applied when practices from the above constructs came together to instill confidence in one's ability to perform a behavior. These constructs were assessed via the ESES, which has previously been used in education intervention programs (Kroll et al., 2007). Studies have shown the ESES is valid and reliable in assessing self-efficacy to exercise in the following populations of adults with neurological diseases, older adults, and adults with spinal cord injury (Ahlström et al., 2015; Nooijen et al., 2013; Rydwik et al., 2014). However, this assessment was modified to assess SCT as related nutrition and exercise and used in a different population. The following is an example question from our adapted ESES questionnaire: Using the scale below, how true do you feel the following statement currently is for you: I am confident that I can overcome barriers and challenges with regard to living a healthy lifestyle if I try hard enough (1 (not at all true for me), 2, 3 (moderately true for me), 4, 5 (always true for me)).

The Köhler effect is seen during competition when individuals push themselves to achieve more than they would in the absence of competition, especially when they are part of a

group/team (Kerr & Hertel, 2011). The Köhler effect was incorporated into the Challenge via revealing weekly team point totals to all teams in the Challenge on the leaderboard. Teams earned more points when individuals on the teams accomplished more of their daily SMART goals throughout the week. Additionally, teams were eligible for bonus points if all team members completed the nutrition and physical activity videos, and the nutrition and physical activity assignments for the week. These constructs were not directly assessed in this study. More information can be found in Table 1.

The constructs of group dynamics include identity, size, role, and norms. The constructs work together to create a sense of cohesion and improve participation in programs such as the Challenge (Mailey et al., 2019; Martin et al., 2009). To participate in the Challenge, departments had to have enough interest in the Challenge to form teams of at least three or be willing to let the study coordinators form teams with other interested individuals outside of their departments. Teams were working towards a common goal of improved health and were able to select their own name to form a team identity. Team size was capped at six individuals to promote optimal group size for participation. At the team's discretion, each individual was assigned a role to support the team's efficacy and progress in the Challenge. Norms in the Challenge related to each individual earning points for the team, and bonus points for 100% participation in the weekly Challenge components. These constructs were assessed via the Community Readiness Assessment which has previously been used in education intervention programs (*Community Readiness Tools page*, 2019). Previous studies have used the Community Readiness Assessment to understand key factors that influence a community's preparedness to take action on issues such as childhood obesity, local smoke-free policy, and the establishment of a community farmers market (Findholt, 2007; Freedman et al., 2012; York et al., 2008). However, this assessment was modified to assess community readiness as related to nutrition and exercise and used in a different population than previous studies. The following is an example question from our

adapted Community Readiness Assessment questionnaire: Using the scale below, how supportive do you feel other firefighters/officers in the department are as a whole of improving the health of the force? (1 (not at all), 2, 3, 4, 5, 6, 7, 8, 9 (fully)).

Table 1. Intervention Theory-based Components and Construct Assessments

Theory	**Construct**	**Construct Definition**	**Construct Application within the Program**	**Assessment of Construct Effectiveness**
Self-determination theory (SDT) (Mailey et al., 2019; Patrick & Williams, 2012; Ryan & Deci, 2000)	Autonomy	Internal perceived locus of control/ causality of behavior *Psychological need	*Participants chose their own daily health goals. *The Challenge provides lots of tools while explaining the reason for using such tools to encourage individual buy-in and interest.	BREQ-2 (Markland & Tobin, 2004; Teixeira et al., 2012; Wilson et al., 2006)
	Competence	Efficacy, confidence in one's ability to successfully perform a behavior, knowledge and skills *Psychological need	*Participants repeatedly complete daily goals for points to encourage confidence in their ability to be successful. *Participants complete activities utilizing and reinforcing information gained from the educational videos to also increase confidence in their	

			ability to use the information.	
	Relatedness	Sense of belonging/ connectedness, need for close relationships with others *Psychological need	*There is a team aspect to this challenge.	
Social Cognitive Theory (SCT) (Bandura, 1994; LaMorte, 2018)	Vicarious experience (modeling, observational learning)	Observe others successfully performing behavior	*Participants may see the expert researcher performing the behavior in a video and may also see teammates performing the behavior.	ESES (Kroll et al., 2007)
	Mastery experience (behavioral capability)	Providing an opportunity to practice the behavior *Cannot be too easy or barriers will easily end behavior *Must overcome some obstacles	*Participants repeatedly complete daily goals for points to encourage confidence in their ability to be successful. *Participants complete activities utilizing and reinforcing information gained from the educational videos to also increase confidence in their ability to use the information.	
	Verbal/social persuasion	Persuade person they have what it	*The Challenge videos explain the	

	(expectations, reciprocal determinism)	takes to successfully perform behavior and the rationale as to why *Boost must be realistic or a major failure will end behavior	rationale for changing behaviors, including benefits and risks, establishing expectations. *Participants earn points for performing behaviors and interacting more with the program. *Researchers and teammates provide feedback to each other to encourage successfully performance of behaviors.	
	Reinforcement	Internal/external feedback that influence likelihood of performing behavior again	*Participants earn points for performing behaviors and interacting more with the program. *Researchers and teammates provide feedback to each other to encourage successfully performance of behaviors.	
	Self-efficacy	Confidence in ability to successfully perform behavior	*The above four constructs when present increase self-efficacy.	

Köhler effect (Kerr & Hertel, 2011; Mailey et al., 2019)	Competition	Weaker performers will put forth more effort to achieve the same level as the stronger performers	*Individual points contribute to the team score. Teams then compete against other teams to be at the top of the leaderboard.	N/A
Group Dynamics & Cohesion (Estabrooks et al., 2011; Mailey et al., 2019; Martin et al., 2009; Nackers et al., 2015)	Identity	When applied, these four dynamics increase group cohesion, which will increase participation in the program.	Team name, motto	Community Readiness Assessment (*Community Readiness Tools page*, 2019)
	Size		Team sizes were ideally around 4-5 and limited to 6 people	
	Roles		Team members were assigned a job/role *Team captain, point keeper, motivator, video compliance officer, and assignment compliance officer	
	Norms		*Teams were provided a team contract that allowed them to establish group norms including communication routes and frequency, meeting times if desired, roles, etc. *Points were earned toward the weekly team total by individuals achieving their	

			individual goals and bonus points were earned by all team members completing all weekly activities	

Data Collection

The pre-program assessment was conducted via an online survey using Qualtrics (Qualtrics, Provo, UT) and was taken by participants between December 28, 2020, and January 4, 2021, or before beginning the Challenge. Demographic data collected on the pre-program assessment survey included department type, department location, rank, job title/ position, age, sex, relationship status, child status, ethnicity, education, height, and weight. The pre-program assessment also contained the International Physical Activity Questionnaire Short (IPAQ short) to determine physical activity level (Craig et al., 2003; Lee et al., 2011; van Poppel et al., 2010), a 24-hour food recall to determine nutrient content [using ESHA Food Processor nutrient analysis software (ESHA Research, Food Processor, version 11.6.441, 2018, Salem, OR)] and dietary quality [using the Healthy Eating Index 2015 (USDA, 2020)], dietary and herbal supplement use questions, and perceived knowledge questions to determine nutrition and physical activity knowledge. The pre-program assessment also evaluated constructs of the behavior modification theories on outcomes. Evaluation tools were adapted to fit this specific intervention, related to nutrition and physical activity behaviors, and included the Behavioral Regulation in Exercise Questionnaire (BREQ-2) for SDT (Markland & Tobin, 2004; Teixeira et al., 2012; Wilson et al., 2006), Exercise Self-efficacy Scale (ESES) for SCT (Kroll et al., 2007), and Community Readiness Assessment for the group level (*Community Readiness Tools page*, 2019). Prior to entering the challenge, participants were recommended to complete the Physical Activity Readiness Assessment (PAR-Q) (Warburton, 2021) and to consult their doctor/dietitian if they

were on a special diet to ensure their safety in participating in this Challenge. The results of the PAR-Q were for personal safety and use and were not collected by the researchers.

Program participation data was collected using Canvas analytics. Study coordinators tracked individual access reports, number of videos viewed, proportion of the total video viewed, number of assignments submitted, number of times individual points were submitted, and proportion of total points possible earned (252 possible individual points) to assess individual participation in the Challenge. Study coordinators also tracked individual page views, total actions, and cumulative time spent on Canvas. To assess team participation, leaderboard point posting consistency and number of times bonus points were earned was tracked.

The post-program assessment was taken by participants again using Qualtrics between March 29, 2021, and April 5, 2021, immediately following completion of the Challenge. The post-program survey was the same as the pre-program assessment. Participants were also invited to attend a post-program focus group to determine what aspects of the Challenge worked well, what could be improved, preference for the Canvas platform and delivery method, feasibility and likelihood for future use within their department, and content acceptability.

Data Analysis

Results from the pre- and post-assessments were exported to Excel so IPAQ, BREQ-2, ESES, and Community Readiness scores could be calculated. The HEI scores were calculated using an excel calculator built by one of the researchers utilizing food group intake amounts, as well as nutrient intake amounts from the nutrient analysis conducted on the participant's 24-food recalls using ESHA. The HEI results in a total score that ranks diet quality from 0 (being extremely poor) to 100 (being extremely good) as well as thirteen subcomponent scores ranging from 0 to 5 or 10 points which can be entered directly into SPSS. IPAQ scores were coded as 0, 1, 2 to represent low, moderate, and high levels of physical activity, respectively, as determined by the

questionnaire. These scores were summed and entered as a total IPAQ score. BREQ-2 scores from each of the five subscales, amotivation, external regulation, introjected regulation, identified regulation, and intrinsic regulation are based on a 5-point Likert scale (0 = not true for me, 4 = very true for me) (Verloigne et al., 2011). The subscale scores were summed for an overall BREQ-2 score. Amotivation, external regulation, and introjected regulation contain negatively phrased questions and as such, these scores were subtracted from the total score instead of summed. ESES scores are based on a 4-point Likert scale (1 = not at all true, 2 = rarely true, 3 = moderately true, 4 = always true) for each of its 10 questions. The responses to each question were summed for a total ESES score. The Community Readiness score is determined by summing the five subscales, similar to the BREQ-2. Overall scores from each of these assessments were entered into SPSS for comparison analysis between the pre- and post-assessments. BMI was calculated from the heights and weights reported in the pre-and post-program assessments in Excel and then entered into SPSS.

Descriptive statistics were run on data from both the pre- and post-program assessments. Differences in scores by demographic characteristics were assessed using paired *t*-tests for continuous variables and Chi-square for categorical variables between pilot 1 and pilot 2 as well as between those who did and did not complete the post-program assessment. Paired *t*-tests were used to detect differences in BMI, BREQ-2 scores, ESES scores, IPAQ scores, Community Readiness scores, and HEI scores from pre- to post-program assessments. The analysis allowed researchers to determine if there was a significant difference in BMI, BREQ-2 scores, ESES scores, IPAQ scores, community readiness scores, and HEI scores between the two time points. The level of significance was set at $p<0.05$.

CHAPTER IV

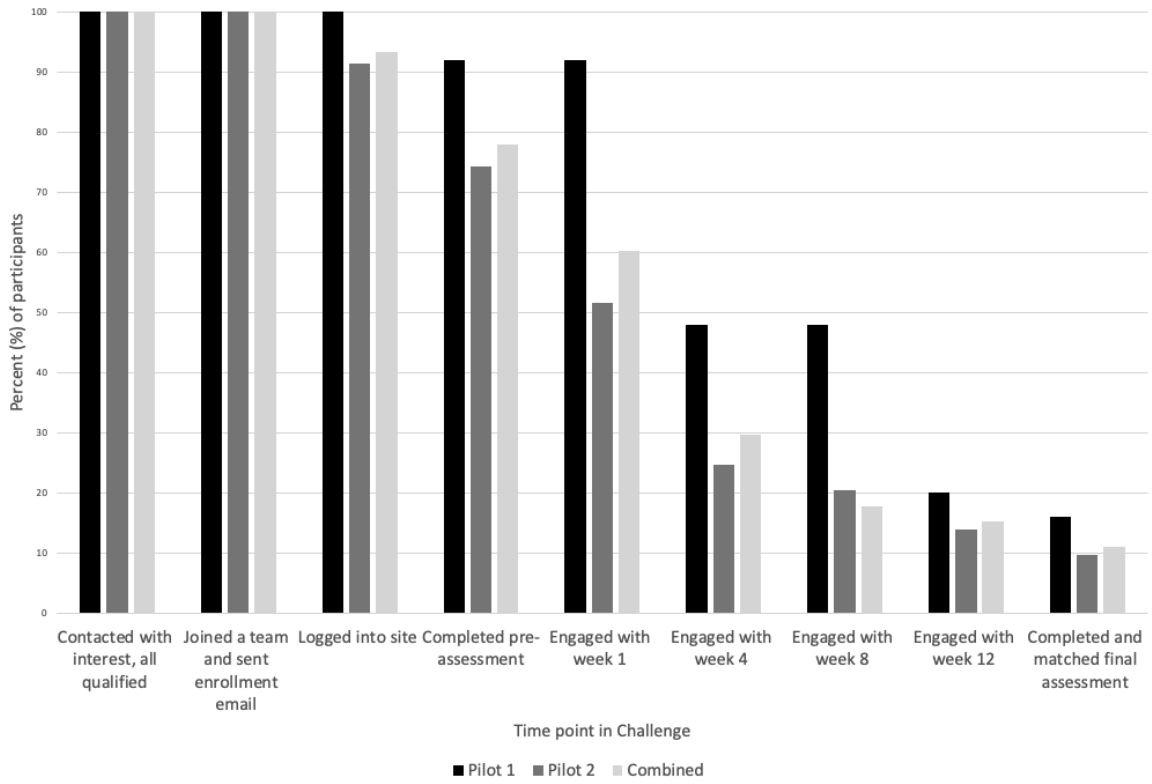
RESULTS

Participant Characteristics and Retention

Figure 1 shows participant retention and engagement with the Fittest Force Challenge. The Challenge coordinator was contacted by 136 eligible participants with interest in the program. Of the interested participants, 118 joined a team, which was a requirement for the Challenge, 110 participants logged into Canvas, and 92 participants completed the pre-program assessment. Engagement with the Challenge was measured at weeks 1, 4, 8, and 12, with 71 (60.2% of eligible participants who joined a team), 35 (30.0%), 21 (17.8%), and 18 (15.3%) participants engaging, respectively. At the end of the Challenge, 13 participants (11.0% of eligible participants who joined a team) completed the post-assessment and were matched to their pre-assessment.

In Table 2, participant characteristics are broken down by all participants, by pilot (1 or 2) and by completion of the post-assessment (completed or did not complete). The mean age of all participants was 39.2 ± 7.7. City/ town police accounted for 39.5% of all participants followed by career firefighters (38.3%), state police/ highway patrol (13.6%), university police (3.7%), and volunteer firefighters (3.7%). Most participants were located in Oklahoma (66.7%), while the remainder were located in Pennsylvania, Nebraska, Arkansas, Colorado, Iowa, and North Dakota. The majority of participants were male (71.4%) and identified as Caucasian (81.9%), over half

Figure 1. Participant Retention and Engagement



were married (67.5%) and had children (68.7%). Relationship status was categorized by married (67.5%), dating (10.8%), divorced (8.4%), single (8.4%), and engaged (4.8%). The age group of participants' youngest child was categorized by preschool/ elementary school (49.1%), infant/ toddler (29.8%), middle school (14.0%), and high school (7.0%). Highest education attainment of participants was completion of college/ advanced degrees (71.1%) followed by completion of some college (26.5%), and completion of high school (2.4%). All participants completed high school at a minimum. In the pre-assessment, participants were asked if they were following a diet, 76.1% responded they were not and 23.9% responded they were. Of those who response they were on a diet, 14.1% were following a fad diet (e.g., keto, Whole 30, intermittent fasting) and 9.9% were following an evidence-based diet (e.g., DASH, high protein, for diabetes). Supplement use was reported by 60.3% of participants. Supplements in use included protein powder, pre-workout, creatine, and products labeled for immune support. There were minimal differences

between pilots and those who did or did not complete the post-assessment. Significant differences between participants in Pilot 1 and Pilot 2 were noted in terms of location ($p<0.001$), while significant differences in participants who did not complete the post-assessment and those who did were seen in location ($p=0.028$) and sex ($p=0.035$).

Table 2. Baseline Demographic Characteristics of Participants, All and by Pilot and Assessment Completion

		All Participants (n = 92)	Pilot 1 (n = 23)	Pilot 2 (n = 69)	p-value for difference between Pilots 1 & 2	Participants Not Completing the Post-assessment only (n = 79)	Participants Completing Pre- & Post-assessment (n = 13)	p-value for difference between Completing & Not Completing Post-assessment
Mean ± Standard Deviation								
Age (years)		39.2± 7.7	37.7 ± 5.3	39.6 ± 8.3	0.231	38.6 ± 7.6	42.7 ± 8.1	0.099
Frequency, Percent of Total								
Tactical Population Type	State Police/ Highway Patrol	11, 13.6%	4, 21.1%	7, 11.3%	0.087	9, 12.9%	2, 18.2%	0.155
	City/ Town Police	32, 39.5%	4, 21.1%	28, 45.2%		27, 38.6%	5, 45.5%	
	University Police	3, 3.7%	0, 0%	3, 4.8%		3, 4.3%	0, 0%	
	County Sheriff	1, 1.2%	1, 5.3%	0, 0%		0, 0%	1, 9.1%	

	Career Firefighter	31, 38.3%	10, 52.6%	21, 33.9%		28, 40.0%	3, 27.3%	
	Volunteer Firefighter	3, 3.7%	0, 0%	3, 4.8%		3, 4.2%	0, 0%	
Location	Oklahoma	54, 66.7%	4, 21.1%	50, 80.6%	<0.001*	47, 67.1%	7, 63.6%	0.028*
	Pennsyl-vania	4, 4.9%	4, 21.1%	0, 0%		2, 2.9%	2, 18.2%	
	Nebraska	4, 4.9%	4, 21.1%	0, 0%		3, 4.3%	1, 9.1%	
	Arkansas	1, 1.2%	0, 0%	1, 1.6%		1, 1.4%	0, 0%	
	Colorado	13, 16.0%	6, 5.3%	7, 11.3%		13, 18.6%	0, 0%	
	Iowa	1, 1.2%	1, 5.3%	0, 0%		0, 0.0%	1, 9.1%	
	North Dakota	4, 4.9%	0, 0%	4, 6.5%		4, 5.7%	0, 0%	
Sex	Female	36, 43.4%	6, 28.6%	30, 48.4%	0.113	28, 38.9%	8, 72.7%	0.035*
	Male	47, 56.6%	15, 71.4%	32, 51.6%		44, 61.1%	3, 27.3%	
Relationship Status	Single	7, 8.4%	3, 14.3%	4, 6.5%	0.150	5, 6.9%	2, 18.2%	0.525
	Dating	9, 10.8%	0, 0%	9, 14.5%		8, 11.1%	1, 9.1%	
	Engaged	4, 4.8%	0, 0%	4, 6.5%		4, 5.6%	0, 0%	
	Married	56, 67.5%	15, 71.4%	41, 66.1%		48, 66.7%	8, 72.7%	
	Divorced	7, 8.4%	3, 14.3%	4, 6.5%		7, 9.7%	0, 0%	
	Widowed	0, 0.0%	0, 0%	0, 0%		0, 0%	0, 0%	

Children	No	26, 31.3%	5, 23.8%	21, 33.9%	0.390	22, 30.6%	4, 36.4%	0.699
	Yes	57, 68.7%	16, 76.2%	41, 66.1%		50, 69.4%	7, 63.6%	
Child Age Group	Infant/ toddler	17, 29.8%	7, 43.8%	10, 24.4%	0.365	15, 30.0%	2, 28.6%	0.609
	Preschool/ elemen-tary school	28, 49.1%	7, 43.8%	21, 51.2%		24, 48.0%	4, 57.1%	
	Middle school	8, 14.0%	2, 12.5%	6, 14.6%		8, 16.0%	0, 0%	
	High School	4, 7.0%	0, 0%	4, 9.8%		3, 6.0%	1, 14.3%	
Ethnicity	Caucasian	68, 81.9%	19, 90.5%	49, 79.0%	0.188	58, 80.6%	10, 90.9%	0.556
	African American	5, 6.0%	0, 0%	5, 8.1%		5, 6.9%	0, 0%	
	Hispanic	6, 6.9%	1, 4.8%	5, 8.1%		6, 8.3%	0, 0%	
	Native American	3, 3.6%	0, 0%	3, 4.8%		2, 2.8%	1, 9.1%	
	Asian/ Pacific Islander	1, 1.1%	1, 4.8%	0, 0%		1, 1.4%	0, 0%	
	Other	0, 0%	0, 0%	0, 0%		0, 0%	0, 0%	
Education Level	Some high school	0, 0%	0, 0%	0, 0%	0.697	0, 0%	0, 0%	0.656
	Com-pleted high school	2, 2.4%	0, 0%	2, 3.2%		2, 2.8%	0, 0%	
	Some college	22, 26.5%	6, 28.6%	16, 25.8%		20, 27.8%	2, 18.2%	

	Com-pleted college/ advanced degrees	59, 71.1%	15, 71.4%	44, 71.0%		50, 69.4%	9, 81.8%	
Diet Type	Not on a diet	54, 76.1%	15, 78.9%	39, 75.0%	0.727	45, 75.0%	9, 81.8%	0.863
	Evidenced -based diet	7, 9.9%	1, 5.3%	6, 11.5%		6, 10.0%	1, 9.1%	
	Fad diet	10, 14.1%	3, 15.8%	7, 13.5%		9, 15.0%	1, 9.1%	
Supplement Use	Not using	29, 39.7%	7, 38.9%	22, 40.0%	0.933	24, 38.7%	5, 45.5%	0.674
	Using	44, 60.3%	11, 61.1%	33, 60.0%		38, 61.3%	6, 54.5%	

0.*p<0.05 indicating significant difference

^Participation score was calculated as the sum of video viewing each week (0 points = didn't view, 1 point = viewed part, 2 points = viewed all, 0 to 48 points possible), assignment submissions each week (0 points = didn't submit, 1 point = submitted late, 2 points = submitted on time, 0 to 48 points possible), and points earned from achieving daily smart goals (smart goals were worth 1 point each, max 3 points per day, 0 to 252 points possible)

Baseline Outcome Assessment

A summary of baseline outcome assessment data broken down by pilot (1 or 2) and by completion of the post-assessment (completed or did not complete) can be found in Table 3. A summary of baseline outcome assessment data broken down by tactical population type (state police/ highway patrol, city/ town police, university police, county sheriff, career firefighter, and volunteer firefighter) can be found in Table 4. Differences between participants in Pilot 1 and Pilot 2 were found in intrinsic motivation (p=0.005), ESES total score (p=0.023), minutes of light physical activity (p=0.049), and added sugar HEI score (p=0.001). Differences between participants who did not complete the post-assessment and those who did were found in days of moderate physical activity (p=0.028), perceived knowledge of increasing fruit and vegetable

intake (p=0.017), perceived knowledge of increasing whole grain intake (p=0.042), dark green and legumes HEI score (p=0.045), sodium HEI score (p=0.023), added sugar HEI score (p=0.049), and participation score (p<0.001). Those who completed the post assessment, had higher responses for days of moderate physical activity, dark green and legumes HEI score, sodium HEI score, added sugar HEI score, and participation score and lower responses for perceived knowledge of increasing fruit and vegetable intake and perceived knowledge of increasing whole grain intake.

Table 3. Baseline Outcome Assessment of Participants, All and by Pilot and Assessment Completion

		All Participants (n = 92)	Pilot 1 (n = 23)	Pilot 2 (n = 69)	p-value for difference between Pilots 1 & 2	Participants Not Completing the Post-assessment only (n = 79)	Participants Completing Pre- & Post-assessment (n = 13)	p-value for difference between Completing & Not Completing Post-assessment
Mean ± Standard Deviation								
BMI		29.8 ± 5.6	28.5 ± 4.7	30.2 ± 5.9	0.222	30.0 ± 5.2	28. 1± 7.9	0.288
BREQ-2 Scores (out of 5)	External Motivation	2.0 ± 0.8	2.02 ± 0.9	2.0 ± 0.7	0.869	2.0 ± 0.8	2.1 ± 0.6	0.669
	Amotivation	1.2 ± 0.4	1.2 ± 0.3	1.2 ± 0.4	0.656	1.2 ± 0.4	1.2 ± 0.5	0.972
	Introjected Motivation	3.3 ± 1.0	3.4 ± 1.0	3.3 ± 1.0	0.655	3.3 ± 1.0	3.5 ± 0.9	0.611
	Identified Motivation	4.3 ± 0.6	4.5 ± 0.5	4.3 ± 0.6	0.087	4.3 ± 0.6	4.3 ± 0.6	0.980

	Intrinsic Motivation	3.7 ± 0.8	4.1 ± 0.8	3.5 ± 0.7	0.005*	3.7 ± 0.8	3.6 ± 0.9	0.628
ESES Total Score (out of 50)		37.6 ± 6.7	40.6 ± 5.8	36.4 ± 6.8	0.023*	37.8 ± 6.8	36.6 ± 6.7	0.607
Community Readiness (out of 9)	Community Readiness – Awareness of Efforts	5.5 ± 2.6	5.4 ± 3.8	5.5 ± 2.4	0.929	5.4 ± 2.7	5.8 ± 2.1	0.630
	Community Readiness – Supportive Leader	5.6 ± 2.7	6.1 ± 3.0	5.5 ± 2.8	0.411	5.6 ± 2.7	5.9 ± 2.7	0.693
	Community Readiness – Supportive Group	5.8 ± 2.0	6.2 ± 1.8	5.6 ± 2.1	0.316	5.7 ± 2.1	6.3 ± 1.3	0.359
	Community Readiness – Resources Available	6.0 ± 2.3	6.5 ± 2.3	6.0 ± 2.4	0.266	6.0 ± 2.3	5.6 ± 2.5	0.605
Vigorous Physical Activity	Days of VPA	3.3 ± 2.0	3.8 ± 2.0	3.1 ± 2.0	0.180	3.2 ± 2.0	3.5 ± 2.3	0.716
	Minutes of VPA	52.9 ± 65.5	46.1 ± 28.3	55.1 ± 73.8	0.603	56.0 ± 69.7	34.6 ± 23.9	0.319
Moderate Physical Activity	Days of MPA	3.0 ± 2.2	2.9 ± 2.0	3.0 ± 2.3	0.881	2.8 ± 2.2	4.4 ± 1.7	0.028*
	Minutes of MPA	51.3 ± 102.4	31.7 ± 17.9	57.4 ± 116.4	0.354	53.8 ± 110.4	36.8 ± 20.5	0.615
Light Physical Activity	Days of LPA	4.6 ± 2.3	4.9 ± 2.0	4.5 ± 2.4	0.556	4.7 ± 2.3	3.9 ± 2.3	0.268
	Minutes of LPA	54.9 ± 76.1	34.7 ± 32.1	61.5 ± 85.0	0.049*	56.6 ± 79.2	44.6 ± 55.3	0.630
Sedentary Time (minutes)		424.4 ± 383.0	338.45 ± 233.8	453.0 ± 419.0	0.262	405.4 ± 388.4	536.4 ± 344.1	0.297

Perceived Knowledge (out of 5)	Nutrition Literacy	3.0 ± 1.0	3.3 ± 1.3	2.8 ± 0.9	0.199	3.0 ± 1.1	2.6 ± 0.7	0.162
	Increase FV	3.2 ± 0.9	3.4 ± 1.0	3.1 ± 0.8	0.240	3.2 ± 0.9	2.8 ± 0.4	0.017*
	Increase WG	2.9 ± 1.0	3.2 ± 1.4	2.8 ± 0.8	0.320	3.0 ± 1.0	2.4 ± 0.5	0.042*
	Portion Size	3.2 ± 1.0	3.4 ± 1.2	3.1 ± 0.9	0.369	3.2 ± 1.0	3.1 ± 0.7	0.747
	Social Supports	2.8 ± 1.0	2.9 ± 1.1	2.7 ± 1.0	0.473	2.9 ± 1.0	2.5 ± 0.9	0.243
	Food Environment	3.0 ± 0.9	3.1 ± 1.1	3.0 ± 0.9	0.562	3.1 ± 0.9	2.6 ± 0.9	0.160
	Supplements	2.7 ± 1.0	2.8 ± 1.3	2.6 ± 0.8	0.578	2.7 ± 1.0	2.6 ± 0.7	0.611
	Caffeine	3.0 ± 1.1	3.3 ± 1.3	2.9 ± 1.1	0.166	3.0 ± 1.2	2.9 ± 0.8	0.740
	Eating Out	3.0 ± 0.9	3.2 ± 1.2	3.0 ± 0.9	0.279	3.0 ± 1.0	3.0 ± 0.6	0.958
HEI Scores	Total HEI Score (out of 100)	50.2 ± 14.5	50.9 ± 15.8	49.9 ± 14.2	0.816	48.8 ± 13.9	57.7 ± 16.3	0.061
	Total Fruit HEI (out of 5)	1.4 ± 2.0	1.1 ± 1.7	1.5 ± 2.1	0.403	1.2 ± 1.9	2.3 ± 2.4	0.083
	Whole Fruit HEI (out of 5)	1.4 ± 2.1	1.5 ± 2.1	1.4 ± 2.2	0.853	1.4 ± 2.1	1.8 ± 2.5	0.586
	Total Veg HEI (out of 5)	3.0 ± 2.0	2.6 ± 2.0	3.3 ± 2.0	0.205	3.1 ± 2.0	2.8 ± 2.3	0.597
	Dark Greens & Legumes	1.5 ± 2.3	1.4 ± 2.3	1.5 ± 2.3	0.871	1.2 ± 2.2	2.8 ± 2.3	0.045*

	HEI (out of 5)							
	Whole Grains HEI (out of 10)	3.3 ± 4.3	4.2 ± 4.6	3.1 ± 4.3	0.359	3.0 ± 4.2	4.6 ± 4.9	0.284
	Dairy HEI (out of 10)	4.6 ± 3.8	4.0 ± 4.0	4.8 ± 3.7	0.447	4.3 ± 3.7	6.0 ± 4.0	0.195
	Total Protein HEI (out of 5)	4.9 ± 0.51	5.0 ± 0	4.9 ± 0.6	0.357	5.0 ± 0.2	4.6 ± 1.2	0.385
	Seafood & Plant Protein HEI (out of 5)	1.7 ± 2.3	1.5 ± 2.6	1.7 ± 2.3	0.776	1.5 ± 2.2	2.5 ± 3.0	0.319
	Fatty Acid Ratio HEI (out of 10)	3.3 ± 3.5	3.2 ± 3.4	3.4 ± 3.5	0.883	3.5 ± 3.6	2.2 ± 2.4	0.258
	Refined Grains HEI (out of 10)	7.0 ± 4.1	7.8 ± 4.3	6.7 ± 4.1	0.332	7.0 ± 4.1	6.73 ± 4.7	0.842
	Sodium HEI (out of 10)	4.6 ± 3.7	4.6 ± 3.6	4.6 ± 3.7	0.947	4.2 ± 3.6	6.9 ± 3.6	0.023*
	Added Sugar HEI (out of 10)	8.5 ± 3.0	9.8 ± 0.7	8.0 ± 3.4	0.001*	8.3 ± 3.2	9.5 ± 1.5	0.049*
	Saturated Fat HEI (out of 10)	4.9 ± 3.6	4.3 ± 3.7	5.1 ± 3.6	0.425	4.9 ± 3.5	5.0 ± 4.1	0.969
Participation Score^		80.9 ± 106.3	107.7 ± 99.1	70.6 ± 108.0	0.175	51.3 ± 78.2	256.0 ± 78.2	<0.001*
Frequency, Percent of Total								
BMI Classification	Underweight (<18.5)	0, 0%	0, 0%	0, 0%	0.770	0, 0%	0, 0%	0.328

	Normal weight (18.5 – 24.9)	12, 14.5%	4, 19.0%	8, 12.9%		9, 12.5%	3, 27.3%	
	Overweight (25 – 29.9)	35, 42.2%	8, 38.1%	27, 43.5%		30, 41.7%	5, 45.5%	
	Obese (>30)	36, 43.4%	9, 42.9%	27, 43.5%		33, 45.8%	3, 27.3%	

*$p<0.05$ indicating significant difference

^Participation score was calculated as the sum of video viewing each week (0 points = didn't view, 1 point = viewed part, 2 points = viewed all, 0 to 48 points possible), assignment submissions each week (0 points = didn't submit, 1 point = submitted late, 2 points = submitted on time, 0 to 48 points possible), and points earned from achieving daily smart goals (smart goals were worth 1 point each, max 3 points per day, 0 to 252 points possible)

[a] Lack of standard deviation due to singular responses

Table 4. Baseline Outcome Assessment of Participants, by Tactical Population Group

		State Police & High-way Patrol (n =11)	City & Town Police (n = 32)	Univer-sity Police (n = 3)	County Sheriff (n = 1)[a]	Career Fire-fighter (n = 31)	Volun-teer Fire-fighter (n = 3)[a]	Tac Pop Un-known (n = 2)[a]
Mean ± Standard Deviation								
BMI		29.2 ± 6.5	29.0 ± 5.6	33.4 ± 6.0	25.9	30.1 ± 5.1	33.6 ± 10.2	30.8 ± 2.7
BREQ-2 Scores (out of 5)	External Motivation	1.8 ± 0.7	2.0 ± 0.7	1.9 ± 0.5	2.3	2.0 ± 0.9	2.4 ± 0.2	2.5 ± 0.4
	Amotivation	1.1 ± 0.2	1.3 ± 0.5	1.2 ± 0.1	1.0	1.2 ± 0.4	1.1 ± 0.2	1. ± 0
	Introjected Motivation	3.1 ± 0.9	3.1 ± 0.9	3.0 ± 1.0	3.3	3.6 ± 1.1	3.3 ± 0.9	3.7 ± 0.9
	Identified Motivation	4.4 ± 0.6	4.2 ± 0.6	4.0 ± 0.3	4.7	4.46 ± 0.6	3.5 ± 0.7	5.0 ± 0

	Intrinsic Motivation	4.0 ± 0.7	3.5 ± 0.7	3.2 ± 0.3	3.3	3.8 ± 0.9	3.0 ± 0	4.6 ± 0.5
ESES Total Score (out of 50)		41.3 ± 6.5	36.7 ± 6.7	35.3 ± 10.1	39.0	37.5 ± 6.8	34.5 ± 6.4	38.5 ± 7.8
Community Readiness (out of 9)	Community Readiness – Awareness of Efforts	5.0 ± 3.0	5.6 ± 2.1	2.7 ± 2.9	2.0	6.1 ± 2.4	5.0 ± 5.7	1.0
	Community Readiness – Supportive Leader	4.6 ± 2.7	6.1 ± 2.6	4.3 ± 2.9	6.0	5.9 ± 2.6	1.0 ± 0	6.0
	Community Readiness – Supportive Group	4.6 ± 1.4	6.0 ± 2.1	4.0 ± 1.7	6.0	6.3 ± 1.6	1.5 ± 0.7	9.0
	Community Readiness – Resources Available	4.3 ± 2.2	6.7 ± 1.7	4.7 ± 3.2	-	6.1 ± 2.3	1.5 ± 0.7	9.0
Vigorous Physical Activity	Days of VPA	3.9 ± 2.1	3.1 ± 1.9	3.3 ± 1.5	0	3.5 ± 2.1	0.50 ± 0.7	2.5 ± 0.7
	Minutes of VPA	53.7 ± 36.9	39.0 ± 25.3	180.0 ± 259.8	0	56.8 ± 57.5	60.0 ± 84.9	22.5 ± 10.6
Moderate Physical Activity	Days of MPA	3.1 ± 2.6	2.8 ± 2.0	3.0 ± 2.0	2.0	3.3 ± 2.5	2.5 ± 3.5	2.5 ± 0.7
	Minutes of MPA	37.4 ± 36.0	30.2 ± 22.2	173.3 ± 265.8	40.0	42.9 ± 48.6	375.0 ± 530.3	45 ± 21.2
Light Physical Activity	Days of LPA	4.7 ± 2.2	4.5 ± 2.4	4.0 ± 3.6	7.0	4.7 ± 2.3	7.0 ± 0	3.5 ± 0.7
	Minutes of LPA	62.3 ± 54.0	36.0 ± 39.7	166.7 ± 271.5	20.0	51.2 ± 61.7	200.0 ± 141.4	45 ± 21.2
Sedentary Time (Minutes)		449.4 ± 395.9	422.7 ± 363.4	240.0 ± 216.3	300.0	456.1 ± 443.1	150.0 ± 42.4	480 ± 169.7

Perceived Knowledge (out of 5)	Nutrition Literacy	2.5 ± 0.9	2.9 ± 1.0	3.0 ± 0.0	2.0	3.2 ± 1.1	3.0	5.0
	Increase FV	2.8 ± 0.8	3.2 ± 1.0	3.3 ± 0.58	3.0	3.3 ± 0.9	3.0	5.0
	Increase WG	2.6 ± 0.9	2.8 ± 1.0	2.7 ± 0.6	2.0	3.1 ± 1.0	3.0	5.0
	Portion Size	2.9 ± 1.1	3.1 ± 1.0	3.3 ± 0.6	3.0	3.3 ± 0.8	3.0	5.0
	Social Supports	2.6 ± 1.2	2.9 ± 1.0	2.3 ± 0.6	3.0	2.7 ± 1.1	3.0	4.0
	Food Environment	2.9 ± 1.1	3.0 ± 0.9	2.7 ± 0.6	4.0	3.0 ± 1.0	3.0	3.0
	Supplements	2.6 ± 1.0	2.3 ± 0.8	2.3 ± 0.6	3.0	3.2 ± 0.9	3.0	-
	Caffeine	2.6 ± 1.0	3.0 ± 1.2	2.7 ± 0.6	3.0	3.2 ± 1.0	1.0	5.0
	Eating Out	2.7 ± 1.1	3.1 ± 1.0	3.0 ± 0	4.0	3.0 ± 0.8	3.0	5.0
HEI Scores	Total HEI Score (out of 100)	52.5 ± 11.7	48.8 ± 16.6	45.7 ± 14.3	60.3	51.3 ± 14.8	44.0	47.2 ± 5.9
	Total Fruit HEI (out of 5)	1.7 ± 2.4	1.4 ± 2.0	2.7 ± 2.5	2.2	1.2 ± 2.0	0	0 ± 0
	Whole Fruit HEI (out of 5)	1.8 ± 2.5	1.5 ± 2.1	1.7 ± 2.9	4.4	1.3 ± 2.1	0	0 ± 0
	Total Veg HEI (out of 5)	2.3 ± 2.1	3.1 ± 2.2	2.7 ± 2.3	3.2	3.6 ± 1.8	4.3	0.7 ± 1.0
	Dark Greens & Legumes HEI (out of 5)	1.8 ± 2.5	1.2 ± 2.2	1.7 ± 2.9	5.0	1.4 ± 2.3	5.0	0 ± 0

	Whole Grains HEI (out of 10)	3.7 ± 4.2	2.8 ± 4.3	1.1 ± 1.8	0.0	4.2 ± 4.6	0	5.0 ± 7.1
	Dairy HEI (out of 10)	5.9 ± 3.8	5.5 ± 3.8	3.1 ± 1.2	0.0	3.5 ± 3.5	0	6.4 ± 5.1
	Total Protein HEI (out of 5)	4.9 ± 0.3	4.8 ± 0.8	5.0 ± 0	5.0	5.0 ± 0.12	5.0	5.0 ± 0
	Seafood & Plant Protein HEI (out of 5)	2.1 ± 2.8	1.1 ± 2.0	0 ± 0	4.4	2.1 ± 2.5	5.0	0.0 ± 0
	Fatty Acid Ratio HEI (out of 10)	3.8 ± 3.9	2.8 ± 3.3	3.0 ± 2.8	4.9	3.6 ± 3.8	4.9	2.1 ± 3.0
	Refined Grains HEI (out of 10)	6.3 ± 4.6	6.3 ± 4.5	9.0 ± 1.7	10.0	7.4 ± 3.9	8.0	10.0 ± 0
	Sodium HEI (out of 10)	3.6 ± 4.0	5.3 ± 3.8	6.3 ± 3.2	10.0	3.8 ± 3.5	7.0	3.5 ± 2.1
	Added Sugar HEI (out of 10)	9.4 ± 1.5	9.0 ± 2.4	1.8 ± 2.8	10.0	8.5 ± 3.1	0.0	10 ± 0
	Saturated Fat HEI (out of 10)	5.2 ± 4.1	4.0 ± 3.7	7.6 ± 1.5	1.2	5.8 ± 3.3	4.8	4.5 ± 2.1
Participation Score^		137.9 ± 129.1	88.0 ± 128.8	42.0 ± 12.7	99.0	67.3 ± 78.6	50.3 ± 84.6	0.50 ± 0.7
Frequency, Percent of Total								
BMI Classification	Underweight (<18.5)	0, 0%	0, 0%	0, 0%	0, 0%	0, 0%	0, 0%	0, 0%
	Normal weight (18.5 – 24.9)	4, 36.4%	6, 18.8%	0, 0%	0, 0%	2, 6.5%	0, 0%	0, 0%

	Overweight (25 – 29.9)	1, 9.1%	14, 43.8%	1, 33.3%	1, 100%	15, 48.4%	2, 66.7%	1, 50.0%
	Obese (>30)	6, 54.5%	12, 37.5%	2, 66.7%	0, 0%	14, 45.2%	1, 33.3%	1, 50.0%

*p<0.05 indicating significant difference

^Participation score was calculated as the sum of video viewing each week (0 points = didn't view, 1 point = viewed part, 2 points = viewed all, 0 to 48 points possible), assignment submissions each week (0 points = didn't submit, 1 point = submitted late, 2 points = submitted on time, 0 to 48 points possible), and points earned from achieving daily smart goals (smart goals were worth 1 point each, max 3 points per day, 0 to 252 points possible)

[a] Lack of standard deviation due to singular responses

Program Effectiveness

Program effectiveness is summarized in Table 5. There were no significant differences in confidence and motivation to change measured by the BREQ-2 [External Motivation (p=0.210), Amotivation (p=0.111), Introjected Motivation (p=0.347), Identified Motivation (p=0.559), or Intrinsic Motivation (p=0.225)], ESES total score (p=0.586), or Community Readiness Assessment [Awareness of Efforts (p=0.724), Supportive Leader (p=0.509), Supportive Group (p=0.081), or Resources Available (p=0.499)] from the pre-assessment to the post-assessment. There were no significant differences in physical activity levels measured by number of days per week [Vigorous (p=0.636), Moderate (p=0.999), and Light (p=0.260)] or by minutes per day [Vigorous (p=0.443), Moderate (p=0.450), and Light (p=0.379)]. Sedentary time per day decreased by over four hours on average (mean difference pre to post = -289.4 ± 196.7, p=0.001). There was no change in body composition measured by BMI (p=0.210) or BMI category (p=0.675). Total HEI score and HEI subcomponent scores also had no significant differences between the pre-assessment and the post-assessment (ps>0.05). There were several significant increases in perceived knowledge on topics addressed by the program, including nutrition literacy (mean difference pre to post = 0.9 ± 0.6 out of 5, p=0.002), increasing fruit and vegetable consumption (mean difference pre to post = 1.3 ± 0.7 out of 5, p<0.001), incorporating whole

grains (mean difference pre to post = 1.4 ± 1.1 out of 5, p=0.005), setting up social supports (mean difference pre to post = 1.2 ± 1.3 out of 5, p=0.023), creating food environments for dietary change (mean difference pre to post = 1.4 ± 1.2 out of 5, p=0.008), safe and effective supplement use (mean difference pre to post = 0.9 ± 0.8 out of 5, p=0.009), safe caffeine consumption (mean difference pre to post = 1.4 ± 1.0 out of 5, p=0.003), and eating healthy while eating out (mean difference pre to post = 0.9 ± 0.8 out of 5, p=0.009). Perceived knowledge of portion sizes did not change significantly (p=0.139).

Table 5. Comparison of Pre-program and Post-program Outcome Assessment

		Pre-program	Post-program	Mean Difference (Post – Pre)	*p*-value
Mean ± Standard Deviation					
BMI		28.1 ± 7.9	27.6 ± 7.3	-0.5 ± 1.2	0.210
BREQ-2 Scores (out of 5)	External Motivation	2.1 ± 0.6	1.8 ± 0.6	-0.3 ± 0.5	0.111
	Amotivation	1.2 ± 0.4	1.2 ± 0.5	0.2 ± 0.5	0.347
	Introjected Motivation	3.5 ± 0.9	3.7 ± 0.7	0.2 ± 0.6	0.299
	Identified Motivation	4.3 ± 0.6	4.3 ± 0.6	-0.1 ± 0.4	0.559
	Intrinsic Motivation	3.6 ± 0.9	3.6 ± 0.8	0.1 ± 0.3	0.225
ESES Total Score (out of 50)		36.6 ± 6.7	38.1 ± 6.5	1.0 ± 5.6	0.586
Community Readiness (out of 9)	Community Readiness – Awareness of Efforts	5.8 ± 2.1	5.3 ± 2.8	-0.4 ± 3.5	0.724
	Community Readiness –	5.9 ± 2.7	5.4 ± 2.8	-0.4 ± 1.8	0.509

	Supportive Leader				
	Community Readiness – Supportive Group	6.3 ± 1.3	5.3 ± 2.3	-0.9 ± 1.5	0.081
	Community Readiness – Resources Available	5.6 ± 2.5	5.7 ± 1.8	0.6 ± 2.4	0.499
Vigorous Physical Activity	Days of VPA	3.5 ± 2.3	4.3 ± 1.9	0.5 ± 1.7	0.363
	Minutes of VPA[b]	34.6 ± 23.9	43.0 ± 13.0	5.0 ± 21.3	0.443
Moderate Physical Activity	Days of MPA	4.4 ± 1.7	4.6 ± 2.2	0 ± 2.1	0.999
	Minutes of MPA[b]	36.8 ± 20.5	40.0 ± 15.8	5.5 ± 23.4	0.450
Light Physical Activity	Days of LPA	3.9 ± 2.3	5.5 ± 2.2	1.2 ± 3.2	0.260
	Minutes of LPA	44.6 ± 55.3	31.5 ± 18.1	-17.5 ± 59.8	0.379
Sedentary Time (minutes)		536.4 ± 344.1	276.6 ± 295.6	-289.4 ± 196.7	0.001*
Perceived Knowledge (out of 5)	Nutrition Literacy	2.6 ± 0.7	3.3 ± 0.9	0.9 ± 0.6	0.002*
	Increase FV	2.8 ± 0.4	4.1 ± 0.8	1.3 ± 0.7	<0.001*
	Increase WG	2.4 ± 0.5	3.8 ± 0.8	1.4 ± 1.1	0.005*
	Portion Size	3.1 ± 0.7	3.6 ± 0.7	0.6 ± 1.0	0.139
	Social Supports	2.5 ± 0.9	3.6 ± 0.7	1.2 ± 1.3	0.023*

	Food Environment	2.6 ± 0.9	4.0 ± 0.9	1.4 ± 1.2	0.008*
	Supplements	2.6 ± 0.7	3.4 ± 1.0	0.9 ± 0.8	0.009*
	Caffeine	2.9 ± 0.8	4.3 ± 0.7	1.4 ± 1.0	0.003*
	Eating Out	3.0 ± 0.6	3.9 ± 0.8	0.9 ± 0.8	0.009*
HEI Scores	Total HEI Score (out of 100)	57.7 ± 16.3	53.2 ± 17.0	-7.6 ± 20.7	0.276
	Total Fruit HEI (out of 5)	2.3 ± 2.4	2.4 ± 2.6	-0.2 ± 2.8	0.857
	Whole Fruit HEI (out of 5)	1.8 ± 2.5	1.7 ± 2.4	-0.3 ± 2.9	0.793
	Total Veg HEI (out of 5)	2.8 ± 2.3	4.0 ± 1.5	1.4 ± 3.1	0.177
	Dark Greens & Legumes HEI (out of 5)	2.8 ± 2.3	1.5 ± 2.4	-1.5 ± 2.4	0.081
	Whole Grains HEI (out of 10)	4.6 ± 4.9	2.4 ± 4.2	-2.7 ± 5.5	0.161
	Dairy HEI (out of 10)	6.0 ± 4.0	6.2 ± 4.1	-0.3 ± 4.4	0.849
	Total Protein HEI[b] (out of 5)	4.6 ± 1.2	4.6 ± 1.3	-0.4 ± 1.3	0.593
	Seafood & Plant Protein HEI (out of 5)	2.5 ± 3.0	1.8 ± 2.4	-1.0 ± 3.5	0.396

	Fatty Acid Ratio HEI (out of 10)	2.2 ± 2.4	1.8 ± 3.1	-0.6 ± 4.0	0.640
	Refined Grains HEI (out of 10)	6.73 ± 4.7	6.4 ± 4.2	-1.0 ± 5.1	0.552
	Sodium HEI (out of 10)	6.9 ± 3.6	6.3 ± 4.5	-0.3 ± 6.1	0.880
	Added Sugar HEI (out of 10)	9.5 ± 1.5	9.9 ± 0.3	0.4 ± 1.6	0.462
	Saturated Fat HEI (out of 10)	5.0 ± 4.1	4.2 ± 4.1	-1.2 ± 5.3	0.477
Frequency, Percent of Total					
BMI Classification[c]	Underweight (<18.5)	0, 0%	0, 0%	0	0.675
	Normal weight (18.5 – 24.9)	3, 27.3%	4, 36.4%	1, 9.1%	
	Overweight (25 – 29.9)	5, 45.5%	3, 27.3%	-2, -18.2%	
	Obese (>30)	3, 27.3%	4, 36.4%	1, 9.1%	

[b]Wilcoxon signed-rank test was used in place of a paired t-test due to skewedness of the variable

[c]Chi-square test was used

CHAPTER V

DISCUSSION

The purpose of this study was to assess the effectiveness of the Fittest Force Challenge in improving dietary quality, physical activity levels, weight status, motivation to change, and nutrition knowledge in firefighters and law enforcement officers by comparing pre-program survey results to post-program survey results. There were no significant improvements in dietary quality overall or by HEI subcategories. There was also no change in physical activity levels. There was, however, a significant decrease in sedentary time. Body mass index and BMI category were not significantly altered over the 12-week Challenge. Additionally, there was no change in confidence or individual or community motivation to change. Despite no change in dietary quality or motivation to change, which was already relatively high, there were significant improvements in perceived knowledge on almost all nutrition topics addressed in the 12-week Challenge. It is also worth noting that engagement with the 12-week Challenge decreased throughout the program with only 11% of participants completing both the pre-program assessment and the post-program assessment.

Very few health promotion programs have been created and studied for these tactical populations (fire and law enforcement). While there are voluntary health standards, there is no program to work in conjunction with these standards (NIOSH, 2007). There have been a few small scale, in-person interventions with firefighters and law enforcement officers. The Promoting Healthy Lifestyles: Alternative Model's Effects (PHLAME) program was designed for

firefighters to improve diet and exercise behaviors (Elliot et al., 2004). In the study, 48 fire stations were randomly assigned to one of three interventions, PHLAME, motivational interviewing, or control. PHLAME was an in-person, team-based program that requires participants to be present at the same time for a total of eleven 45-minute sessions. During the sessions, a team leader conducted lessons using provided materials and workbooks that covered a broad range of health topics. The program also incorporated behavior change theories including social cognitive theory and the health belief model. Baseline and one year health data were compared using ANCOVAs to determine the effectiveness of the program. The program was effective in improving healthy dietary behavior and general well-being. For law enforcement officers, the SHIELD program was developed to promote overall health, including physical activity, body weight, stress, sleep, tobacco use, and alcohol use (Kuehl et al., 2014). In this study, 928 officers from three departments were assigned to an intervention group and a control group and teams were formed. Similar to the PHLAME program, it was an in-person program, extremely broad in the topics covered, and administered by individuals within the departments, not trained health professionals. Baseline and six-month follow up data were compared and did indicate the program was effective in improving several of their measured health outcomes.

The online, asynchronous design of the Fittest Force Challenge is unique to the limited number of programs designed and tested for this population. The core content of the Fittest Force Challenge program is broadly focused on physical health and covers a variety of nutrition and physical activity concepts. The program also maintains flexibility, as participants are able to tailor their individual wellness goals to meet their current needs and motivations. Potentially most importantly, this online program would be widely available with minimal resource input by departments or the limited number of practitioners specializing in this field, at any time, to address nutrition and physical activity habits broadly.

Strengths

The design of this program and the resulting study yielded many strengths. First and foremost, the Challenge program was tailored to the audience based on firsthand interactions between the principle investigator (PI) and this population. Additionally, the program was designed to be low burden for a population with high stress, fast-paced jobs and unpredictable schedules while incorporating the traditional team nature of tactical groups. The program also drew on many health behavior theories, including SDT, SCT, the Köhler effect, and group dynamics and included valid and reliable assessment methods including the BREQ-2, ESES, Community Readiness Assessment, HEI, and IPAQ. Participants in this study were diverse with a large number of females and non-Caucasian individuals relative to tactical populations at large. Further, the ability of researchers to track participation and engagement with the program via Canvas logistics is another strength of this study, as well as this online program delivery method.

Limitations

A convenience sample was used to recruit participants via social media and personal contacts of the PI limiting generalizability. To assess the effectiveness of the program, the study utilized a paired assessment design, which led to several limitations in the research, including surveyor fatigue, self-report error and biases, and limited matched data. Due to the small sample size of matched assessment data, the study had limited power and ability to perform further sub-analyses. Additionally, participants were only required to complete two 24-hour food recalls (one with the pre-program assessment and one with the post-program assessment), which have high potential for self-report error and bias, to provide us with a single day snapshot of participants' intake to compare. The 24-hour recall data was entered into ESHA (ESHA Research, Food Processor, version 11.6.441, 2018, Salem, OR)] by the research team and converted into HEI scores, where there was potential for researcher error in addition to response bias.

Additionally, individuals who elected to participate in this research were likely more motivated than the overall tactical population, thus limiting the generalizability of the results. Participants in this study may have been more motivated and more confident in their health knowledge and practices to begin with which would limit the amount of change a program like this would precipitate. Similarly, if participants were moderately supported for change at the organizational level, were fairly active, or didn't have weight to lose from the start, there would have been little room for improvement pre-program to post-program. Also, the timing of the Challenge (New Years and prior to the summer season) may have led participants to be more motivated to change than they would typically be at other times of the year.

Finally, while the flexibility of the program allowed participants to self-select their individual wellness issues/ goals, this limited the researcher's ability to assess specific outcomes where potentially significant improvements were made. Researchers were unable to see all potential health changes as the inclusion of additional measurement tools would have increased participant burden and limited assessment completion further.

Directions for Future Research

Areas of future research may include testing an in-person version of the program to compare effectiveness and engagement levels. Members of this population have conveyed a preference for in-person programs to the PI, however, that limits the reach of the program due to cost, scheduling, and availability of program administrators. Future research may also test the team-based health challenge aspect of the program without video lessons and assignments to see if this alone is effective in promoting positive health outcomes. The Challenge only program could be tested for effectiveness both online and in-person.

To the best of our knowledge, this was the first time an online health promotion program has been administered in this population. Therefore, researchers on this study encountered several

limitations and considered several points of development for future testing and administration of this program. Many fire and law enforcement departments have a peer fitness leader, engaging with that leader to provide program participants with reminders and nudges could potentially decrease the number of dropouts and increase engagement consistently throughout the duration of the program. Additionally, a small but meaningful fee required for participation in the program may also encourage sustained engagement with the program. A final suggestion for improvements to the program is to offer the program with a nutrition only or physical activity only focus depending on the needs/ wants of the department and its employees.

Conclusions

The Fittest Force Challenge resulted in positive outcomes related to decreased sedentary time and increased perceived knowledge of nutrition literacy, increasing fruit, vegetable, and whole grain intake, setting up social supports and food environment for change, safe and effective dietary supplement and caffeine use, and eating healthy while eating out indicating the program was effective in those areas. This pilot program also provides valuable guidance for future programing with this population, in addition to serving as an immediate, inexpensive, high reach, and evidence-based resource.

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APPENDICES

Appendix 1. IRB Approval

The Oklahoma State University Institutional Review Board (IRB) has approved the following application:

Application Number: IRB-20-492
PI: Jill Joyce
Title: Fittest Force Challenge
Review Level: Expedited

You will find a copy of your Approval Letter in IRBManager. Click IRB - Initial Submission to go directly to the event page. Please click attachments in the upper left of the screen. The approval letter is under "Generated Docs." Stamped recruitment and consent documents can also be found in this location under "Attachments". Only the approved versions of these documents may be used during the conduct of your research.

As Principal Investigator, it is your responsibility to do the following:

- Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted for IRB approval before implementation.
- Submit a request for continuation if the study extends beyond the approval period.
- Report any adverse events to the IRB Chair within 5 days. Adverse events are those which are unanticipated and impact the subjects during the course of the research; and
- Notify the IRB office when your research project is complete by submitting a closure form via IRBManager.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact the IRB office at 405-744-3377 or irb@okstate.edu.

VITA

Taylor Michelle Peabody

Candidate for the Degree of

Master of Public Health

Thesis: EFFECTIVENESS OF THE FITTEST FORCE CHALLENGE: A 12-WEEK ONLINE THEORY-BASED NUTRITION AND PHYSICAL ACTIVITY INTERVENTION FOR FIRST RESPONDERS

Major Field: Public Health

Biographical:

Education:

Completed the requirements for the Master Public Health at Oklahoma State University, Stillwater, Oklahoma in May 2022.

Completed the requirements for the Bachelor of Science in Agricultural, Food, and Life Sciences at the University of Arkansas, Fayetteville, Arkansas is 2020.

Completed the requirements for the Bachelor of Science in Human and Environmental Sciences at the University of Arkansas, Fayetteville, Arkansas is 2020.

Experience:

Graduate Teaching Assistant

Undergraduate Honors Student Thesis

Professional Memberships:

Academy of Nutrition and Dietetics

Oklahoma Academy of Nutrition and Dietetics