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Examining the Relationship Between Healthy Eating Score and ACFT Performance in Reserve Officer Training Corps (ROTC) Cadets

Original Research

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Abstract

Introduction: Reserve Officers' Training Corps (ROTC) cadets must maintain military readiness by meeting physical fitness standards and passing the newly implemented Army Combat Fitness Test (ACFT). Prior research established a positive relationship between nutrition and performance, however the relationship between diet and ACFT performance has not been studied. This study aimed to examine the relationship between diet quality and ACFT performance in cadets.

Methods: ROTC cadets (n=52) completed the Healthy Eating Score-7 (HES-7) and an ACFT. HES-7 is a proxy for diet quality and scored between 0 and 35. The ACFT is a measure of performance with a maximum score of 600. The association of HES-7 score with total ACFT score was evaluated using multiple linear regression analysis. Models adjusted for body mass and physical activity as potential confounders. Statistical significance was set at $p \leq 0.05$.

Results: The average scores for ACFT and HES-7 were 485.5±71.5 and 19.7±5.2 points, respectively. There was no significant association between HES-7 and ACFT ($r=-0.213$, $p=0.088$). The final regression model included HES, physical activity time, and body mass, and explained 10.4% of the variance in the ACFT score.

Conclusions: Favorable dietary habits assessed by HES-7 were not associated with physical performance.

Key Words: Physical performance, military readiness, diet

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Introduction

Fit and capable service members are required to successfully meet the Army's mission to deploy, fight and win our nation's wars. Reserve Officer Training Corps (ROTC) program cadets make up over half of all military leaders. During ROTC and in preparation to enter service, cadets must maintain physical readiness by meeting body composition standards and passing a standardized physical fitness test. In 2020, the Army announced a transition from the previously established Army Physical Fitness Test (APFT) to the Army Combat Fitness Test (ACFT) and fully implemented the ACFT in October 2022. When compared to the APFT, the ACFT includes double the number of graded events designed to better assess functional fitness and military readiness. Prior research identified a strong positive relationship between nutrition and military test performance (i.e., APFT).[1] However, the relationship between diet quality and ACFT performance has not been studied. Understanding the relationship between diet quality and ACFT performance in ROTC cadets is warranted and results may generate targeted interventions to improve performance.

Recent studies suggest that ROTC cadets tend to meet their overall daily energy needs without consuming the recommended amounts of whole grains, fruits and vegetables.[2,3] It can be assumed that similar to the general college population, ROTC cadets make suboptimal food choices and adopt dietary patterns that may negatively impact their fitness levels.[4] An association has been observed between diet quality and physical performance among Active-Duty Military Personnel (ADMP).[1,5,6] Special Forces candidates reporting better dietary quality performed better on physical tests (e.g., APFT) compared to those with the lowest dietary quality.[5] Another study in college students found that adherence to a Mediterranean diet, a proxy for higher diet quality, was associated with high levels of muscular and cardiorespiratory fitness.[7] Evidence, although limited, suggests that dietary quality may influence physical performance more broadly in a military population. Understanding these associations could inform practices to optimize physical performance and provide insight for adapting eating and physical activity training programs. Thus, the primary aim of this study was to explore the relationship between diet quality and total ACFT performance in a cadet population. We hypothesized that there would be a positive relationship between Healthy Eating Scores and total ACFT scores.

Scientific Methods

This study was a pre-planned secondary analysis of a cross-sectional study that explored associations between ACFT scores and body composition, omega-3 fatty acids, and vitamin D.[8] This analysis was limited to examining associations between Healthy Eating Scores and total ACFT scores. All assessments were completed during a single visit that lasted approximately 30-60 minutes. Participants were fasted and asked to wear light, comfortable athletic clothing. The ACFT was taken within the previous 7 days and provided to the study team after informed consent was obtained.

Participants

Participants were eligible for the study if they were ROTC students between ages 18 and 42. Pregnant participants were excluded. Informed consent was obtained by a member of the study team. The study was approved by the Baylor University Institutional Review Board (1675892-4).

Anthropometric measurements

Height was measured without shoes using a stadiometer (Seca 703, Hamburg, Germany) and rounded to the nearest 0.01 cm. Body mass was measured on a digital scale and rounded to the nearest 0.01 kg. Body mass index (BMI) was calculated from the measured height and body mass as kg/m^2.

Healthy Eating Score

The Healthy Eating Score-7 (HES-7) is a tool used to assess diet quality in military populations.[9] Total HES-7 score was calculated from self-reported frequency of consumption of the following items: fruits, vegetables, whole grains, dairy, fish, energy drinks/shots, and sugary beverages over the last 30 days. All components except fish were scored on a 5-point scale including 0 with respective answers: rarely or never, 1-2 times per week, 3-6 times per week, one time per day and 2+ times per day. Score of 0 represented a lower diet quality score and 5 represented a higher diet quality score. Fish was scored with 0 (rarely or never), 3 (1-2 times per week), or 5 (3+ times per week). Reverse coding was used to calculate scores for energy drinks and sugary beverages which scored 5 (rarely or never), 3 (1-2 times per week), 2 (3-6 times per week), 1 (1 time per day) or 0 (2+ times per day). The maximum score was 35 points with a higher score indicating greater adherence to dietary guidelines.

Physical Performance

The version of the ACFT completed at the time of study (December 2021) included six events (prescribed order including performance to achieve minimum and maximum scores): 1) Three-repetition maximum hexagon deadlift (min: 140 lbs.; max 340 lbs.), 2) Standing power throw with a ten-pound medicine ball; the highest score of the two attempts is recorded (min: 4.5 meters; max: 12.5 meters), 3) Maximum effort hand-release-pushups in two minutes (min: 10 push-ups; max: 60 push-ups), 4) Five 50-meter shuttles: a sprint, a 90-pound backward sled pull, a lateral shuttle, a 40-pound kettlebell carry, a sprint without weight (min: 180 seconds; max: 93 seconds), 5) Hanging leg tuck with an alternate option of a timed plank (min: 1 leg tuck; max: 20 leg tucks; or min: 2:09 minute plank; max: 4:20 minute plank), and 6) Two-mile run (min: 21:00 min; max: 13:30 min). Scores for each event range from 0-100 points with 60 points required in each category to pass. (Note: The leg tuck event has been replaced with the Plank Test and scoring has been updated as of March 2023). Additionally, average physical activity data were calculated from two questions taken from the Military Eating Behaviors Survey.

Statistical Analysis

HES-7 and ACFT were evaluated for linearity using scatter plots with Pearson's correlation coefficients. Multiple linear regression analyses were used to evaluate the association of the HES-7 score with total ACFT score. Physical activity time and weight were entered in the model as controls. Statistical significance for all tests was set at $p \leq 0.05$ and alpha at 0.80. Based on 80% power and 25% standard deviation post-hoc power analysis, 29 participants were needed for this study. Of note, our primary outcome (HES-7) was slightly above this threshold (SD: 26.4%). All data was analyzed using the Statistical Package and Service Solutions (SPSS) software Version 27 (IBM SPSS, Chicago, IL, USA).

Results

Refer to Table 1 for demographic characteristics of the study population.

Table 1. Demographic Characteristics for Reserve Officer Training Corps (ROTC) Cadets.

	All (n = 52)	**Male (n = 36)**	**Female (n =16)**
Age (Years)	20.3 ± 1.7	20.1 ± 1.1	20.6 ± 2.8
ROTC[a]			
Year 1	3	2	1
Year 2	15	11	4
Year 3	9	7	2
Year 4	21	14	6
Body mass (kg)	75 ± 14.1	81 ± 12.2	61.5 ± 7.3
BMI (kg/m^2)	24.4 ± 3.3	25.4 ± 3.2	22.2 ± 2.5
Physical Activity[b] (mins/wk.)	415.5 ± 198.8	445.9 ± 199.8	330 ± 177.2
HES-7 Score (Points)	19.7 ± 5.2	18.9 ± 5.4	22.1 ± 4.2
ACFT Total Score	485.5 ± 71.5	519.3 ± 44.1	398.6 ± 52.3

ROTC – Reserve Officer Training Course, BMI – Body Mass Index, HES – Healthy Eating Score, ACFT – Army Combat Fitness Test

[a]Missing values due to non-reporting of demographics (ROTC year, n=4; Sex, n = 1)

[b]Physical activity time was computed from two questions in the Military Eating Behavior Survey

The cohort scored an average of 19.7±5.2 points on the HES-7. Average scores for each HES-7 category were as follows: fruits=2.2±1.3, vegetables=2.7±1.2, whole grains=2.53±1.3, dairy=2.5±1.2, fish=1.4±1.6, sugary beverages=4.1±0.7.

Table 2. Models Evaluating the Relationship between the Healthy Eating Score (HES-7) and Army Combat Fitness Test Total Score

	Model 1			**Model 2**		
	β	SE	*p*-value	β	SE	*p*-value
HES-7	-0.176	2.017	0.258	-0.112	2.025	0.472
Physical Activity	0.244	0.056	0.12	0.184	0.056	0.239
Weight	---	---	---	0.274	0.777	0.090

Model 1 = adjusted for total physical activity time

Model 2 = adjusted for total physical activity time and body mass,

Significance = $p<0.05$

The ACFT total scores ranged from 261.0-593.0 points with an average of 485.5±71.5 points. Out of 100 maximum points, cadets scored the following on each event: 3 repetition maximum deadlift, 80.8±14.7; standing power throw, 72.1±16.1; hand-release push-ups, 81.1±11.1; sprint-drag-carry, 83.0±21.6; leg tucks, 81.8±13.6; plank, 60.5±24.0; 2-mile run, 84.9±14.1. Out of the entire sample (n=52), 10 participants (19.1%) chose the plank alternative. Most cadets passed the ACFT (88.5%). All participants who failed the ACFT (11.5%) were female (n=6). The event that contributed to the highest failing rate was the standing power throw (n=4, 7.6%), followed by the sprint-drag-carry (n=3, 3.8%), and two-mile run (n=2, 3.8%).

The analysis failed to identify a significant relationship between the HES-7 and ACFT total score (r= -0.213 p=0.088). The first model was adjusted for HES-7 and total physical activity time (R^2= 0.058, F(2, 39)=2.356, p=0.118) and it explained 5.8% of the variance in ACFT total scores. The second model was additionally adjusted for body mass since there is a strong relationship between body mass and ACFT score[8] (R^2 =0.104, F(3, 38)=2.594, p=0.067) and it explained 10.4% of the variance in ACFT total score; however, neither model was significant.

Discussion

To our knowledge, this is one of the first published studies that assessed the relationship between Healthy Eating Score and ACFT performance in ROTC cadets. Overall, the HES-7 scores in this study were consistent with a previous study by Dyal et al.[9] with comparable HES-7 mean scores and ranges in active-duty military personnel. The results did not identify a significant relationship between HES-7 scores and ACFT performance. Previous studies in military populations identified an association between diet quality and performance, although there is variability between studies. Purvis et al.[1] found an association between HES-5 and APFT passing rate in which Soldiers with high HES-5 scores were more likely to pass the APFT than those with low HES-5 scores. Furthermore, a previously mentioned study found that those with poor diet quality (assessed by Healthy Eating Index-2015 [HEI]) were less likely to be selected to Special Forces, which is based largely on physical performance.[5] The discrepancies in these findings might be due to the complexity in ACFT compared to the APFT (six events and 600 max total points vs. 3 events and max total 300 points). Interestingly, HES-7 only displays moderate correlation with diet quality as compared to HEI,[9] the latter of which is highly correlated with the Dietary Guidelines for Americans. Most importantly, all other studies had > 400 military personnel included, whereas this study had < 60. Although speculative, our standard deviation for our primary outcome was greater than 25%, so a more adequate sample size may have led to results that align with previous investigations.[1,5] Considering that specific nutrition strategies have been developed to enhance aspects of physical performance in the general population, this study emphasizes the need for further research in the military populations.

Strengths and Limitations

This study was conducted using standardized, validated measures to evaluate healthy eating (i.e., HES-7) and physical performance (i.e., ACFT), which allows for comparison across other studies in different samples using the same tools, increasing generalizability. Additionally, this study builds on the limited knowledge base of eating habits among ROTC students. The simple nature of the HES-7 tool facilitates rapid data collection; however, it may exclude certain dietary aspects that could negatively skew diet quality scores. For example, the tool will not capture many high-fat and sodium containing foods obtained from fast food sources, or from processed foods (e.g., candy, chips, frozen meals). Another limitation is the use of an initial version of the ACFT that used a sex neutral scoring system and the leg tuck exercise. More recent versions of the ACFT are scored according to age and sex while replacing the leg tuck event with the plank. These revisions limit the ability to compare current findings to future research involving ACFT. Future studies should include variables representing a participants' training regime (frequency and type), living situation, engagement in other healthy behaviors and/or body composition.

Conclusions

To our knowledge, this is the first published study examining the relationships between diet quality (HES-7) and ACFT performance in a sample of ROTC cadets. Although no relationship was found between HES-7 and ACFT, previous investigations have detailed the important relationship between nutrition, not dietary quality *per se*, and military performance. A more thorough dietary analysis, versus a proxy measure, may be warranted in future studies.

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Disclaimer

The views expressed are solely those of the authors and do not reflect the official policy or position of the US Army, US Navy, US Air Force, the Department of Defense, or the US Government.

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