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# PRELIMINARY DEVELOPMENT OF A TACTICAL ATHLETE NUTRITION SCORE

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**Johnson BVB and Mayer JM.** Tactical athletes are at high risk for numerous conditions that are susceptible to nutritional intake. However, nutrition risk assessments in tactical athletes are not routinely implemented. The purpose of this paper was to describe preliminary development of the Tactical Athlete Nutrition Score (TANS). A cross-sectional study was conducted in a convenience sample of career firefighters (*N* = 150, all males) in southern California. Participants completed a 3-Day Food Record and other health-related questionnaires, and anthropometric measurements. The TANS was developed through best available evidence, observations, and an expert judgment exercise. The TANS include five variables: total energy, protein, omega-3 fatty acids, total sugar, and fruit and vegetable consumption. Risk levels were quantified according to data from these categories and analyzed accordingly. The TANS appeared to effectively differentiate individuals based on nutrition risk, with separation observed among the TANS risk levels – low risk (*n* = 7), moderate risk (*n* = 77), high risk (*n* = 66). One-way analysis of variance revealed significant difference among the risk categories for the five nutrition variables and TANS total ($p < 0.001$). The observed risk categories are plausible based on knowledge of this population. This study suggests the TANS is feasible to proceed to full-scale validation research trials. If validity is established, TANS will contribute to assessing nutrition risk level and improving nutrition interventions among tactical athletes.

**Key Words:** nutrition, diet, energy intake, firefighters, risk assessment

## INTRODUCTION

Tactical athletes are individuals in law enforcement, military, and first responders (e.g. firefighters) who require physical training for occupational performance (Scofield & Kardouni, 2015). Firefighters have one of the most dangerous, physically-taxing, and psychologically stressful jobs in the world (International Association of Fire Fighters & International Association of Fire Chiefs, 2018). Maintaining a healthy body is essential for firefighters to counteract the intense demands of their activities, perform high-level job-related tasks, prevent injuries, and improve quality of life (e.g. decreasing chronic diseases, improving sleep) (International Association of Fire Fighters & International Association of Fire Chiefs, 2018).

Meeting nutritional demands is critical for tactical athletes, first responders, and firefighters to maintain physical performance related to job duties, prevent injuries, and improve overall health and wellness, which is well-documented in the literature (Evelyn, Heilbronn, & Hawley, 2020; Farina et al., 2020). Despite the high-level job demands, more than 70% of firefighters are overweight and 30-40% are obese (Brown et al., 2016; Jitnarin, Poston, Haddock, Jahnke, & Day, 2014; Mayer et al., 2012). It is imperative to address nutritional concerns within this population because nutrition is linked with wellness (e.g. reducing risk of chronic diseases) and kinesiology (e.g. physical fitness). Nutrition plays a critical role in controlling body weight which impacts health, future risk of injury, and fitness levels. By developing a valid nutrition risk screening tool, high risk tactical athletes can be identified to implement preventative measures. Healthful food choices and dietary patterns can help reduce the prevalence of obesity and prevent chronic disease when consuming minimally processed foods (Mente, de Koning, Shannon, & Anand, 2009).

Firefighting requires a significant amount of calories and nutritional support over extended periods of time (Elsner & Kolkhorst, 2008). Firefighters might have prolonged periods with no operations and their diets should be adjusted based on their schedule (Barringer & Crombie, 2017). Thus, a primary goal of fueling firefighters is achieving energy balance to support physical demands, promote healthy body composition, and supply nutrients necessary for health (International Association of Fire Fighters & International Association of Fire Chiefs, 2018).

It appears that the military provides the only published guidance for Dietary Reference Intakes (DRI) for tactical teams (Hertzler & Carlson-Phillips, 2017), yet the suitability for use outside of the military is unknown. No standards are available to guide clinical-decision-making in prescribing dietary plans for firefighters. Furthermore, a survey of U.S. career firefighters found 68% of firefighters did not feel they received adequate nutrition information, 71% did not follow any specific dietary pattern, and 75% were interested in learning more about healthy eating (Yang, Farioli, Korre, & Kales, 2015). Thus, research is needed to identify nutritional gaps in firefighters' diets so that nutrition interventions can be developed to improve the firefighter's quality of life and job performance.

While self-reported food records have not been widely implemented in firefighters, preliminary findings are available to help guide future research. For example, studies found inadequate energy intake during fire rescue days and overall, lacking nutrient dense foods (Robertson et al., 2017). Another pilot study found high levels of sodium and low levels of fiber compared to the Dietary Guidelines for Americans (DGA) using Food Frequency Questionnaires (FFQ) (Pohle-Krauza et al., 2008). Protein intake from self-reported 3-Day Food Records in overweight and obese career firefighters averaged 17% of total calories. Greater protein intake was associated with less body fat percent (Hirsch et al., 2018). In general, firefighter populations are overconsuming carbohydrates and sodium, while under consuming fiber, potassium, vitamin D and E (Robertson et al., 2017).

Clinicians can use dietary assessments, such as food records, to identify nutritional risks and behaviors, which is important to help guide decision-making and interventions. We believe customized nutrition interventions based on detailed assessment, risk analysis, individual needs, and shared decision-making can enhance adherence and clinical outcomes (Dagenais, Brady, & Haldeman, 2012; Desroches et al., 2011). However, previous firefighter nutrition research lacks customization and largely focuses on implementing specific dietary patterns (e.g. Mediterranean Diet) (Elliot et al., 2007) or general nutrition education (Goheer, Bailey, Gittelsohn, & Pollack, 2014).

Despite the lack of precision and customization, some nutritional interventions have shown promise and modest clinical benefits in firefighters. The Promoting Healthy Lifestyles: Alternative Models' Effects study with firefighter is one of the largest interventions aiming to reduce percent of fat consumed (less than 30%), increase fruit and vegetables (FV) (> 5 servings/day), and improve energy balance (Elliot et al., 2004). Dietary habits were analyzed with FFQ and found intervention groups significantly increased FV servings. A 6-month intervention educating on energy balance and well-balanced meals (MyPlate), found improved dietary intakes from self-reported surveys (Goheer et al.2014). We believe these outcomes can be improved by implementing customized approaches.

Most studies have analyzed firefighters' nutritional intake using FFQ. Very few have used 3-Day Food Records and have small sample sizes (Robertson et al., 2017; Elsner & Kolkhorst, 2008; Pohle-Krauza et al., 2008). Research studies conducted more than 10 years ago need to be reconsidered due to the ever-changing food and nutrition industry, specifically in the last 10 years (James et al., 2017). From the evidence aforementioned, it is clear improvements are needed in the nutritional assessment, risk analysis, and intervention strategies for firefighters. Given the unique barriers to adequate nutrition and the physical demands within this population, identifying nutrition risk is the first step to promoting health and optimizing performance. It is customary practice for coaches to complete a needs analysis for their athletes when crafting training programs (Alvar, Sell, & Deuster, 2017; McDonough, Phillips, & Twilbeck, 2015). This principle should be practiced similarly with dietary habits. Risk assessments allow the clinician to gather data as a starting point for needs. Without knowing the needs for improvement, the effectiveness of interventions may be limited. Therefore, developing a risk screening tool can provide specific nutrition interventions to promote health and performance.

The purpose of this paper is to describe preliminary development of the Tactical Athlete Nutrition Score (TANS) (Johnson & Mayer, 2019). The TANS is a nutrition risk screening tool for tactical athletes. This paper describes the tool and how we used TANS to determine nutrition risk level in a sample of career firefighters.

## METHODS

### *Participants*

A cross-sectional study was conducted in a sample of firefighters (*N* = 150, all males). Data were gathered from baseline assessments from career firefighters employed by departments in Southern California. Inclusion criteria to participate were: 1) career firefighters, full active duty, and no work restrictions. Exclusion criteria were: 1) relevant current workers' compensation or personal injury case, 2) pregnant women, and 3) any reason the principal investigator deemed unsuitable, such as clinical contraindications to physical activity, behavioral concerns, and unwillingness to complete the study procedures. All firefighters who completed the 3-Day Food Record were included in this study. The research procedures were approved by an Institutional Review Board and all firefighters provided informed consent prior to participation.

### *Procedures*

Recruitment presentations occurred in Southern California Fire Departments from June 2019 to August 2019. During recruitment presentations, research personnel introduced the Regional Firefighter Wellness Initiative to candidates. Firefighters who expressed interest were consented following the presentations or provided their personal information to be later contacted and scheduled an appointment. The individual firefighter was provided an opportunity to consent in a private area of the fire station if preferred. Research personnel thoroughly explained the purpose of the study, risk/benefits, confidentiality, and that their participation was voluntary. At any point, the firefighter could choose to withdrawal from the study for any reason or no reason, without penalty.

*Baseline Assessments*

After providing informed consent, participants completed baseline assessments, which included an extensive battery of self-report questionnaires, anthropometric measures, and dietary assessment. Pertinent data for the current study included: 1) self-report questionnaires for demographics, health history, injury and illness, diet habits, and a food record; and 2) objective data for resting blood pressure, body fat percent measured by Bioelectrical Impedance Analysis (TANITA BC-601FS FitScan Segmental Body, Arlington Heights, Illinois), height, weight, and waist and hip circumferences.

*Food Record*

To capture specific nutrient intake following baseline assessments, the firefighters completed a 3-Day Food Record via the online system - FoodProdigy (Version 1.81, ESHA Research, Salem, OR). FoodProdigy is an online food logging database where the firefighter submits their food record over 3-days via a personal online account input. To improve the accuracy of recording dietary intakes, firefighters were provided a protocol with detailed instructions on how to accurately measure food and beverages. Capturing dietary intake in this manner has been shown to be reliable and valid (Ortega et al., 2015). The protocol asked firefighters to measure their food using measuring cups and a food scale when possible. If measuring or weighing food was not possible, instructions and a handout were provided with standard portions using simple comparators (e.g. baseball = 1 cup broccoli) or their hands (e.g. palm size = 3 oz. protein foods) to estimate portions (Centers for Disease Prevention and Control, 2019). Due to the limitation of varying hand sizes, firefighters were encouraged to use the standardized approach using comparators such as a deck of cards, a baseball, or dice when estimating portions. Using these guidelines as a measuring tool for a majority of food items is ±25% of true weight (Gibson et al., 2016). Participants were asked to log their food and beverage over a 72-hour period (two on-duty days with their employment as a firefighter and one off-duty day) for standardization among the various shift schedules. Upon completing the 3-Day Food Record, reports were emailed to the principal investigator. The report was imported into the ESHA Food Processor Software to analyze average nutrient consumption. During analysis, the investigator screened the food records to ensure accuracy with the days logged. One firefighter was excluded because the food record only included one day.

*Model Development - Nutritional Assessment and Risk Level Classification*

The Tactical Athlete Nutrition Score (TANS) tool was developed through 1. Best available evidence, 2. Observations during mealtime at the fire stations and informal interviews with firefighters, and 3. An expert judgment exercise. These processes helped determine critical nutrition variables and cut-off scores until agreement was reached to adequately capture nutrient deficiencies.

Step 1: Best available evidence: A systematic search of the literature was conducted by the investigator reviewing current science-based nutrition evidence for tactical athletes, first responders, and other high-risk workers. This search revealed major gaps in knowledge. For example, within the tactical athlete group, only the military provides DRIs specific to tactical athletes' unique needs. These gaps in knowledge presents the opportunity to create a tool to identify nutrition risk specific for tactical athletes. For each category, the investigator reviewed dietary recommendations from the DRI, military DRI, and DGA, historical food intake in the population, and previous nutrition analyses of firefighters' diets.

Step 2: Firefighter mealtime observations and interviews: The investigators have been exposed to usual activities of thousands of firefighters in their natural on-shift environment for this study and previous work. Informal conversations, interviews, and observations were carried out during mealtime and other relevant times regarding nutritional habits. These situations provided a unique opportunity in a relaxed atmosphere (outside of a controlled environment) to glean useful information about nutrition intake and needs of firefighters.

Step 3: Expert judgment exercise: After obtaining information from steps 1 and 2 and preparing a draft of the TANS categories and cutoff scores, the investigator conducted an expert judgement exercise with two other experienced clinicians and researchers in nutrition, human performance, occupational health, and firefighters. The experts were provided a description of the task at hand, evidence uncovered, and the draft of the TANS categories. Each independently provided their feedback on the TANS categories and risk cutoff scores. The investigator reviewed this information with the experts and worked with them until a consensus in level of agreement was reached.

Following steps 1 - 3, the final working tool of the TANS for this project was developed, which consisted of five nutrition variables as follows (Table 1): 1. Energy intake (kcal), 2. Protein, 3. Omega-3 fatty acids (*n*-3FA), 4. Total sugar (TS), and 5. Fruit and vegetable servings (FV). The final nutrition variables selected are strongly correlated with health and performance for general populations (Broussard et al., 2015; Halson, 2014) and firefighters (Hirsch et al., 2018; McDonough, Phillips, & Twilbeck, 2015; Wooding et al., 2018). Justification for these five variables are described in this section.

*Energy Intake (kcal)*

Proper kcal intake is important to provide adequate energy for physical demands and promote healthy body composition. The participants' average kcal intake was compared to their daily Estimated Energy Requirements (EER) based on the Harris-Benedict calculation. The Harris-Benedict calculation has been shown to be the most accurate in predicting Resting Metabolic Rate (RMR) when compared to direct calorimetry (Lee & Kim, 2012). The Harris-Benedict formula for male participants used recorded height and weight, age, and a standardized activity level factor (1.55, moderate activity) to determine EER. The lower-midrange of the physical activity level factor was selected considering self-reported dietary intakes often under report energy intake (Johnson, 2002; Subar et al., 2015) and only 3.6% of annual fire department calls are fire rescue requiring additional energy needs (National Fire Protection Association, 2019)

*Protein Intake*

Protein is a vital macronutrient necessary to support muscle tissue in tactical athletes. The Acceptable Macronutrient Distribution Range (AMDR) for protein is 10-35% of total energy intake for adults (Institute of Medicine, 2005). Given the physical demands of job-tasks, the upper end of the AMDR was selected. Based on previous research findings, firefighters are under consuming protein and higher protein intake is beneficial for healthy body composition (Hirsch et al., 2018). Given the correlation of body composition and injury risk in firefighters (Jahnke et al., 2013; Kuehl et al., 2013), adequate protein intake is critical. The range of 25-35% will promote higher protein intake, while simultaneously reducing the percent of calories consumed from carbohydrates and fat.

*Omega-3 Fatty Acids*

Omega-3 fatty acids are an important nutrient with anti-inflammatory properties (National Institute of Health, 2019). Empirical evidence documents several health benefits positively associated with *n*-3FA consumption, specifically relevant to firefighters, such as reduced cardiovascular disease, cancer prevention, and cognitive function (National Institutes of Health, 2019). The DRI suggests at least 1.6g *n*-3FA per day is adequate for 97-99% of the population (NIH, 2019). Due to the prevalence of cardiovascular disease and cancer within firefighters, the principal investigator and expert judgment team suggest at least 2g *n*-3FA per day.

*Total sugar*

Total sugar was selected to address concerns of high levels of sugar intake from processed foods. The 2010-2015 DGA suggest less than 10% of total calories consist of added sugars (U.S. Department of Health and Human Services & United States Department of Agriculture, 2015). However, food companies and nutrition software are transitioning to the updated food label regulations requiring added sugars to be isolated from TS (Food and Drug Administration, 2019). Due to the limitation of nutrition databases in a transition period, extracting only added sugars is not possible. Total sugar includes both naturally occurring sugars and added sugars. To reduce intakes of added sugars, the TS low risk level was calculated to be l0% of EER.

*Fruit and vegetable servings*

Finally, given the prevalence of low-quality food consumption (Dobson et al., 2013; Wooding et al., 2018), the number of FV servings was included. By measuring FV servings, the goal is to identify individuals missing nutrient-dense foods previously low within the population. Fruits and vegetables provide important vitamins and minerals for tactical athletes. Furthermore, FV intake is associated with decreased risk of all-cause mortality and cardiovascular disease (Wang et al., 2014).

*TANS Scoring*

For each variable, an individual score of 0, 1, or 2 was assigned based on the selected cut-off scores (see Table 1). The scores for each variable were added together to calculate total TANS, ranging from 0-10. Based on the expert judgment exercise, the team selected a score of 0-2 to indicate low risk, 3-6 moderate risk, and 7-10 high risk. Observations about initial validity of these scores are described in the results section.

***Table 1.*** *Tactical Athlete Nutrition Score (TANS) Tool: Risk levels depicted by five variables and TANS Total.*

| | **Tactical Athlete Nutrition Score Risk Level** | | |
|---|---|---|---|
| **Variable** | **Low** | **Moderate** | **High** |
| Energy Intake (%) | 85-109 | 70-84 or 110-120 | < 70 or > 120 |
| Protein (%) | 25-35 | 10-24 or 36-40 | < 10 or > 40 |
| Omega-3 Fatty Acids (g) | > 2 | 1-2 | < 1 |
| Total Sugar (%) | < 10 | 10-15 | > 15 |
| Fruits/Vegetables (cups) | > 6 | 2-6 | < 2 |
| TANS Total (0-10) | 0-2 | 3-6 | 7-10 |

***Analysis***

Descriptive statistics (means, standard deviations, ranges) were calculated for all participant characteristics and TANS and were compared among the nutrition risk categories. One-way analysis of variance (ANOVA) was conducted for each of the five variables and TANS total score comparing among the nutrition risk categories. Statistical significance for the ANOVA models was accepted at alpha = 0.05.

**RESULTS**

***Participant Characteristics***

All participants ($N$ = 150) were males and participant characteristics related to wellness and kinesiology are shown in Table 2. Key baseline characteristics reflect some diversity in the selected sample and generally appear to reflect the population of firefighters from which the sample was derived. For example, the age of participants was 37.4 ± 8.4 years (min: 22; max: 59 years), BMI was 28.3 ± 3.7 kg/ $m^2$ (min: 21.3 kg/ $m^2$; max: 42.9 kg/$m^2$), and % bodyfat was 21.5 ± 6.0% (min: 8.6%; max: 41.2%).

***Tactical Athlete Nutrition Score Results***

Table 3 portrays the descriptive statistics and risk categories for the five nutrition variables and the overall TANS (see Table 1). Overall TANS risk level for the 150 participants were as follows: low risk: $n$ = 7, moderate risk: $n$ = 77, high risk: $n$ = 66. The average intake and standard deviations for each variables of TANS appeared to effectively differentiate individuals based on nutrition risk, with separation of key variables observed among the TANS risk levels. For example, low nutrition risk participants ($n$ = 7) had an average energy intake of 103.2 ± 15.2 percent daily EER, 24.3 ± 5.1 percent protein intake, 3.26 ± 1.5 g $n$-3FA, 8.1 ± 0.89 percent TS, and 4.9 ± 1.8 FV servings. The moderate risk group ($n$ = 77) had an average energy intake of 85.0 ± 17.2 percent daily EER, 18.8 ± 5.2 percent protein intake, 1.24 ± 0.74 g $n$-3FA, 10.3 ± 4.1 percent TS, and 3.3 ± 1.7 FV servings. The high risk group ($n$ = 66) had an average energy intake of 61.8 ± 21.8 percent daily EER, 12.7 ± 5.5 percent protein intake, 0.62 ± 0.49 g $n$-3FA, 13.5 ± 6.8 percent TS, and 1.8 ± 1.2 FV servings.

Notably, for the two categories (caloric intake and protein intake) that have outside of normal scores above and below the recommended range, the vast majority of participants reported values below the recommended range. For the moderate risk group, two participants consumed too many calories (based on the cutoff scores) and one participant consumed too much protein, which increased the mean values for kcal and protein intake for the moderate risk group. For the high risk group, one participant consumed too many kcals, which increased the mean value for the high risk group.

Significant differences among the nutrition risk categories were found for each of the five variables and TANS total score: Energy Intake ($p < 0.001$), Protein ($p < 0.001$), Omega-3 Fatty Acids ($p < 0.001$), Total Sugar ($p < 0.001$) Fruits/Vegetables ($p < 0.001$), TANS Total ($p < 0.001$). For each variable and TANS total, post-hoc pairwise comparisons of nutrition risk categories revealed significant differences ($p < 0.05$) among the high risk, moderate risk, and low risk groups for each comparison in the expected order (e.g. Low Risk > Moderate Risk > High Risk) (Table 3).

**Table 2.** *Demographic characteristics of participants depicted by total Tactical Athlete Nutrition Score (TANS) risk level.*

| | Low (n = 7) | Moderate (n = 77) | High (n = 66) | Total (n = 150) |
|---|---|---|---|---|
| **Variable** | mean ± SD (min-max) | mean ± SD (min-max) | mean ± SD (min-max) | mean ± SD (min-max) |
| Age (yr) | 35.0 ± 3.7 (28-40) | 37.6 ± 8.0 (22-59) | 37.3 ± 9.3 (23-55) | 37.4 ± 8.4 (22-59) |
| Heart Rate (BPM) | 65.7 ± 15.5 (52-95) | 63.3 ± 10.8 (46-92) | 66.2 ± 10.9 (46-96) | 64.7 ± 11.1 (46-96) |
| BP systolic (mmHg) | 124.6 ± 2.7 (106-141) | 128.6 ± 13.3 (103-170) | 131.9± 15.4 (104-191) | 129.8 ± 14.3 (103-191) |
| BP diastolic (mmHg) | 69.6 ± 3.1 (65-75) | 76.6 ± 10.1 (52-104) | 78.0 ± 9.9 (53-107) | 76.9 ± 9.9 (52-107) |
| Height (in) | 70.6 ± 1.6 (68.8-72.5) | 70.9 ± 2.9 (62.5-77.3) | 70.7 ± 2.6 (63.3-76.5) | 70.8 ± 2.7 (62.5-77.3) |
| Weight (lb) | 184.4 ± 15.0 (164.0-209.0) | 199.5 ± 30.7 (138.6-271.8) | 206.5 ± 30.8 (152.2-304.4) | 201.9 ± 30.5 (138.6-304.4) |
| BMI (kg/m$^2$) | 26.1 ± 2.7 (21.9-28.7) | 27.8 ± 3.4 (21.3-35.3) | 29.0 ± 3.9 (21.4-42.9) | 28.3 ± 3.7 (21.3-42.9) |
| Bodyfat (%) | 16.4 ± 5.4 (9.8-24.6) | 21.2 ± 5.6 (8.6-35.2) | 22.5 ± 6.2 (9.9-41.2) | 21.5 ± 6.0 (8.6-41.2) |
| Waist Circumference (in) | 34.5 ± 2.8 (31.4-38.4) | 36.6 ± 3.7 (30.3-44.6) | 37.6 ± 3.9 (30.1-48.2) | 36.9 ± 3.8 (30.1-48.2) |
| Waist:Hip Ratio | 0.90 ± 0.06 (0.85-1.01) | 0.91 ± 0.0 (0.80-1.10) | 0.92 ± 0.05 (0.84-1.06) | 0.92 ± 0.06 (0.80-1.10) |

***Table 3.*** *Descriptive statistics for the five variables depicted by Tactical Athlete Nutrition Score (TANS) risk level and total.*

| | Tactical Athlete Nutrition Scores | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Low | | Moderate | | High | | Total | |
| **Variable** | n | mean ± SD (min-max) | n | mean ± SD (min-max) | n | mean ± SD (min-max) | n | mean ± SD (min-max) |
| Energy Intake (%) | 44 | 93.9 ± 6.9 (82-106) | 38 | 82.5 ± 15.4 (70-123) | 68 | 60.0 ± 23.1 (23-142) | 150 | 75.7 ± 23.1 (23-142) |
| Protein (%) | 13 | 29.0 ± 3.0 (25-35) | 114 | 16.6 ± 4.2 (10-36) | 23 | 7.8 ± 1.3 (4-9) | 150 | 16.3 ± 6.3 (4-36) |
| Omega-3 Fatty Acids (g) | 15 | 3.2 ± 1.1 (2-5) | 50 | 1.3 ± 0.2 (1-2) | 85 | 0.5 ± 0.2 (0-1) | 150 | 1.1 ± 0.9 (0-5) |
| Sugar (%) | 69 | 7.0 ± 1.9 (2-10) | 43 | 12.2 ± 1.4 (10-15) | 38 | 19.3 ± 4.4 (15-33) | 150 | 11.6 ± 5.7 (2-33) |
| Fruits/Vegetables (cups) | 10 | 6.9 ± 0.4 (6-8) | 76 | 3.4 ± 1.0 (2-6) | 64 | 1.2 ± 0.5 (0-2) | 150 | 2.7 ± 1.7 (0-8) |
| TANS Total (0-10) | 7 | 1.9 ± 0.4 (1-2) | 77 | 4.6 ± 1.0 (3-6) | 66 | 7.7 ± 0.8 (7-10) | 150 | 5.8 ± 2.0 (1-10) |

**DISCUSSION**

The paper described the development of the Tactical Athlete Nutrition Score to determine nutrition risk level in a sample of career firefighters. To our knowledge, this is the first tool that has been developed to specifically assess nutrition risk across several nutritional domains in tactical athletes. Considering that prior studies in firefighters suggest the need for identifying nutrition risk level in this population, the TANS - once fully validated - could fill a gap in knowledge, research, and practice in assisting with nutritional management in career firefighters. Examples of prior studies suggesting the need for nutrition risk level identification are as follows. Several studies have shown the obesity rates within U.S. career firefighters have increased within the fire departments over the years (Poston et al., 2011; Smith et al., 2012). More than 70% of firefighters are overweight and an alarming 30-40% are obese (Brown et al., 2016). Obese firefighters have higher rates of musculoskeletal injury than normal BMI colleagues (Kuehl et al., 2013; Jahnke et al., 2013). The few nutrition studies in firefighter populations found an under consumption of nutrient-dense foods (Pohle-Krauza et al., 2008; Robertson et al., 2017).

One previous study correlated nutrition and physical fitness in career firefighter justifying the need for screening nutritional intake. Hirsch et al. (2018) collected self-reported 3-Day Food Records from a group of overweight and obese career firefighters and found greater protein intake was associated with less percent body fat. Protein intakes greater than 0.8g/kg/day resulted in more favorable body composition in male firefighters (Hirsch et al., 2018). Due to the inherent relationship of obesity with nutrition, it is imperative to address nutritional intake and physical fitness in firefighters. Thus, the TANS can assist clinicians with identifying the risk of nutritional gaps that support health in this population.

The results of this study suggest that the TANS is feasible to proceed to full-scale validation research trials. The ANOVA demonstrated significant differences between the various TANS risk levels across the vast majority of variables, indicating that the TANS is able to differentiate among firefighters across important nutritional domains. Given the ANOVA results, the proposed cutoff scores for five important nutrition variables and TANS Total are clinically meaningful and pragmatic. Based on the findings of the present study, 95% (143/150) of firefighters have nutritional deficiencies which is likely representative of dietary intakes of firefighters. From our preliminary assessment, a significant number of firefighters are falling in the moderate to high risk nutrition groups. These efforts, when considered in aggregate, suggest that few firefighters have optimal dietary intakes and improvement is needed through appropriate nutrition interventions.

If future validation through high quality research studies is positive, the pragmatic applications of this tool are numerous. For example, it can contribute to assessing nutrition risk level among tactical athletes, such as firefighters, and can be used to help guide clinical decision-making for nutritional interventions. Therefore, nutrition interventions can be tailored to individual deficiencies to better optimize health and performance. The TANS can assist in identifying suboptimal nutrient intake to help manage body composition, for example, in career firefighters by focusing on customized and individualized interventions for those firefighters who need it the most. Risk level identification, analysis, and customized interventions can help improve outcomes, satisfaction, and quality of care, and is consistent the current trends in healthcare regarding with patient preferences and shared decision-making (Dagenais, O'Dane, & Haldeman, 2012).

**LIMITATIONS**

The results of this study need to be interpreted with caution given the pilot nature of the design and inherent limitations as follows: 1. The purpose of this study was to describe preliminary development of a nutrition risk scoring tool for tactical athletes. It was not intended to make strong inferences about validity about the TANS tool across the various categories of validity. 2. The cutoff scores and categories for TANS were selected by a small group of experts, which was not subject to extensive review. 3. The findings may not be generalizable to all tactical athletes. The convenience sample selected may not represent all career firefighters in the U.S. The sample population was from Southern California and dietary intakes may differ compared to their colleagues across the country. 4. This study assumed firefighters accurately self-reported their dietary intakes and portions following the protocol. However, the accuracy of a one-time self-report food record is questionable. Nevertheless, a strength of this study is use of the 3-Day Food Record procedure for which reliability has been established (Yang et al., 2010).

**FUTURE RESEARCH**

Full-scale validation is needed before this assessment tool can be fully implemented to help guide clinical decision-making for nutrition interventions. A factor analysis study with a diverse sample of firefighters should be conducted. Nutrition risk factors based on dietary intakes and how they correlate with obesity, injury, sleep, and physical fitness should be investigated. Furthermore, this tool should be tested in other tactical athlete populations to assess various types of validity of nutrition risk, such as face validity, content validity, construct validity, predictive validity, and concurrent validity.

**CONCLUSION**

In summary, preliminary development of a novel tool (TANS) for nutritional assessment and risk level classification in tactical athletes was described in this study, and findings suggest that the TANS can proceed to formal validation studies. The purpose of the TANS is to capture nutritional deficiencies through assessment and screening, since nutrition is strongly correlated with primary health concerns in tactical athletes (e.g. obesity and cardiovascular health) and human performance (e.g. fitness level). This tool allows the clinician and researcher to view specific nutrient intake rather than broad food group consumption for correlation to primary health concerns and performance. Assuming positive results with subsequent full-scale validation studies, the TANS can help identify nutrition risk in tactical athletes to improve overall dietary intakes. By identifying risk level, clinicians can customize interventions that are sustainable, client-centered, and promote health and performance. The intention of ranking low, moderate, and high risk levels is to identify how practitioners can intervene to enhance nutritional quality of diets. By addressing these nutritional gaps, secondary outcomes can be accomplished (e.g. reducing obesity, preventing chronic disease, decreasing injuries, improving sleep, and elevating performance) which improves the quality of life for tactical athletes.

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