Nutrition Knowledge Is Associated With Diet Quality Among US Army Soldiers
Kenneth A. Sheafer1; Dustin M. Lee, PhD, RDN, CSSD1; Beatriz George, PhD, RDN, CSSD1; Julianna M. Jayne, PhD, RDN, CHES2; Renee E. Cole, PhD, RDN3

ABSTRACT
Objective: Examine the relationship between nutrition knowledge, diet quality, and eating behavior among active-duty US Army Soldiers.
Methods: Cross-sectional study with data collection in February 2018 via paper surveys during the validation of the Military Eating Behavior Survey.
Results: Among 440 US Army Soldiers, nutrition knowledge was positively and significantly associated with diet quality ($b = 0.29, P < 0.001$). For every 1-point increase in nutrition knowledge, the Healthy Eating Index-2015 score was expected to increase by 0.29 points. Nutrition knowledge was not significantly associated with skipping breakfast (odds ratio, 1.01; 95% confidence interval, 0.98–1.04) or dining out (odds ratio, 1.01; 95% confidence interval, 0.98–1.03).
Conclusions and Implications: The outcomes of this study warrant further investigation to determine what interventions provide the strongest outcomes for improving nutrition knowledge and diet quality, as well as create and support an environment that enhances healthy behaviors regarding nutrition that lead to improved diet quality among active-duty Soldiers.
Key Words: military, diet quality, nutrition knowledge, Healthy Eating Index, breakfast skipping

INTRODUCTION
Currently, in the United States (US), 41.9% of adults aged ≥20 years have obesity.1 The US military is also affected by the obesity epidemic, with 18% of Soldiers classified as obese in 2021, a 7.9% increase from the previous year.2 Similar patterns of obesity have been noted in foreign militaries, indicating this is not an isolated concern for American military forces.3 Excess body fat and weight gain are associated with increased prevalence and risk of injury, jeopardizing combat readiness.4,7 The US Army has attempted to address the growing trend of obesity by instituting the Performance Triad health promotion program and the Go For Green dining facility nutrition labeling program.8,9 A key component of these programs aims to educate the Soldiers on the benefits of eating behaviors that will lead to better diet quality.5,9 Diet quality refers to the variety and quantities of foods consumed related to the recommendations in the US dietary guidelines, and thus, a high-quality diet reflects dietary intake that has optimal nutrient intake.10 It is well established that diet quality among military personnel reflects suboptimal intakes that lead to low energy availability, poor macronutrient distribution, and inadequate micronutrient intake when compared with sports nutrition guidelines or the Dietary Guidelines for Americans (DGA).11–18 A diet that provides optimal nutrient intake is essential for Soldiers as it is linked to physical performance.15,19,20 A high-quality diet among Soldiers has been associated with higher physical performance, such as higher total Army Physical Fitness Test scores and faster times on loaded ruck marches.15,20 Furthermore, studies assessing the general public support that high-quality diets are associated with normal body composition and aid in long-term weight maintenance.21,22 Research has examined factors associated with diet quality and nutrition knowledge among civilian and foreign military populations. Characteristics of the military population with higher levels of nutrition knowledge and optimal diet quality include female sex, older age, tertiary education, and being an officer, whereas young enlisted men...
without a college education have been found to have the lowest nutrition knowledge.\textsuperscript{20,23,24} The relationship between diet quality and nutrition knowledge among US Army Soldiers has not been established. Although foreign militaries, such as the Australian military, have established this relationship, key differences such as size, culture, and unique demands make it important to determine if nutrition knowledge is associated with diet quality among US Soldiers.\textsuperscript{25} Establishing knowledge is associated with diet quality, key differences such as size, culture, and unique demands make it important to determine if nutrition knowledge is associated with diet quality in both the civilian and foreign military populations.\textsuperscript{17,23,24,26,27} Skipping breakfast or dining out behaviors have been associated with lower diet quality and lower nutrition knowledge in both the civilian and foreign military populations.\textsuperscript{17,23,24,26,27} Skipping breakfast or dining out \textsuperscript{≥} 3 times/wk have been associated with weight gain and suboptimal diet quality.\textsuperscript{17,23,24,26} \textsuperscript{28} whereas nutrition education interventions and nutrition knowledge have both been associated with greater adherence to dietary guidelines and diet quality.\textsuperscript{29–31} To our knowledge, no studies have examined the relationship between nutrition knowledge and the behaviors of frequently skipping breakfast and dining out among US Army Soldiers.

Nutrition education interventions have shown promise in improving nutrition knowledge,\textsuperscript{29,30,32} however, there is a lack of research examining nutrition knowledge and diet quality among US Army Soldiers. This study aimed to explore the association between nutrition knowledge and diet quality with a secondary objective to assess the association between nutrition knowledge and the eating behaviors of breakfast skipping and dining out frequency among active-duty US Army Soldiers. We hypothesized that higher nutrition knowledge scores would be associated with higher diet quality scores and a decreased prevalence of skipping breakfast and dining out.

METHODS

Participants and Recruitment

Participants were recruited, and data were collected in February 2018 from Fort Campbell, Kentucky, and Joint-Based Elmendorf-Richardson, Alaska, during a study validating the Military Eating Behavior Survey (MEBS), which was approved by the US Army Medical Research and Development Command Institutional Review Board.\textsuperscript{33} The Army Medical Research and Development Command Institutional Review Board also deemed the research protocol exempt. Investigators complied with human research policies outlined in Army Regulation 70–25, and the study was conducted in adherence with 32 CFR Part 219 requirements. These locations were chosen because of their large, diverse Soldier population and advanced coordination between the US Army Forces Command, Test Schedule and Review Committee coordination, and the US Army Research Institute of Environmental Medicine. Soldiers were recruited during large group oral briefings held in the installation theater at scheduled times designated by unit commands. Soldiers were eligible for participation if they were on active duty, aged \textsuperscript{≥} 18 years, spoke English, and had completed initial military entry training. These basic requirements are fulfilled by their current military assignment. Four hundred forty-six participants were recruited and completed data collection, and 6 Soldiers were excluded from data analysis because of incomplete responses. Following informed consent, volunteers completed a paper version of the MEBS\textsuperscript{34} and the NutritionQuest Block Food Frequency Questionnaire (FFQ)\textsuperscript{34} in a quiet, conference room-type setting with researchers standing by to respond to questions. The MEBS is a validated survey created to capture eating behaviors and meditators of eating behaviors among service members and obtain information on multiple topics, including nutrition knowledge, breakfast skipping, and dining out.\textsuperscript{33} The surveys were scanable, such that responses were scanned into a computer and double-checked by a trained research assistant. Soldiers were given 120 minutes to complete surveys and a 15-minute break between surveys to reduce survey fatigue.

Diet Quality

Diet quality was assessed using the validated NutritionQuest. The Block FFQ, designed for adults,\textsuperscript{34} is a 113-item survey that asks the participant to recall their usual intake of all meals, snacks, and drinks while at home, dining out, or take-out. The participant is asked to include how often and how much, over the past 6 months, specific foods and beverages were consumed. A measure of diet quality was computed by NutritionQuest by generating a Healthy Eating Index (HEI)-2015 score, which is based on an individual’s adherence to the 2015–2020 DGA.\textsuperscript{35,36} In summary, 13 separate components reflect various food groups, overall intake, and moderation. Nine components assess recommended adequate intakes, including total vegetables, greens and beans, total fruit, whole fruit, whole grains, dairy, total protein foods, seafood and plant protein, and fatty acid ratio. The other 4 components assess the moderation of sodium, refined grains, added sugars, and saturated fats.\textsuperscript{37} The HEI can be used with any set of foods as it relies on the caloric density of foods consumed (per 1,000 kcal) rather than the quantity consumed.\textsuperscript{37} Healthy Eating Index-2015 scores range from 0 to 100,\textsuperscript{35–37} and are interpreted using a standard grading scale from A to F. Total HEI-2015 scores of 90–100 were assigned an A, with a score of 100 indicating optimal alignment with the 2015–2020 DGA. Total scores of 80–89, 70–79, 60–69, and 0–59 were assigned a B, C, D, and F, respectively.\textsuperscript{37,38}

Nutrition Knowledge

The MEBS has a 23-item nutrition knowledge section tailored to a military population on the basis of general health and performance nutrition topics (Supplementary Table 1).\textsuperscript{39} The nutrition knowledge scores range from 0 to 69 points, with higher scores reflecting greater nutrition knowledge. Each of the 23 statements was answered as true or false. To gauge their confidence in each question, participants were asked if they were confident about their response (yes or no). For this study, nutrition knowledge will specifically refer to the total score generated by the nutrition knowledge section of the MEBS.
Breakfast Skipping and Dining Out

In the eating behavior section of the MEBS, respondents are asked to indicate how many times they ate breakfast during the week (Supplementary Table 2). The possible responses are listed as a Likert scale ranging from 0 (did not eat breakfast for the entire week) to 7 (ate breakfast every day that week). If participants indicated they typically skipped breakfast ≥ 3 times/wk, they were classified as a breakfast skipper, whereas if they skipped breakfast ≤ 2 times/wk, they were classified as a breakfast consumer. The Eating Behavior section of the MEBS also asked participants to indicate how many times they dined out over the last 30 days, including eating at a restaurant and ordering take-out or fast food (Supplementary Table 3). Using a Likert scale of 0−5, participants that indicated dining out ≥ 3 times/wk were considered frequent diners, whereas those dining out ≤ 2 times/wk were considered nondiners.

Sociodemographic and Anthropometric Characteristics

Sociodemographic characteristics included sex (male or female), age, level of education, ethnicity, race, marital status, rank, and self-reported height and weight (Table 1). Race and ethnicity were combined and collapsed into 4 categories because of small numbers in some response options: non-Hispanic White, non-Hispanic Black, non-Hispanic Other, and Hispanic. Rank was collapsed into 2 categories: enlisted or officer. Body Mass Index (BMI) was computed using self-reported height and weight and divided into 3 categories as there were only 5 responses that fell into an underweight range: underweight/normal (< 18.5–24.9 kg/m²), overweight (25.0–29.9 kg/m²), and obese (≥ 30 kg/m²). Marital status was dichotomized as either single or married. Soldiers were classified as single if they indicated they were single, unmarried, or separated and classified as married if they indicated they were married or living with a partner. Lastly, education was divided into 3 categories: high school diploma or equivalent, some college or associate degree, and college degree.

Statistical Analysis

SPSS software (version 27, IBM, 2020) was used to perform all analyses. There were 6 Soldiers (1.3%) with missing responses for rank, breakfast consumption, and dining out. A post hoc power analysis using G*Power was conducted for the regression models, and it was determined that 123 participants were needed for adequate power. The sample size (n = 440) was sufficient for regression models with 11 predictors to detect r² as small as 0.15 or an odds ratio (OR) of 1.5 with 80% probability at a significance level of 0.05. All demographic characteristics were summarized with descriptive statistics and reported as mean ± SD or frequency (%) depending on the variable scale of measurement. Collinearity was
examined between all independent and control variables. It was found that being an officer and having a college degree had strong collinearity. The college degree variable was removed, and the officer variable remained, as it is required for military personnel to have a degree to be an officer. Before running the models, all parametric test assumptions were met. Multiple linear regression assessed the association between nutrition knowledge (continuous variable) and diet quality (continuous variable). Multiple logistic regression was used to assess the association between nutrition knowledge and skipping breakfast (yes or no); the same was performed for the association between nutrition knowledge and frequent dining out (yes or no). Models controlled for BMI category, education (high school diploma or some college), sex, rank, ethnicity, and marital status. The level of significance for all models was $P < 0.05$.

RESULTS

The majority of participants were male (91%), aged 23 years, non-Hispanic White (50%), single (64%), with a normal BMI (45%), and a high school diploma or equivalent (56%). Participants had an average nutrition knowledge score of 41.7 (0–69 points) and an average HEI-2015 score of 59.0 within the F-graded category (Table 1), and the multiple linear regression model was statistically significant ($r^2 = 0.11, F[11, 428] = 4.92, P < 0.001$) (Table 2). Nutrition knowledge ($b = 0.29, P < 0.001$) was significantly associated with diet quality. An overweight BMI classification was also positively associated with diet quality ($b = 2.46, P = 0.02$). Nutrition knowledge was not significantly associated with skipping breakfast (OR, 1.02; 95% confidence interval, 0.93–1.09) or dining out frequency (OR, 1.01; 95% confidence interval, 0.98–1.03).

DISCUSSION

This study aimed to assess the relationship between nutrition knowledge and diet quality among active-duty Soldiers with a secondary objective to examine the relationship between nutrition knowledge and skipping breakfast or frequent dining out. The study results support our hypothesis that nutrition knowledge was associated with higher HEI-2015 scores, demonstrating that nutrition knowledge is positively associated with diet quality in US Army Soldiers. Our results did not support the secondary hypothesis that nutrition knowledge would be associated with skipping breakfast and dining out.

The average HEI-2015 score of 59 in this study is comparable to the American civilian average (58 points). Several other studies within the military population support the observation that low/poor diet quality is common. Our study identified that for every 1-point increase in nutrition knowledge, the HEI score was expected to increase by 0.29 points, indicating that increasing knowledge may be a strategy for improving adherence to the DGAs. Similarly, a 2018 study assessing food choice and diet quality within a military dining facility (DFAC) demonstrated an improvement in HEI scores from 59 to 64 points following changes to the food

### Table 2. Associations Between Nutrition Knowledge, Diet Quality (HEI-2015), Skipping Breakfast, and Dining Out Among Active-Duty Soldiers (n = 440)

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Diet Quality (HEI-2015 Score)$^a$</th>
<th>Skipping Breakfast$^b$</th>
<th>Dining Out$^c$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$b$</td>
<td>$P$</td>
<td>OR</td>
</tr>
<tr>
<td>Nutritional knowledge score</td>
<td>0.29</td>
<td>&lt; 0.001</td>
<td>1.02</td>
</tr>
<tr>
<td>Control variables</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overweight</td>
<td>2.46</td>
<td>0.02</td>
<td>1.02</td>
</tr>
<tr>
<td>Obese</td>
<td>1.15</td>
<td>0.49</td>
<td>0.33</td>
</tr>
<tr>
<td>Some college</td>
<td>0.75</td>
<td>0.71</td>
<td>1.68</td>
</tr>
<tr>
<td>Female</td>
<td>1.98</td>
<td>0.24</td>
<td>0.48</td>
</tr>
<tr>
<td>Age</td>
<td>0.21</td>
<td>0.22</td>
<td>1.01</td>
</tr>
<tr>
<td>Officer</td>
<td>0.78</td>
<td>0.73</td>
<td>3.32</td>
</tr>
<tr>
<td>Non-Hispanic Black</td>
<td>2.18</td>
<td>0.14</td>
<td>1.01</td>
</tr>
<tr>
<td>Non-Hispanic Other</td>
<td>-0.95</td>
<td>0.56</td>
<td>2.23</td>
</tr>
<tr>
<td>Hispanic</td>
<td>2.62</td>
<td>0.04</td>
<td>1.22</td>
</tr>
<tr>
<td>Married</td>
<td>0.17</td>
<td>0.87</td>
<td>0.90</td>
</tr>
<tr>
<td>Constant</td>
<td>36.5</td>
<td>&lt; 0.001</td>
<td>1.17</td>
</tr>
</tbody>
</table>

$^b$ indicates an unstandardized coefficient; CI, confidence interval; HEI, Healthy Eating Index; MEBS, Military Eating Behavior Survey; OR, odds ratio.

$^a$Multiple linear regression. The model excluded 6 Soldiers who had a missing rank value. The variance explained for models was 11.2%.

$^b$Multiple logistic regression. The model excluded 6 Soldiers with missing or invalid breakfast consumption responses. The model predicts 80.7% of the responses correctly. The Nagelkerke $R^2$ is 0.10.

$^c$Multiple logistic regression. The model excluded 6 Soldiers with missing or invalid responses regarding dining out frequency. The model predicts 55% of the responses correctly. The Nagelkerke $R^2$ is 0.13.

Note: The reference group was men, enlisted, non-Hispanic White, high school education or General Educational Development, under/normal weight, and single. The level of significance for all models was $P < 0.05$. 

4 Sheafer et al Journal of Nutrition Education and Behavior • Volume 000, Number 000, 2023
knowledge may be a factor in eating behaviors, many nutrition-related environmental factors may hinder desirable eating behaviors. Studies have identified barriers such as proximity and density of fast-food restaurants on installations, lack of healthy alternative foods on the installation, limited operating hours of dining facilities, and Soldier-perceived time constraints. It is also unclear if those skipping breakfast followed a planned program, such as intermittent fasting. Although this study did not specifically assess the frequency of eating in a DFAC, much of the study population likely relied on the DFAC as a main source of nutrition. A recent study showed nearly one-third of Soldiers reported they ate most of their meals at a DFAC. The Army is taking steps to improve DFAC food choices and quality to align with the DGAs; however, these changes were implemented after this study was completed.

In addition, the Army has mandatory biannual BMI-based screening assessments of the weights and heights collected for this study were self-reported, and this population may be concerned with their weight because of the Army body composition standards. Soldiers may modify their eating behaviors around weight for height screening periods regardless of their nutrition knowledge level. The average BMI in this study was overweight at 25.7 kg/m². The Army allows Soldiers to be in the overweight BMI category per the Army height and weight requirement tables when the body fat assessment is within authorized limits. BMI does not account for lean muscle mass and serves mainly as a screening tool.

Finally, our study findings are consistent with previous research in that young males had the lowest diet quality and nutrition knowledge scores, whereas those who were female, older, and with higher education had higher nutrition knowledge and diet quality. This could reflect the lack of variability in the population and the low HEI scores within the study population. The poor diet quality among Soldiers is consistent with research that has indicated the eating patterns of Soldiers do not promote adequate energy, macronutrient distribution, and micronutrient sufficiency.

The strengths of this study included the use of validated surveys tailored to a military-specific population. Furthermore, the percentage of male and non-Hispanic White participants in this study was representative of total Army demographics. However, the population in this study is overrepresented by lower-ranking Soldiers compared with the full active-duty population, which may affect generalizability to the broader Army. A limitation of this study was self-reported data, subject to recall and social desirability bias. In addition, the cross-sectional design precludes the determination of cause and effect.

**IMPLICATIONS FOR RESEARCH AND PRACTICE**

The results of this study confirm the need for nutrition interventions to improve nutrition knowledge and diets among Soldiers as a strategy for improving performance and readiness. The outcomes of this study warrant further investigation to determine what interventions provide the strongest outcomes for improving nutrition knowledge and diet quality among US active-duty Soldiers. Future interventions are warranted to focus on creating and supporting an environment that enhances nutrition education and healthy nutrition behaviors that lead to improved diet quality.

**ACKNOWLEDGMENTS**

This study was funded by the Army Medical Research and Development Command. The authors thank the Soldiers who participated in this research and the research staff and Soldiers who assisted with study implementation and data collection. The views expressed in this article are those of the authors and do not reflect the official policy of the Department of Army, Department of Defense, or the US Government.
SUPPLEMENTARY DATA

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jneb.2023.07.008.

REFERENCES


32. Prem D, Bhagwant S, Jeeon R, A Pre and post survey to determine effectiveness of a dietitian-based nutrition education strategy on fruit and vegetable

**ORCIDs**

Kenneth A. Sheafer: http://orcid.org/0000-0002-5032-1529
Julianna M. Jayne: http://orcid.org/0000-0001-7736-5006
Renee E. Cole: http://orcid.org/0000-0002-7345-5650