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An Examination of Veterans' Diet Quality

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Abstract

Veterans represent about 7 to 8 percent of the U.S. adult population and may participate in Government programs, including healthcare and nutrition education programs administered by the U.S. Department of Veterans Affairs. Registered dietitians and other nutrition professionals work with veterans and their families (at VA healthcare facilities across the country) to promote wellness and prevent disease. In this study, we assess veterans' diets using the Healthy Eating Index (HEI) of the U.S. Department of Agriculture and the National Cancer Institute. The HEI measures how well diets align with key Federal recommendations, and higher HEI scores are associated with a reduced risk of disease and lower healthcare costs. HEI scores are measured using data from the National Health and Nutrition Examination Survey's (NHANES) dietary intake module. Individuals participating in this module of the survey complete two 24-hour dietary recalls on nonconsecutive days. They also provide extensive demographic and biomedical data. For the study, we pool survey records collected between 2003 and 2016. Results reveal that, similar to other Americans, veterans could improve their diet quality. Given veterans' reported energy intake, their consumption of added sugars and solid fats is too high and their consumption of fruits, vegetables, whole grains, and dairy products too low relative to the dietary guidelines. After controlling for demographic characteristics and a general time trend, we find that veterans attained lower total HEI scores for overall diet quality than did nonveterans.

Keywords: Veterans, diet quality, Healthy Eating Index (HEI), empty calories, fruits, vegetables, whole grains, NHANES

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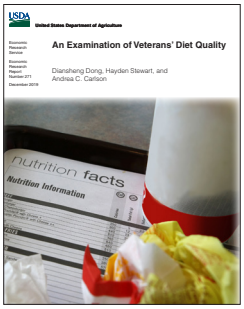


An Examination of Veterans' Diet Quality

Diansheng Dong, Hayden Stewart, and
Andrea C. Carlson

What Is the Issue?

Veterans, who make up about 7 to 8 percent of the U.S. adult population, are the focus of numerous Government programs, including healthcare and nutrition education programs administered by the U.S. Department of Veterans Affairs. In these programs, registered dietitians and other nutrition professionals work with veterans and their families at the various Veterans Health Administration healthcare facilities to promote wellness and prevent disease. Consuming a healthy diet is associated with a reduced risk of diseases like type 2 diabetes, cardiovascular disease, and certain cancers, resulting in lower healthcare costs. However, to our knowledge, there has not been a national assessment of veterans' diet quality. Using the Healthy Eating Index (HEI) of the U.S. Department of Agriculture and the National Cancer Institute, we examine whether veterans have significantly better or poorer diets than nonveterans.

What Did the Study Find?

Like other Americans, individuals who have served on active duty in the U.S. Armed Forces, military reserves, or National Guard could benefit from improvements to their diet quality. Given their reported energy intake, veterans overconsume added sugars and solid fats and underconsume fruits, vegetables, dairy products, and whole grains.

However, after controlling for demographic characteristics and a general time trend, this study finds that veterans deviate further than nonveterans from Federal dietary recommendations:

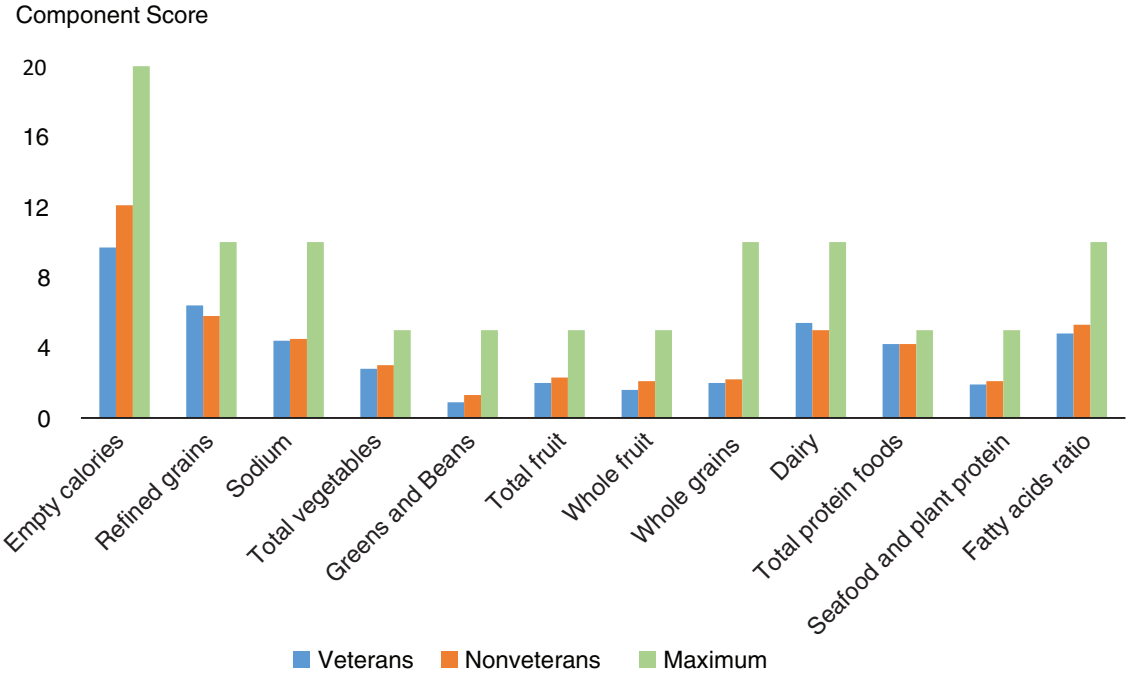
- During the period 2003 to 2016, veterans attained an adjusted total HEI score 3.7 points below that attained by nonveterans (an expected score of 45.6 of 100 for veterans versus 49.3 of 100 for nonveterans). An individual's overall HEI score is calculated by summing 12 component scores, which measure how well the person satisfies recommendations for specific food groups and subgroups.
- Being a veteran is associated with lower HEI component scores for empty calories; veterans tend to acquire a greater share of their total calories from less nutrient-rich added sugars and solid fats.
    - Added sugars accounted for about 13 percent of the average American adult's daily caloric intake over the study period and the share was another 2 to 3 percentage

points higher among veterans. Added sugars include caloric sugars and syrups added to foods. According to the 2015-2020 Dietary Guidelines, they should represent less than 10 percent of all calories consumed by an individual.

- Solid fats accounted for about 16 percent of the average American adult's daily caloric intake over the study period and the share was another 1 to 3 percentage points higher among veterans. Solid fats are the fats found in meats, poultry, dairy products, hydrogenated vegetable oils, and some tropical oils.
- There was no significant difference in empty calories consumed from excess alcohol between veterans and nonveterans.

- Other differences identified between veterans and nonveterans were relatively small. Veterans scored slightly lower on HEI components for fruits and vegetables than nonveterans but had slightly better scores for the Dairy component.

Average Healthy Eating Index (HEI) component scores for veterans versus nonveterans after adjusting for demographic differences and a time trend



Healthy Eating Index component scores in the figure control for demographic differences between veterans and nonveterans and are based on the HEI-2010. In the HEI-2010, calories from added sugars, solid fats, and excess alcohol are in the empty calories component.

Source: USDA, Economic Research Service analysis of National Health and Nutrition Examination Survey, 2003-2016.

How Was the Study Conducted?

Veterans' diets were assessed using dietary recall data collected between 2003 and 2016 in the National Health and Nutrition Examination Survey (NHANES). Among all 30,280 adults who provided data on their food and beverage intake, 12.9 percent (3,901 of 30,280) had served on active duty in the U.S. Armed Forces, military reserves, or National Guard. To control for demographic differences between veterans and nonveterans (e.g., veterans were older and more likely to be male than nonveterans), a statistical model was estimated to predict HEI-2010 scores for veterans and nonveterans during the years 2003 to 2016.

An Examination of Veterans' Diet Quality

Introduction

Veterans represent about 7 to 8 percent of the U.S. adult population and the focus of numerous Government programs, including some focused on healthcare and diet quality. The U.S. Department of Veterans Affairs (VA), in particular, operates 1,250 healthcare facilities across the Nation, including 172 medical centers and 1,069 outpatient sites for care of varying complexity (Veterans Health Administration, 2019). Nutrition education and counseling are among the services provided (VA Nutrition and Food Services, 2019a). Veterans may also learn about health and nutrition at one of the VA's Healthy Teaching Kitchens (HTK); which teach veterans and their families how to make healthy food choices and prepare foods. Some facilities offer cooking demonstrations while others offer hands-on participation. Many HTKs focus on the role of nutrition in disease-specific conditions such as diabetes (VA Nutrition and Food Services, 2019b).

Like all Americans, veterans can live healthier lives and lower costs for their healthcare by following Federal dietary recommendations published by USDA and the Department of Health and Human Services (DHHS). Much research shows that following these recommendations is associated with a reduced risk for cardiovascular disease, cancer, and type 2 diabetes (e.g., Onvani et al., 2017; Schwingshackl, et al., 2018; Schwingshackl and Hoffman, 2015). Still other research shows that following the recommendations can reduce healthcare expenditures (Scrafford et al., 2019).

In this study, we assess veterans' conformance with Federal dietary recommendations. Previous studies have investigated other aspects of their welfare, including obesity among veterans (Masheb et al., 2015); veterans' employment status (Faberman and Foster, 2013, Kleykamp, 2013); food insecurity (Miller et al., 2015; Widome et al., 2015), mental health (Hoerster et al., 2016); and economic well-being (Wilmoth et. al., 2015), as well as the association between their economic well-being and disability status (London et. al., 2011). In one study, Wright et al. (2017) provided food, ancillary services, and education to low-income veterans and their families. Participants were recruited at food pantries in Indiana and Kentucky. Adult food security improved over the study period. In another study, Miller et al. (2015) found that the probability of food insecurity was higher among more recent veterans than among those who served during the Vietnam War. Substance-use disorders, which encompass alcohol and drug-use disorders, are among the most common and costly of all health conditions afflicting veterans (Lan et. al., 2016; Seal et al., 2011; Bohnet et al., 2012; Capone et al., 2013). Food security, mental health, obesity, and substance abuse may be associated with diet quality (e.g., Leung and Tester, 2018; Shrestha et al., 2018; Becerra et al., 2017; Hoerster et al., 2016; Ko et al., 2011; Breslow et al., 2010). However, to our knowledge, no previous study has systematically assessed veterans' diets using national data and the USDA and National Cancer Institute's Healthy Eating Index (HEI). Veterans not only represent an important component of the U.S. population, but additional opportunities exist for intervention given the number of Government programs that already work with them (as compared with the population at large) and that recognize the importance of diet and nutrition.

Measuring Diet Quality

The *Dietary Guidelines for Americans* demonstrate how individuals and their families can consume a healthful and nutritionally adequate diet. By law, USDA and DHHS update the guidelines every 5 years (DHHS Office of Disease and Health Promotion, 2019). Each edition of the *Dietary Guidelines* reflects the current body of nutrition science, helps health professionals and policymakers guide Americans to make healthy food and beverage choices, and serves as the science-based foundation for vital nutrition policies and programs across the United States. The HEI as a measure of diet quality is used by health nutrition researchers to assess how well a set of foods aligns with key recommendations (e.g., DHHS National Cancer Institute, 2019; Krebs-Smith et al. 2018; Schap et al., 2017; Guenther et al., 2013). The HEI was developed by the USDA in 1995 and is now updated by the USDA's Center for Nutrition Policy and Promotion (USDA-CNPP) and DHHS's National Cancer Institute (DHHS-NCI) each time *the Dietary Guidelines for Americans* is updated. The 2010 Healthy Eating Index (HEI-2010) (Guenther et al., 2013), for example, measures how well an individual's reported diet conforms to a Healthy U.S.-Style Eating Pattern as outlined in the *Dietary Guidelines for Americans, 2010* (USDA/DHHS, 2010). The HEI-2015, designed to align with the *2015-2020 Dietary Guidelines for Americans* (DHHS/USDA, 2015), is the latest iteration (Krebs-Smith et al., 2018).

HEI scores are based on a Healthy U.S.-Style Eating Pattern, one of three recommended eating patterns in both the *2010 Dietary Guidelines for Americans* and the *Dietary Guidelines for Americans 2015-2020.* All three eating patterns recommend the amount of food individuals should consume from different food groups (vegetables, fruits, protein, dairy, grains, liquid oils) and subgroups, such as red-orange vegetables and whole grains. While recommended quantities vary across individuals based on their caloric needs—which, in turn, depend on an individual's age, level of physical activity, and gender (Britten, 2006)—there is comparatively little variation in the relative amounts of fruits, vegetables, dairy products, and other types of foods that should be consumed. For example, according to the Healthy U.S.-Style Eating Pattern, individuals at the 2,000-calorie level need 2.5 cup-equivalents of vegetables and 6 ounce-equivalents of grains per day, whereas individuals at the 3,000-calorie level should consume 4 cup-equivalents of vegetables and 10 ounce-equivalents of grains per day. In order to apply a common standard across individuals and capture the balance among foods consumed—which, in turn, serves as a measure of diet quality—the HEI evaluates individuals' diets on a density basis (i.e., the amount of a dietary component consumed divided by total energy (calories)).

The HEI-2010 includes 12 component scores that sum to a total score of 100 possible points and measure overall alignment with the Healthy U.S.-Style Eating Pattern. Among these 12 component scores, 9 are adequacy components—Total Vegetables; Greens and Beans; Total Fruit; Whole Fruit; Whole Grains; Dairy; Total Protein Foods; Seafood and Plant Protein; and Fatty Acid Ratio—while 3 are moderation components—Refined Grains; Sodium; and Empty Calories. Empty calories are defined as those from solid fat, excess alcohol, and added sugars. Excess alcohol is defined as alcohol above 13 grams per 1,000 calories consumed, where one drink equals 8-14 grams of alcohol (NCI, 2019). For the nine adequacy components, higher scores reflect higher intakes that meet or exceed the standards.

For the three moderation components, higher scores reflect lower intakes because lower intakes are more desirable. Summing over all 12 components produces a total HEI-2010 score of 100, where a higher score represents a healthier diet.

Although the HEI-2015 is the most current version, we chose the HEI-2010 for our study. A key difference between the HEI-2010 and HEI-2015 is that Empty Calories is replaced in the HEI-2015 by separate components for Added Sugars and Saturated Fats. Alcohol is no longer specifically addressed as a single component, though the calories from alcohol are still included in calculating the level of total energy used in the density calculations for each component (Krebs-Smith et al. 2018). This distinction is important for our study if veterans and nonveterans do not consume similar amounts of excess alcohol (e.g., Lan et. al., 2017; Seal et al., 2011; Bohnet et al., 2012; Capone et al., 2013). The HEI-2010 and 2015 also allocate legumes differently. Other components are consistent between the two versions.

Over 700 scientific papers and Federal reports using the HEI have been published since 2008 when the HEI-2005 was released (USDA-CNPP, 2019). For example, two recent ERS studies (Mancino et al., 2018 a and b) use data from the National Household Food Acquisition and Purchase Survey (FoodAPS) to calculate HEI scores for individual households and generate average HEI scores for population subgroups. Similarly, Carlson et al. (2012) use the HEI and data from the National Health and Nutrition Examination Survey (NHANES) to estimate the relationship between diet cost and diet quality. Reedy (2018) uses the NHANES to estimate HEI scores using the population-ratio method (Kirkpatrick et al., 2018).[1] Carlson et al. (2019) estimate HEI scores for all retail food purchases reported in the InfoScan retail scanner data of Information Resources Inc. (IRI), and Miller et al. (2015) use the ERS Food Availability Data System to estimate the HEI scores of all food available for human consumption in 2010. Although research findings vary somewhat depending on the data used or the calculation method, results consistently show most Americans should consume more fruits, vegetables, whole grains, and dairy and simultaneously rely less on added sugars and solid fats. Americans also overconsume refined grains.

Previous studies also show that, while most Americans do not follow Federal dietary recommendations, some groups come closer than others. Hiza et al. (2013), for one study, estimated HEI-2005 scores using 2003-2004 NHANES. Older adults generally had better quality diets than younger and middle-aged adults. Women had better quality diets than men. Education was positively associated with diet quality among adults aged 18 to 64 years; individuals with a college education scored higher on both the total vegetables and whole grains components than individuals with no post-high-school education.

Still other research examines the relationship between HEI scores, risk for disease, and healthcare costs. In one recent meta-analysis of published studies, Onvani et al. (2017) find that higher HEI scores are associated with a reduced risk of cardiovascular and cancer mortality. In another meta-analysis, Schwingshackl, et al. (2018) find that higher HEI scores are associated with a reduced risk for cardiovascular disease, cancer, and type 2 diabetes. Scrafford et al. (2019) estimate that a 20-percent increase in the average American's total HEI score for overall diet quality could reduce healthcare expenditures by $23.9 billion to $38.9 billion based on cost estimates reported by the National Cancer Institute, the American Heart Association, and the American Diabetes Association, among other sources.

[1]For more information on the population-ratio method, see Kirkpatrick et al. (2018).

In this study, we use the HEI-2010 and data from the NHANES to assess veterans' diets. Each year about 5,000 individuals participate in the NHANES, an ongoing, nationally representative survey of the noninstitutionalized civilian resident population of the United States. NHANES does not include persons in supervised care or custody in institutional settings, all active-duty military personnel and active-duty family members living overseas.[2] In addition to information on individuals' health and nutrition status, the survey includes a dietary intake module known as What We Eat in America (WWEIA). Individuals participating in this module complete two 24-hour dietary recalls on nonconsecutive days. Using the USDA's Automated Multiple Pass Method (USDA, Agricultural Research Service, 2019), they recall a detailed description of each food and beverage consumed during the previous 24-hour period. They also recall the amounts consumed. This information can be further matched with an individual's age, race, household income, veteran status, and other demographic characteristics as captured in the broader NHANES. One question asks NHANES participants whether they have ever served on active duty in the U.S. Armed Forces, military Reserves, or National Guard. Prior active duty is defined in NHANES to exclude training for the Reserves or National Guard, but to include activation for service in the United States or in a foreign country in support of military or humanitarian operations.

NHANES data are released every 2 years. Pooling data on American adults from 7 survey cycles (i.e., NHANES 2003-04, 2005-06, 2007-08, 2009-10, 2011-12, 2013-14, and 2015-16), we obtain a sample of 30,280 individuals aged 18 years and above. Veterans account for a decreasing share of these participants over time.[3] In 2003-04, they represented 13.2 percent (640 out of 4,632). In 2009-10, they represented 12.3 percent (666 out of 5,432). In 2015-16, they represented 9.1 percent (429 out of 4,705). Among all participants in the 7 cycles, 3,901 individuals (12.9 percent of all 30,280 individuals in the analytical data set) served on active duty in the U.S. Armed Forces, military Reserves, or National Guard (table 1). After weighting the data to account for survey design, the economic and demographic differences we identify between veterans and nonveterans are consistent with the American Community Survey (ACS).[4] Veterans, for example, tended to be older than nonveterans (58.6 years versus 44.4 years, on average) and were less likely to be female (less than 10 percent of participating veterans were female).

[2]The NHANES could include current members of the reserve.

[3]Simple counts of the number of veterans and nonveterans in the sample are not weighted and may not be nationally representative.

[4]The ACS is an ongoing survey administered by the U.S. Census Bureau that provides annual data on the social and economic characteristics of the U.S. population. An online search tool is available, with which users can access ACS statistics on veterans. These data show, for example, that veterans accounted for 11 percent of the adult population in 2005, 9.1 percent in 2011, and 7.3 percent in 2017.

A Look at Veterans' Diet Quality

How closely do veterans follow Federal dietary recommendations? To answer this question, we evaluate veterans' diets in each of the seven cycles of NHANES using Day 1 survey data.[5] For consistency across the different cycles and because HEI-2010 scores isolate calories from excess alcohol, as discussed above, we calculate HEI-2010 scores for all individuals in the analytical data set. These scores can be interpreted as a measure of how well an individual's reported diet during the year he or she participated in NHANES satisfied recommendations in the *Dietary Guidelines for Americans, 2010.*

A Simple Comparison of Veterans and Nonveterans

To begin our empirical analysis, we first calculated average HEI-2010 scores across survey participants within population subgroups, as in Mancino et al. (2018 a, b).[6] Survey weights were used to obtain nationally representative estimates. HEI-2010 scores for both veterans and nonveterans are shown in table 2 for each of the seven NHANES survey cycles.

Veterans, like nonveterans, do not follow Federal dietary recommendations. They attained an average total HEI-2010 score of 48.2 out of 100 in 2003-04, 50.8 in 2009-10, and 49.4 in 2015-16 (table 2). Their consumption of added sugars and solid fats is too high given their reported energy intake, while their consumption of fruits, vegetables, whole grains, and dairy products is too low.

However, as compared with adult nonveterans, veterans have a higher income and have a higher Body Mass Index (BMI), are older, are more likely to be male, and are more likely to be non-Hispanic, on average (table 1).[7] Still other data show that veterans are less likely than nonveterans to participate in the USDA Supplemental Nutrition Assistance Program (SNAP).[8] These economic and demographic differences could be confounding our results (e.g., Hiza et al., 2013). We likewise cannot say from the data in table 2 whether veterans have better or worse diets than demographically similar Americans who have not served in the military.

[5]Although research methods vary, it is common to use only Day 1 survey data in NHANES. Hiza et al. (2013), for one, do the same. One reason for doing so is that survey participants tend to report healthier intakes on Day 2 (e.g., Zeballos et al., 2019; Mancino et al., 2009), which might reflect their experiences while participating in the survey on Day 1.

[6]Alternatively, we could have used the population-ratio method as Reedy (2018) does. However, we believe the current approach is best since we later use a regression model to compare HEI-2010 scores for veterans and nonveterans while controlling for each subpopulation's economic and demographic characteristics.

[7]As shown in table 1, 95 percent confidence intervals for veterans and nonveterans do not overlap for each of these characteristics which implies that the two population groups are different with respect to these characteristics. The confidence interval method used here to test these differences may be more stringent than other tests, as pointed out by Wright et. al., (2019). Using a less stringent method would not change our finding that the two population groups are different.

[8]ACS data show that about 7.1 percent of veterans participated in SNAP in 2017 as compared with 14.4 percent of the U.S. population as a whole.

Table 1

Demographics of veterans and nonveterans, 18 years and above, 2003-2016

	Veterans (observations = 3,901)			Nonveterans (observations = 30,280)		
	Mean	95% CL for Mean		Mean	95% CL for Mean	
BMI: Body mass index of the individual	29.2	29.0	29.5	28.7	28.5	28.9
AGE: Age of the individual	58.6	57.9	59.3	44.4	43.9	44.8
INCOME RATIO: Ratio of family income to poverty level	3.3	3.2	3.4	2.9	2.9	3.0
HOUSEHOLD SIZE: Number of persons in the household	2.6	2.5	2.7	3.1	3.0	3.1
FEMALE: 1=if the individual is a female*	0.1	0.1	0.1	0.6	0.6	0.6
HISPANIC: 1=if the individual is Hispanic*	0.0	0.0	0.1	0.1	0.1	0.2
COLLEGE: 1=if the individual has a college degree*	0.3	0.2	0.3	0.3	0.3	0.3
MARRIED: 1=if the individual is married*	0.7	0.7	0.7	0.5	0.5	0.5
YEARS 2003-04: 1=if the survey is in 2003-04*	0.2	0.1	0.2	0.1	0.1	0.1
YEARS 2005-06: 1=if the survey is in 2005-06*	0.2	0.1	0.2	0.1	0.1	0.2
YEARS 2007-08: 1=if the survey is in 2007-08*	0.1	0.1	0.2	0.1	0.1	0.2
YEARS 2009-10: 1=if the survey is in 2009-10*	0.1	0.1	0.2	0.1	0.1	0.2
YEARS 2011-12: 1=if the survey is in 2011-12*	0.1	0.1	0.2	0.1	0.1	0.2
YEARS 2013-14: 1=if the survey is in 2013-14*	0.1	0.1	0.2	0.2	0.1	0.2
YEARS 2015-16: 1=if the survey is in 2015-16*	0.1	0.1	0.2	0.2	0.1	0.2

*Values represent the share of the sub-population that is female, Hispanic, completed college, married, and participated in each of the 7 NHANES waves.

Source: USDA, Economic Research Service analysis of National Health and Nutrition Examination Survey–What We Eat In America (NHANES-WWEIA) data, 2003-2016.

Table 2

Average HEI-2010 scores for veterans and nonveterans over time

		2003-04	2005-06	2007-08	2009-10	2011-12	2013-14	2015-16
Component	sample size (non-vet)	3,992	4,154	4,445	4,766	4,175	4,472	4,276
(Maximum score)*	sample size (veteran)	640	607	655	666	445	459	429
Total HEI								
(100)	nonveterans	46.3	48.1	48.4	50.4	50.8	50.9	50.9
	veterans	48.2	50.0	49.5	50.8	52.1	51.3	49.4
Total vegetables								
(5)	nonveterans	3.0	3.0	2.9	3.0	3.0	2.9	3.0
	veterans	3.2	3.0	3.1	3.1	3.1	3.0	3.0
Greens and beans								
(5)	nonveterans	1.1	1.2	1.2	1.2	1.3	1.4	1.4
	veterans	1.0	1.1	1.1	1.1	1.3	1.3	1.2
Total fruit								
(5)	nonveterans	2.0	1.9	2.0	2.2	2.1	2.0	2.0
	veterans	2.1	2.1	2.2	2.1	1.9	1.9	1.8

continued

Table 2
Average HEI-2010 scores for veterans and nonveterans over time - *continued*

Component (Maximum score)*		2003-04	2005-06	2007-08	2009-10	2011-12	2013-14	2015-16
	sample size (non-vet)	3,992	4,154	4,445	4,766	4,175	4,472	4,276
	sample size (veteran)	640	607	655	666	445	459	429
Whole fruit (5)	nonveterans	1.8	1.8	2.0	2.2	2.0	2.0	2.0
	veterans	2.2	2.0	2.1	2.0	2.0	1.9	1.9
Whole grains (10)	nonveterans	1.8	2.0	2.1	2.4	2.6	2.6	2.6
	veterans	2.3	2.4	2.3	2.7	2.9	2.8	2.6
Dairy (10)	nonveterans	4.7	5.1	5.1	5.4	5.2	5.2	5.0
	veterans	4.7	4.9	5.0	5.0	4.9	4.8	4.8
Total protein foods (5)	nonveterans	4.1	4.1	4.2	4.2	4.1	4.2	4.2
	veterans	4.4	4.3	4.4	4.5	4.4	4.4	4.4
Seafood and plant protein (5)	nonveterans	1.9	1.9	1.9	2.1	2.1	2.1	2.1
	veterans	2.1	2.0	1.8	2.2	2.2	2.1	2.0
Fatty acids ratio (10)	nonveterans	5.0	4.8	4.8	5.0	5.2	5.1	4.8
	veterans	4.9	4.5	4.7	5.0	5.3	5.2	5.1
Sodium (10)	nonveterans	5.0	4.6	4.7	4.2	4.4	4.3	4.2
	veterans	4.7	5.2	4.5	3.9	4.2	4.1	3.7
Refined grains (10)	nonveterans	5.7	5.9	6.1	6.1	6.1	6.2	6.3
	veterans	6.5	6.9	6.6	6.6	6.7	6.5	6.4
Empty calories (20)	nonveterans	10.1	11.6	11.5	12.4	12.6	13.0	13.3
	veterans	10.2	11.5	11.7	12.4	13.2	13.4	12.5

HEI=Healthy Eating Index.

*Numbers in parentheses under each component are the maximum HEI scores that component can be achieved.

Source: USDA, Economic Research Service analysis of National Health and Nutrition Examination Survey–What We Eat In America (NHANES-WWEIA) data, 2003-2016.

A Further Comparison of Veterans and Demographically Similar Nonveterans

In order to best compare the diet quality of veterans and nonveterans, given that significant demographic and socioeconomic differences exist between these two population subgroups, we next estimate a statistical model. This model includes a binary indicator variable for veteran status and controls for age, gender, race, education, marital status, and BMI. A single model is estimated pooling data from all years. To control for time trends, we also include indicator variables for survey year and interact those indicators with our variable for veteran status. The results show how veterans differed from demographically similar nonveterans over the years 2003 to 2016, on average.

Statistical Model

In this study, we assume that individual *i*'s HEI (diet quality) can be expressed as:

$$(1)\ \mathrm{HEI}_i = a_1 Demo_i + a_2 Vet_i + a_3\ Year_i + a_4 Year_i * Vet_i + \varepsilon_i$$

where Demo_i is a vector of demographic variables that describe individual *i,* Vet_i is a binary variable to indicate that individual *i* is a veteran. This variable equals 1 for veterans and 0 for nonveterans. $\mathrm{Year}_i * Vet_i$ is a vector of binary variables to indicate which cycle of NHANES individual *i* participated in. In this study, Year_i consists of seven elements: 2003–04, 2005–06, 2007–08, 2009–10, 2011–12, 2013–14, and 2015–16. Each of the seven elements takes either 1 or 0 to indicate when the survey was administered. is an interaction term between survey year and veteran status to capture how any differences in HEI scores between veterans and nonveterans have been changing over time. The term ε_i is the stochastic error in measuring HEI_i, which comes from data collection and variable measurement. We assume that $\varepsilon_i \sim n(0,\sigma^2)$.

Usual regression techniques are likely to produce biased estimates of the relationship between diet quality and veteran status since HEI scores are double-censored with a lower bound of 0 and one of four upper bounds (5, 10, 20, or 100 for the different component and the total scores, respectively).[9] In order to appropriately model the statistical relationships, we build up the log-likelihood function for individual *i* according to whether he or she scores the minimum, maximum, or somewhere in between for each component, as shown in table 3. Model estimates are then obtained by maximizing the sum of the log-likelihood functions over the three patterns across all the individuals defined as:

$$(2)\ L = \sum_{i=1}^{n}\sum_{j=1}^{3} d_{ij} ln L_{ij}$$

where *i* is the index for the individual, *j* is the index for the individual's consumption pattern determined by the component scores, and d_{ij} is the pattern indicator, which takes the value of 1 if individual *i* falls into consumption pattern *j* and 0 otherwise. L_{ij} is the specific likelihood value for pattern *j* given individual *i* defined in table 3. By maximizing (2) we obtain model estimates for all 13 HEI equations.[10] Our results are provided in Appendix 1 (table A1).

[9]As mentioned above, HEI scores are calculated from food intakes. If the intakes are below or above a certain level relative to Federal dietary recommendations, HEI scores are set to zero (lower bound) or a maximum (upper bound). We call a dependent variable censored when its values in a certain range are all transformed to a single value (Greene, 2000, page 905).

[10]A system of Tobit equations could be used to simultaneously estimate the 13 HEI equations to gain some efficiency in parameter estimates. However, given the large size sample of our data, efficiency is not an issue in this study.

In order to better interpret the relationship between diet quality and each of the model's explanatory variables, we used our model estimates (table A1) to calculate marginal effects (table A2). Marginal effects measure the expected change in HEI score given a change in an explanatory variable while holding all the other variables constant. Specifically, we calculate the expected value of equation (1) shown below in equation (3):

$$(3)\quad E(HEI_i) = M\left[1 - \Phi\left(\frac{\theta_{i2}}{\sigma}\right)\right] + \theta_i\left[\Phi\left(\frac{\theta_{i2}}{\sigma}\right) - \Phi\left(\frac{\theta_{i1}}{\sigma}\right)\right] + \sigma\left[\phi\left(\frac{\theta_{i1}}{\sigma}\right) - \phi\left(\frac{\theta_{i2}}{\sigma}\right)\right]$$

M is the upper bound of the dependent variable (HEIs). s are defined in table 3. The marginal effect of an explanatory variable, *x*, on HEI score for individual *i* is:

$$(4)\ \eta_x = \alpha\left[\Phi\left(\frac{\theta_{i2}}{\sigma}\right) - \Phi\left(\frac{\theta_{i1}}{\sigma}\right)\right].$$

Finally, using our results in tables A1 and A2, we calculate expected average HEI scores for veterans and nonveterans over the seven survey cycles after controlling for their demographics. The results are provided in table 4. A detailed discussion of how we calculated these values is also provided in Appendix 1.

Table 3
Likelihood Regimes

Consumption pattern (j)	Component Score	Likelihood Function (L_{ij})
1	0	$\int_{-\infty}^{\theta_{i1}} f\varepsilon_i d\varepsilon_i = \Phi(\frac{\theta_{i1}}{\sigma})$
2	M	$\int_{\theta_{i2}}^{+\infty} f\varepsilon_i\, d\varepsilon_i$=1- $\Phi(\frac{\theta_{i2}}{\sigma})$
3	0< score < M	$\phi(\varepsilon_i) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{\varepsilon_i^2}{2\sigma^2}}$

Note: the consumption pattern indicates whether individual *i* scores the minimum (j=1), maximum (j=2), or somewhere in between for each component (j=3), where:

$$\theta_{i1} = 0 - \theta_i$$
$$\theta_{i2} = M - \theta_i$$
$$\theta_i = \alpha_1 Demo_i + \alpha_2 Vet_i + \alpha_3 Year_i + \alpha_4 Year_i * Vet_i$$
$$\varepsilon_i = HEI_i - \theta_i \text{ , and}$$
$$M = upper\ bound\ of\ dietary\ score\ (5, 10, 20\ or\ 100\ points).$$

Model Results

After we control for household income and key demographics, the results show that veterans deviate more from Federal dietary guidance than do Americans who have not served in the military, on average. Veterans realized an average total HEI-2010 score 3.7 points below what other Americans attained (45.6 out of 100 for veterans versus 49.3 out of 100 for nonveterans) (table 4, row 1).

Veterans generally have lower HEI-2010 scores for all fruit and vegetable components than nonveterans after we control for differences in income and demographic characteristics (table 4, rows 2 through 5). Veterans' average Total Fruit component score, for example, was 0.3 points lower (2.0 out of 5 for veterans versus 2.3 out of 5 for nonveterans) (table 4, row 4).

Veterans do score better than nonveterans on the Dairy component after differences in income and demographic characteristics are controlled (table 4, rows 7). HEI scores of this adequacy component are 0.4 points higher among veterans than nonveterans (5.4 out of 10 for veterans versus 5.0 out of 10 for nonveterans) (table 4, row 7).

Finally, veterans realize significantly lower scores on the HEI's moderation components. Veterans acquire an even more disproportionate share of their calories from a combination of solid fat, alcoholic beverages, and added sugars than do demographically similar nonveterans. Their average HEI-2010 Empty Calories score is 2.4 points lower after we control for differences in demographic characteristics (9.7 out of 20 for veterans versus 12.1 out of 20 for nonveterans) (table 4, row 13). Given the size of this estimated discrepancy, we further examine below whether veterans' lower HEI-2010 Empty Calories scores drive a substantial portion of the overall difference in their diet quality compared with nonveterans. We also examine to what extent veterans' lower HEI-2010 Empty Calories scores are attributable to calories from solid fat, alcoholic beverages, and/or added sugars.

Table 4

Expected average HEI-2010 scores for veterans versus demographically similar nonveterans from 2003 to 2016

	Veterans	Nonveterans	Maximum
1. Total HEI	45.6	49.3	100
2. Total vegetables	2.8	3.0	5
3. Greens and beans	0.9	1.3	5
4. Total fruit	2.0	2.3	5
5. Whole fruit	1.6	2.1	5
6. Whole grains	2.0	2.2	10
7. Dairy	5.4	5.0	10
8. Total protein foods	4.2	4.2	5
9. Seafood and plant protein	1.9	2.1	5
10. Fatty acids ratio	4.8	5.3	10
11. Sodium	4.4	4.5	10
12. Refined grains	6.4	5.8	10
13. Empty calories	9.7	12.1	20

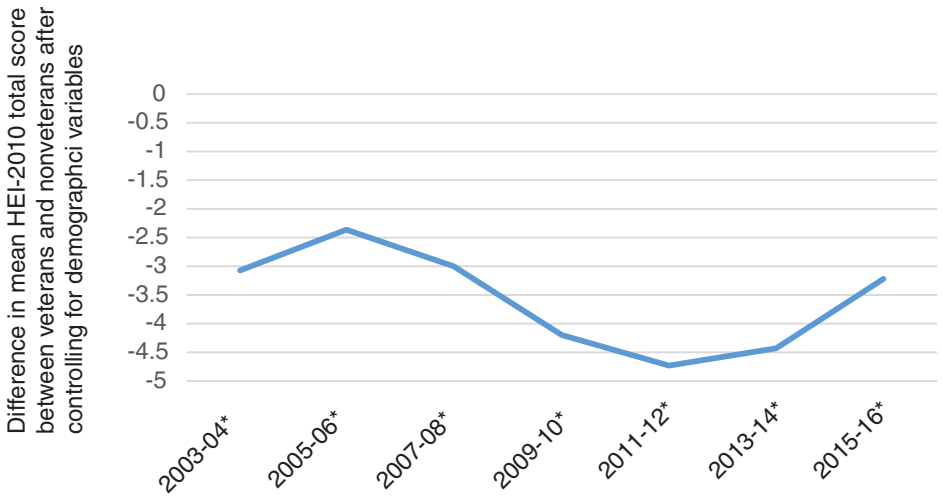
HEI=Healthy Eating Index.

Source: USDA, Economic Research Service analysis of National Health and Nutrition Examination Survey–What We Eat In America (NHANES-WWEIA) data, 2003-2016.

A Closer Look at Empty Calories

As a final exercise, we graph the association between being a veteran and HEI-2010 scores over each of the seven cycles of NHANES (figs. 1 and 2). From this final exercise, we see that the gap in overall diet quality between veterans and demographically similar Americans who have not served in the military was greatest in 2011-12, but narrowed in the two subsequent survey cycles (fig. 1). Moreover, solid fats, alcoholic beverages, and added sugars are the primary driver of this gap in all survey cycles in the study (fig. 2). However, is this gap in diet quality attributable to only one or two Empty Calorie components, or is it due to a combination of all three? Identifying which component(s) contribute most could help counselors working with active military personnel and veterans. We investigate by using our data to separately measure all survey participants' caloric intakes from solid fats, alcoholic beverages, and added sugars. Finally, we re-estimate our statistical model three times, with calories from each separately serving as the dependent variable in lieu of HEI score (see Appendix 2 for details). Results indicate that added sugars and solid fats are responsible for veterans' lower HEI-2010 Empty Calories scores (figs 3 and 4). These two types of empty calories account for a greater share of veterans' overall caloric intake, on average. Moreover, this result holds in all survey cycles under study. Excess alcohol does not appear to be a major factor (fig. 5).

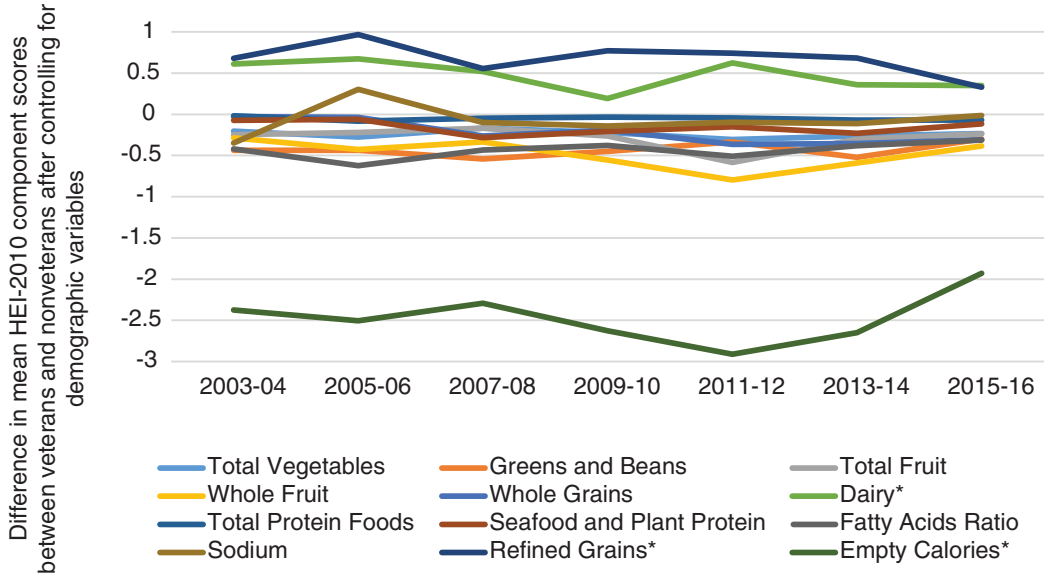
Figure 1
Association between total Healthy Eating Index (HEI) score and being a veteran, 2003-2016



*= Statistically significant at the 5% level.

Source: USDA, Economic Research Service analysis of National Health and Nutrition Examination Survey–What We Eat In America (NHANES-WWEIA) data, 2003-2016.

Figure 2
Association between component scores and being a veteran

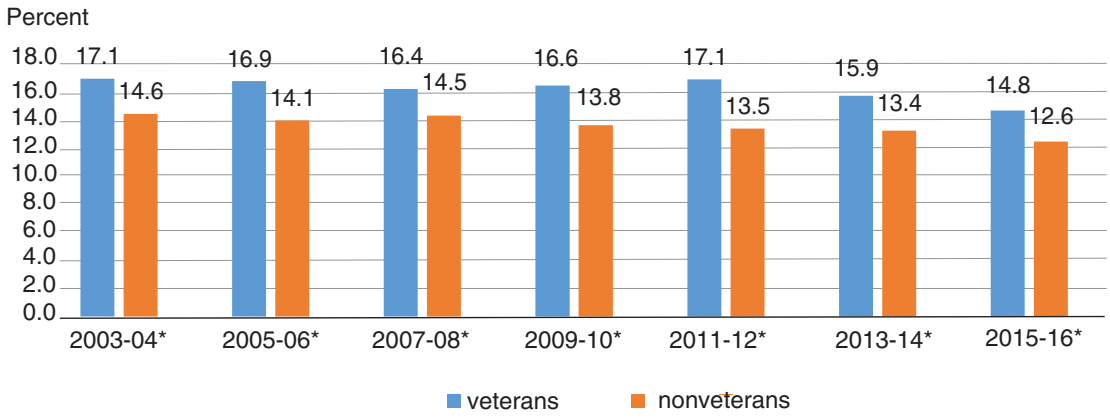


*Statistically significant at the 5% level.

HEI=Healthy Eating Index.

Source: USDA, Economic Research Service analysis of National Health and Nutrition Examination Survey–What We Eat In America (NHANES-WWEIA) data, 2003-2016.

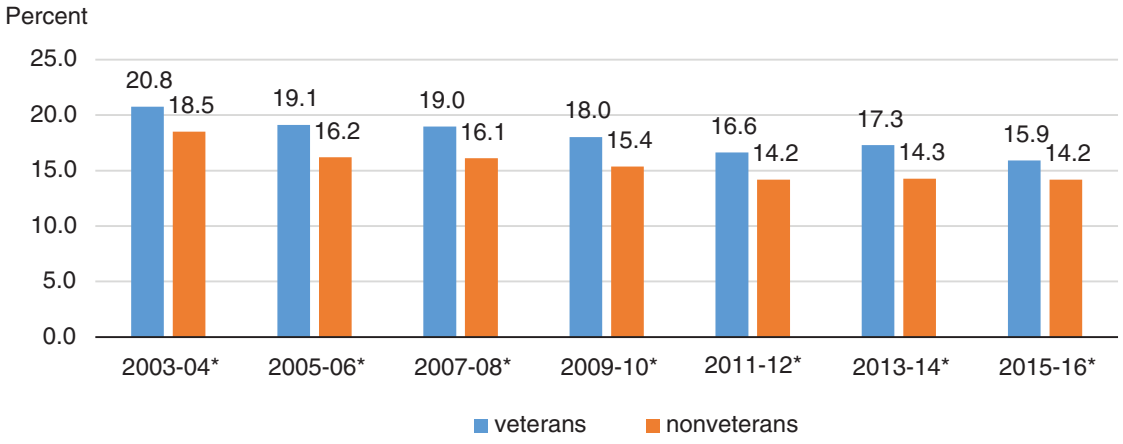
Figure 3
Share of calories from added sugars for veterans and nonveterans, 2003-2016



*Statistically significant at the 5% level.

Source: USDA, Economic Research Service analysis of National Health and Nutrition Examination Survey–What We Eat In America (NHANES-WWEIA) data, 2003-2016.

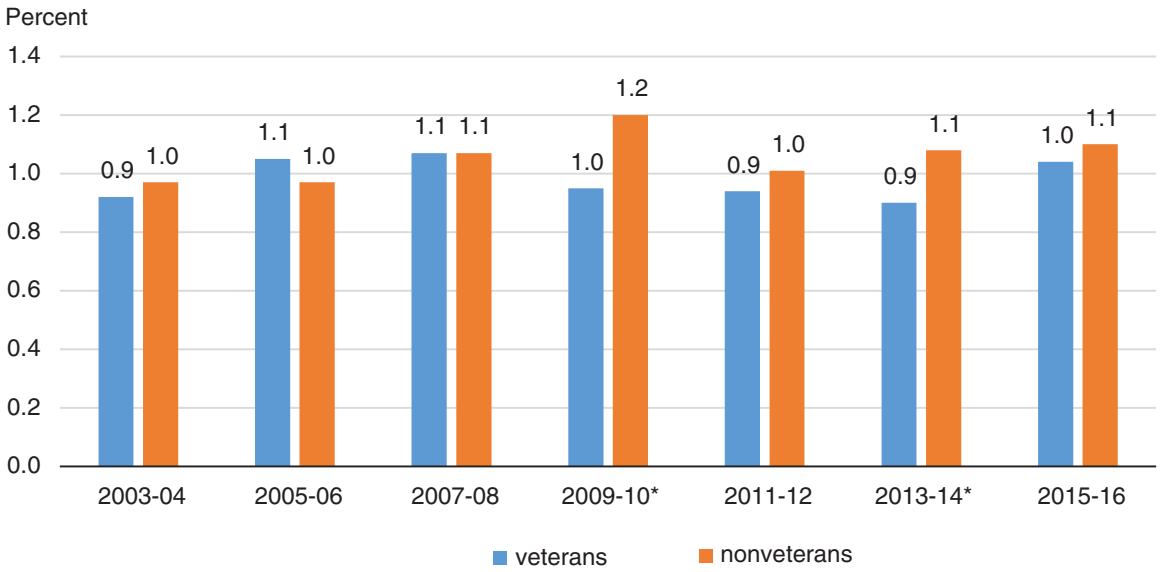
Figure 4
Share of calories from solid fat for veterans and nonveterans, 2003-2016



*Statistically significant at the 5% level.

Source: USDA, Economic Research Service analysis of National Health and Nutrition Examination Survey-What We Eat In America (NHANES-WWEIA) data, 2003-2016.

Figure 5
Share of calories from excess alcohol for veterans and nonveterans, 2003-2016



*Statistically significant at the 5% level.

Note: Excess alcohol is defined as alcohol above 13 grams per 1,000 calories consumed as detailed in Department of Health and Human Services, National Cancer Institute (2019).
One drink of alcohol equals 8-14 grams of alcohol.

Source: USDA, Economic Research Service analysis of National Health and Nutrition Examination Survey-What We Eat In America (NHANES-WWEIA) data, 2003-2016.

Robustness Checks

As a final check of our analysis, we re-estimated our model several times to check the robustness of our results. First, in the preceding analysis, we used HEI-2010 scores because of how that version of the index handles calories from excess alcohol. Re-estimating our model with HEI-2015 scores did not significantly change our results, which was expected given that calories from excess alcohol were found to have little impact on our results, as discussed above. Second, we examine the sensitivity of our results to our choice of control variables. The variables chosen for this study account for factors that might otherwise confound our comparison of veterans' and nonveterans' diet quality. For example, we included BMI in our model to ensure that our study results were not being driven by the simple fact that veterans are physically larger, on average (table 2), and obesity is negatively associated with diet quality (table 4). Our results are quite stable with respect to the variables we chose. For example, we re-estimated our model without BMI and found no significant changes in our results.

Discussion and Directions for Future Research

Previous studies have investigated obesity (Masheb et al., 2005), food insecurity (Miller et al., 2015; Widome et al., 2015), and substance abuse (Lan et. al., 2017; Seal et al., 2011; Bohnet et al., 2012; Capone et al., 2013), among other factors associated with veterans' diet quality. To our knowledge, this is the first national study to systematically assess veterans' diets using the HEI and national data. Higher HEI scores are associated with a reduced risk of disease (Onvani et al., 2017; Schwingshackl, et al., 2018; Schwingshackl and Hoffman, 2015) and lower healthcare costs (Scrafford et al., 2018). We find that veterans consume diets similar in many ways to other Americans. Like nonveterans, placing more emphasis on fruits, vegetables, dairy products, and whole grains would contribute to healthier diets. However, after controlling for Americans' demographic characteristics, veterans deviate somewhat more from Federal dietary recommendations than do nonveterans as measured by each group's average total score on the HEI. Added sugars and solid fats appear primarily responsible. Other differences, including those for fruit and vegetable components, are relatively small.

Additional opportunities exist for helping veterans to improve their diet quality, given the number of Government programs that already work with veterans on health matters as compared with the population at large. As noted, nutrition education and counseling are among the services provided at VA healthcare facilities. The VA also operates Healthy Teaching Kitchens where veterans and their families can learn how to make healthy food choices and prepare foods.

Like other Americans, veterans may also participate in one of USDA's food assistance programs. According to the American Community Survey, in 2017, about 47 million Americans received SNAP benefits, including 1.3 million veterans. Even though veterans are less apt to participate in SNAP than Americans who have not served in the military, many veterans still need, participate in, and benefit from SNAP.[11]

After controlling for an individual's economic and demographic characteristics, differences in diet quality between veterans and nonveterans appear to be driven by empty calories from added sugars and solid fats. While added sugars account for about 13 percent of the average American adult's daily caloric intake, this share is a few percentage points higher among veterans (fig. 3). The *2015-2020 Dietary Guidelines* encourages individuals to keep calories from added sugars below 10 percent. A similarly sized discrepancy between veterans and nonveterans exists for calories from solid fats. By consuming fewer empty calories from both added sugars and solid fats, veterans could improve other component scores and could possibly negate some of the other differences identified in this study. As noted above, HEI scores are calculated on a density basis (i.e., the amount of a dietary component consumed divided by total energy (calories)). Consuming more than the recommended amount of calories, due to Empty Calories or otherwise, can also lower an individual's score on all 9 adequacy components.

[11]As noted above in footnote 8, ACS data show that about 7.1 percent of veterans participated in SNAP in 2017 as compared with 14.4 percent of the U.S. population as a whole.

Future research is needed to identify the reason(s) why veterans rely more on added sugars and solid fats than nonveterans. One possibility is that active duty military personnel adopt the habit of consuming higher calorie foods during their years of service owing to the physically demanding nature of their jobs at that time. Of course, other reasons may exist. Indeed, it is possible that individuals who were physically more active in their childhoods are more likely to enlist in the military as young adults. If so, enlistees might already be more accustomed than other Americans to eating higher calorie snack foods without consequence even before entering the service.

Studies show that a father's war service has a positive and significant effect on his son's likelihood of service in the next generation's military actions (Campante and Yanagizawa-Drott, 2015). Future research might look at the possible long-term impacts on military preparations of helping veterans and their families adopt healthier lifestyles through healthcare, food assistance, and nutrition education.

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Appendix 1: Model estimates, marginal effects, and calculation of expected Health Eating Index (HEI) scores controlling for demographics

Because our dependent variable is double-censored and usual regression techniques may produce biased estimates of the relationship between diet quality and veteran status, we maximize the likelihood function shown in equation (2), where each individual falls into one of three regimes (defined in table 3) to get parameter estimates. We then use our parameter estimates to generate the marginal effect for each explanatory variable based on equations (3) and (4). Finally, using these results, we calculate expected HEI scores for veterans and nonveterans over all the seven National Health and Nutrition Examination Survey–What We Eat in America (NHANES-WWEIA) survey cycles after controlling individuals' demographics and the year of survey. Below, we provide a detailed discussion of these steps, along with our estimated model parameters (tables A1) and estimated marginal effects (tables A2).

Estimation Steps:

1. After estimating our model, we use our results, shown below in tables A1, to calculate expected HEI-2010 scores in 2015-16, using equation (3). All indicator variables for survey cycle (year) are initially set equal to 0 (implying that the 2015-16 dummy variable is 1). The indicator variable for veteran is also set equal to 0 (implying nonveteran), and all other explanatory variables are set equal to their sample mean provided in table 1. The expected total HEI-2010 score for nonveterans in 2015-16 is 50.53 (table A2).

2. Expected HEI-2010 scores are generated for nonveterans for other time periods by adding the marginal effects of the appropriate indicator variables for survey cycle to our above-results from step 1. For total HEI-2010 score, these marginal effects are -3.54 (2003-04), -3.38 (2005-06), -1.92 (2007-08), -0.76 (2009-10), 0.61 (2011-12), and 0.23 (2013-14) (table A2). In 2013-14, for example, the expected total HEI-2010 score is 50.76 (calculated as 50.53 + 0.23).

3. Expected HEI-2010 scores for veterans in 2015-16 are generated by adding the marginal effect of veteran status for 2015-16 (-3.22 in table A2) to our result from step 1 for nonveterans (50.53). In 2015-16, for example, veterans have an expected total HEI-2010 score of 47.31 (calculated as 50.53- 3.22).

4. Expected HEI-2010 scores for veterans in other years are generated by adjusting expected HEI-2010 scores for nonveterans calculated in step 2 to account for both veterans' status (-3.22 for total HEI-2010 in 2015-16) and the interaction of veterans' status with survey cycle effects. For total HEI-2010, the latter marginal effects are 0.15 (2003-04), 0.40 (2005-06), -0.24 (2007-08), -0.98 (2009-10), -1.51 (2011-12), -1.21 (2013-14), and -3.2187 (2015-16) (table A2). In 2013-14, for example, veterans had an expected total HEI-2010 score of 46.33 (calculated as 50.76 from step 2 - 3.22 - 1.21) (fig. 1).

5. Finally, the above approach gives the numbers we used to draw figures 1 and 2. For example, the all year's total HEIs and the differences of the total HEIs between veterans and nonveterans are calculated as shown in the table below. The average is for table 4.

	2003-04	2005-06	2007-08	2009-10	2011-12	2013-14	2015-16	Average
Total HEI (nonvets)	46.99	47.15	48.61	49.77	51.14	50.76	50.53	49.3
Total HEI (veterans)	43.92	44.33	45.14	45.57	46.40	46.33	47.31	45.6
Difference of the two	-3.07	-2.82	-3.46	-4.20	-4.73	-4.43	-3.22	-3.70

Table A1

Estimation results: Coefficients for models of total Healthy Eating Index (HEI) and HEI component scores

Variables	Total HEI	Total veg.	Greens and beans	Total fruits	Whole fruits	Whole grains	Dairy	Total protein foods	Seafood & plant protein	Fatty acid ratio	Sodium	Refined grains	Empty calories
Constant	42.56*	2.08*	-6.80*	-0.35*	-4.11*	-2.19*	4.68*	4.69*	0.15	4.50*	5.28*	7.16*	10.48*
BMI	-0.16*	-0.01*	-0.05*	-0.04*	-0.08*	-0.04*	-0.01*	0.02*	-0.06*	-0.01	-0.04*	-0.01	-0.05*
AGE	0.16*	0.01*	0.04*	0.04*	0.10*	0.06*	-0.01*	0.01*	0.02*	0.01*	0.00	0.01*	0.07*
INCOME RATIO	0.73*	0.07*	0.33*	0.11*	0.30*	0.25*	0.05*	0.05*	0.28*	0.09*	-0.08*	0.20*	0.22*
HOUSEHOLD SIZE	-0.12*	-0.01	0.07	0.00	-0.03	-0.13*	-0.06*	0.01	-0.01	0.03	0.01	-0.21*	0.11*
FEMALE	2.31*	0.40*	0.68*	0.84*	1.74*	0.90*	0.68*	-0.50*	0.50*	0.06	-0.14*	-0.04	0.36*
HISPANIC	2.44*	0.31*	3.39*	0.79*	1.50*	-0.80*	0.25*	0.38*	0.17	0.21*	0.46*	-2.08*	2.05*
COLLEGE	5.69*	0.42*	2.72*	1.17*	2.43*	1.53*	0.44*	0.13*	1.78*	0.45*	-0.28*	0.00	2.56*
MARRIED	1.14*	0.32*	1.17*	0.13*	0.79*	0.13	0.16*	0.18*	0.67*	0.04	-0.34*	-0.52*	0.72*
YEARS 2003-04	-3.54*	0.04	-1.41*	0.62*	-0.25	-0.87*	0.15	-0.33*	0.23	-0.01	1.52*	-0.75*	-4.24*
YEARS 2005-06	-3.38*	0.03	-0.98*	0.57*	-0.11	-0.50*	0.25*	-0.23*	0.18	-0.29*	1.03*	-0.78*	-3.81*
YEARS 2007-08	-1.92*	-0.04	-1.40*	0.19*	0.00	-0.72*	0.40*	-0.11	-0.48*	-0.11	0.94*	-0.09	-2.55*
YEARS 2009-10	-0.76*	-0.06	-1.02*	0.43*	0.38*	-0.10	0.86*	-0.06	-0.11	-0.15	0.15	-0.23	-1.60*
YEARS 2011-12	0.61*	0.04	-0.41	0.42*	0.28	0.30*	0.29*	-0.03	0.18	0.59*	0.24*	-0.02	-0.68*
YEARS 2013-14	0.23	-0.07	-0.02	0.00	0.00	0.20	0.50*	-0.13*	0.12	0.17	0.25*	0.00	-0.55*
VETERAN: equal 1 if the individual is a veteran	-3.22*	-0.32*	-1.85*	-0.50*	-1.46*	-0.69*	0.46*	-0.18	-0.37	-0.46	-0.02	0.53	-2.47*
VET *YEARS 2003-04	3.37*	0.36*	0.98	0.48	1.83*	1.31*	-0.12	0.31	0.50	0.30	-0.47	0.04	1.90*
VET *YEARS 2005-06	3.62*	0.27	0.99	0.53	1.30*	1.29*	-0.03	0.15	0.54	0.00	0.50	0.51	1.73*
VET*YEARS 2007-08	2.97*	0.41*	0.33	0.65*	1.65*	0.79	-0.24	0.24	-0.15	0.28	-0.10	-0.17	2.01*
VET *YEARS 2009-10	2.24*	0.34*	0.90	0.45	0.81	0.95*	-0.67*	0.28	0.09	0.36	-0.17	0.19	1.58*
VET *YEARS 2011-12	1.71	0.22	1.62	-0.24	-0.10	0.57	-0.10	0.25	0.26	0.17	-0.10	0.14	1.21*
VET*YEARS 2013-14	2.01*	0.28	0.46	0.36	0.67	0.59	-0.45	0.19	0.01	0.36	-0.12	0.04	1.55*
SIGMA: model standard error	13.76*	2.19*	9.80*	3.92*	7.22*	5.98*	4.24*	2.65*	5.91*	5.08*	5.07*	5.60*	7.69*

*Indicates statistically significant at the 5% level.

Source: USDA, Economic Research Service analysis of National Health and Nutrition Examination Survey–What We Eat In America (NHANES-WWEIA) data, 2003-2016.

Table A2

Estimation results: Marginal effects for models of total Healthy Eating Index (HEI) and HEI component scores

	Total HEI	Total veg.	Greens and beans	Total fruits	Whole fruits	Whole grains	Dairy
Model predicted HEI value	49.19	3.02	1.26	2.25	2.06	2.25	4.99
Constant	42.56*	1.50*	-1.09*	-0.16*	-1.09*	-0.99*	3.56*
BMI: changes in HEI given a 1% change	-4.59*	-0.13*	-0.25*	-0.49*	-0.62*	-0.50*	-0.24*
AGE: changes in HEI given a 1% change	7.56*	0.48*	0.28*	0.87*	1.19*	1.19*	-0.22*
INCOME: changes in HEI given a 1% change	1.81*	0.13*	0.13*	0.13*	0.20*	0.28*	0.09*
HOUSEHOLD SIZE: changes in HEI given a 1% change	-0.37*	-0.03	0.03	0.00	-0.03	-0.19*	-0.14*
FEMALE: changes in HEI when changes from 0 to 1	2.31*	0.29*	0.11*	0.40*	0.46*	0.41*	0.52*
HISPANIC: changes in HEI when changes from 0 to 1	2.44*	0.22*	0.55*	0.37*	0.40*	-0.36*	0.19*
COLLEGE: changes in HEI when changes from 0 to 1	5.69*	0.30*	0.44*	0.55*	0.64*	0.69*	0.34*
MARRIED: changes in HEI when changes from 0 to 1	1.14*	0.23*	0.19*	0.06*	0.21*	0.06	0.12*
YEARS 2003-04: changes in HEI from base year 2015-16	-3.15*	0.06	-0.21*	0.32*	-0.01	-0.33*	0.10
YEARS 2005-06: changes in HEI from base year 2015-16	-2.97*	0.04	-0.14*	0.30*	0.01	-0.16*	0.19*
YEARS 2007-08: changes in HEI from base year 2015-16	-1.58*	0.00	-0.22*	0.12*	0.05	-0.28*	0.29*
YEARS 2009-10: changes in HEI from base year 2015-16	-0.50	-0.01	-0.15*	0.23*	0.13*	0.00	0.60*
YEARS 2011-12: changes in HEI from base year 2015-16	0.81*	0.05	-0.04	0.19*	0.07	0.17*	0.21*
YEARS 2013-14: changes in HEI from base year 2015-16	0.46	-0.03	0.01	0.02	0.02	0.12*	0.34*
NVET*YEARS 2003-04: changes in HEI for veterans from base year 2015-16	-3.54*	0.03	-0.23*	0.29*	-0.07	-0.39*	0.11
NVET*YEARS 2005-06: changes in HEI for veterans from base year 2015-16	-3.38*	0.02	-0.16*	0.27*	-0.03	-0.23*	0.19*
NVET*YEARS 2007-08: changes in HEI for veterans from base year 2015-16	-1.92*	-0.03	-0.23*	0.09*	0.00	-0.32*	0.31*
NVET*YEARS 2009-10: changes in HEI for veterans from base year 2015-16	-0.76*	-0.04	-0.17*	0.20*	0.10*	-0.05	0.66*
NVET*YEARS 2011-12: changes in HEI for veterans from base year 2015-16	0.61*	0.03	-0.07	0.20*	0.07	0.14*	0.22*
NVET*YEARS 2013-14: changes in HEI for veterans from base year 2015-16	0.23	-0.05	0.00	0.00	0.00	0.09	0.38*
NVET*YEARS 2015-16: changes in HEI for veterans from base year 2015-16	50.53*	3.03*	1.40*	2.11*	2.06*	2.35*	4.70*
VET*YEARS 2003-04: changes in HEI for veterans from base year 2015-16	0.15	0.03	-0.14	-0.01	0.10	0.28*	0.26
VET*YEARS 2005-06: changes in HEI for veterans from base year 2015-16	0.40	-0.04	-0.14	0.02	-0.04	0.27	0.32*
VET*YEARS 2007-08: changes in HEI for veterans from base year 2015-16	-0.24	0.07	-0.24*	0.07	0.05	0.05	0.17
VET*YEARS 2009-10: changes in HEI for veterans from base year 2015-16	-0.98	0.01	-0.15	-0.03	-0.17	0.12	-0.16
VET*YEARS 2011-12: changes in HEI for veterans from base year 2015-16	-1.51*	-0.07	-0.04	-0.35*	-0.41*	-0.05	0.28
VET*YEARS 2013-14: changes in HEI for veterans from base year 2015-16	-1.21	-0.03	-0.22*	-0.07	-0.21	-0.04	0.01
VET*YEARS 2015-16: changes in HEI for veterans from nonveterans for year 2015-16	-3.22*	-0.23*	-0.30*	-0.24*	-0.38*	-0.31*	0.35*

*Indicates statistically significant at the 5% level.

continued

Source: USDA, Economic Research Service analysis of National Health and Nutrition Examination Survey–What We Eat In America (NHANES-WWEIA) data, 2003-2016.

Table A2

Estimation results: Marginal effects for models of total Healthy Eating Index (HEI) and HEI component scores - *continued*

	Total protein foods	Sea-food & plant protein	Fatty acid ratio	Sodium	Refined grains	Empty Calories
Model predicted HEI value	4.23	2.06	5.25	4.51	5.82	12.12
Constant	1.84*	0.05	3.03*	3.54*	4.41*	8.18*
BMI: changes in HEI given a 1% change	0.21*	-0.57*	-0.15	-0.79*	-0.12	-1.07*
AGE: changes in HEI given a 1% change	0.15*	0.36*	0.40*	-0.04	0.31*	2.41*
INCOME: changes in HEI given a 1% change	0.05*	0.23*	0.14*	-0.14*	0.30*	0.43*
HOUSEHOLD SIZE: changes in HEI given a 1% change	0.02	-0.01	0.06	0.03	-0.42*	0.26*
FEMALE: changes in HEI when changes from 0 to 1	-0.20*	0.16*	0.04	-0.09*	-0.03	0.28*
HISPANIC: changes in HEI when changes from 0 to 1	0.15*	0.05	0.14*	0.31*	-1.28*	1.60*
COLLEGE: changes in HEI when changes from 0 to 1	0.05*	0.57*	0.30*	-0.19*	0.00	2.00*
MARRIED: changes in HEI when changes from 0 to 1	0.07*	0.21*	0.03	-0.23*	-0.32*	0.56*
YEARS 2003-04: changes in HEI from base year 2015-16	-0.12*	0.09*	0.01	0.99*	-0.46*	-3.14*
YEARS 2005-06: changes in HEI from base year 2015-16	-0.08*	0.08	-0.19*	0.73*	-0.44*	-2.82*
YEARS 2007-08: changes in HEI from base year 2015-16	-0.03	-0.16*	-0.05	0.62*	-0.07	-1.81*
YEARS 2009-10: changes in HEI from base year 2015-16	-0.01	-0.03	-0.07	0.09	-0.13	-1.11*
YEARS 2011-12: changes in HEI from base year 2015-16	0.00	0.07	0.41*	0.15*	-0.01	-0.42*
YEARS 2013-14: changes in HEI from base year 2015-16	-0.04	0.04	0.14*	0.16*	0.00	-0.29*
NVET*YEARS 2003-04: changes in HEI for veterans from base year 2015-16	-0.13*	0.07	-0.01	1.02*	-0.46	-3.31*
NVET*YEARS 2005-06: changes in HEI for veterans from base year 2015-16	-0.09*	0.06	-0.19*	0.69*	-0.48*	-2.97*
NVET*YEARS 2007-08: changes in HEI for veterans from base year 2015-16	-0.04	-0.15*	-0.07	0.63*	-0.06	-1.99*
NVET*YEARS 2009-10: changes in HEI for veterans from base year 2015-16	-0.02	-0.03	-0.10	0.10	-0.14	-1.25*
NVET*YEARS 2011-12: changes in HEI for veterans from base year 2015-16	-0.01	0.06	0.40*	0.16*	-0.01	-0.53*
NVET*YEARS 2013-14: changes in HEI for veterans from base year 2015-16	-0.05	0.04	0.11	0.17*	0.00	-0.43*
NVET*YEARS 2015-16: changes in HEI for veterans from base year 2015-16	4.28*	2.06*	5.25*	4.13*	5.93*	13.65*
VET*YEARS 2003-04: changes in HEI for veterans from base year 2015-16	0.05	0.04	-0.11	-0.33*	0.35*	-0.45
VET*YEARS 2005-06: changes in HEI for veterans from base year 2015-16	-0.01	0.06	-0.31	0.32*	0.64*	-0.58*
VET*YEARS 2007-08: changes in HEI for veterans from base year 2015-16	0.02	-0.17	-0.12	-0.08	0.23	-0.36
VET*YEARS 2009-10: changes in HEI for veterans from base year 2015-16	0.04	-0.09	-0.07	-0.13	0.44*	-0.70*
VET*YEARS 2011-12: changes in HEI for veterans from base year 2015-16	0.03	-0.03	-0.20	-0.08	0.41*	-0.98*
VET*YEARS 2013-14: changes in HEI for veterans from base year 2015-16	0.00	-0.11	-0.07	-0.10	0.35*	-0.72*
VET*YEARS 2015-16: changes in HEI for veterans from nonveterans for year 2015-16	-0.07	-0.12	-0.31	-0.02	0.33	-1.93*

*Indicates statistically significant at the 5% level.

Source: USDA, Economic Research Service analysis of National Health and Nutrition Examination Survey–What We Eat In America (NHANES-WWEIA) data, 2003-2016.

Appendix 2: Estimation of Calorie Shares From Added Sugars, Solid Fats, and Alcohol

In order to estimate whether added sugars, solid fats, and/or alcohol were responsible for veterans receiving a lower Healthy Eating Index-2010 Empty Calories score than nonveterans in all National Health and Nutrition Examination Survey–What We Eat in America (NHANES-WWEIA) cycles, we re-estimate our statistical model three times with the share of calories from each type of food separately serving as the dependent variable in lieu of HEI score. The revised model is:

$$(1)\quad CalorieShare_i = \alpha_1 Demo_i + \alpha_2 Vet_i + \alpha_3 Year_i + \alpha_4 Year_i * Vet_i + \varepsilon_i$$

where all right-side variables are as defined earlier in the text. Unlike HEI that is double censored, *CalorieShare* is only censored at zero, and the one-limit Tobit model is used in the estimation. Model estimates and the marginal effects calculated from them are provided below in tables A3 and A4. Data for figures 3 to 5 are calculated from table A4 using the same methodology described in Appendix 1.

Table A3

Estimation results, coefficients for models of added sugars, solid fats, and excess alcohol calorie share

Variables	Added sugars calories	Solid fat calories	Alcohol calories
Constant	0.176*	0.1292*	-0.087*
BMI	0.0002*	0.0007*	-0.0021*
AGE	-0.0008*	0	-0.0009*
INCOME RATIO	-0.0044*	0.0002	0.0117*
HOUSEHOLD SIZE	0.0001	-0.0011*	-0.007*
FEMALE	0.004*	0.0008	-0.0845*
HISPANIC	-0.0202*	-0.0089*	-0.0143*
COLLEGE	-0.0259*	-0.0099*	-0.0068
MARRIED	-0.0058*	-0.0009	-0.0236*
YEARS 2003-04	0.0215*	0.0443*	-0.0119
YEARS 2005-06	0.0166*	0.0209*	-0.0117
YEARS 2007-08	0.0204*	0.0199*	-0.0024
YEARS 2009-10	0.0127*	0.012*	0.0092
YEARS 2011-12	0.0103*	0.0002	-0.0084
YEARS 2013-14	0.0085*	0.0009	-0.0019
VETERAN: 1=if the individual is a veteran	0.0243*	0.0177*	-0.0056
VETERAN *YEARS 2003-04	-0.021*	-0.0124*	0.0066
VETERAN *YEARS 2005-06	-0.0178*	-0.0058	0.0183
VETERAN *YEARS 2007-08	-0.0279*	-0.0063	0.0108
VETERAN *YEARS 2009-10	-0.0174	-0.0081	-0.0116
VETERAN *YEARS 2011-12	-0.0103	-0.0104	0.0054
VETERAN *YEARS 2013-14	-0.0212*	-0.0045	-0.0051
SIGMA: model standard error	0.0966*	0.0772*	0.199*

*Indicates statistically significant at the 5% level.

Source: USDA, Economic Research Service analysis of National Health and Nutrition Examination Survey-What We Eat In America (NHANES-WWEIA) data, 2003-2016.

Table A4

Estimation results, marginal effects for models of added sugar, solid fat, and alcohol calorie shares

Variables	Added sugars calories	Solid fat calories	Alcohol calories
Model predicted calorie share	0.1383	0.1564	0.0106
Constant	0.1616*	0.1264*	-0.0096*
BMI: changes in HEI given a 1% change	0.0062*	0.0207*	-0.0066*
AGE: changes in HEI given a 1% change	-0.0364*	-0.0023	-0.0045*
INCOME: changes in HEI given a 1% change	-0.0101*	0.0006	0.0032*
HOUSEHOLD SIZE: changes in HEI given a 1% change	0.0003	-0.0036*	-0.0024*
FEMALE: changes in HEI when changes from 0 to 1	0.0036*	0.0008	-0.0093*
HISPANIC: changes in HEI when changes from 0 to 1	-0.0185*	-0.0087*	-0.0016*
COLLEGE: changes in HEI when changes from 0 to 1	-0.0238*	-0.0097*	-0.0008
MARRIED: changes in HEI when changes from 0 to 1	-0.0053*	-0.0009	-0.0026*
YEARS 2003-04: changes in HEI from base year 2015-16	0.0176*	0.042*	-0.0012
YEARS 2005-06: changes in HEI from base year 2015-16	0.0134*	0.0198*	-0.0011
YEARS 2007-08: changes in HEI from base year 2015-16	0.0158*	0.0188*	-0.0001
YEARS 2009-10: changes in HEI from base year 2015-16	0.0099*	0.0109*	0.0009
YEARS 2011-12: changes in HEI from base year 2015-16	0.0083*	-0.0009	-0.0009
YEARS 2013-14: changes in HEI from base year 2015-16	0.0056*	0.0004	-0.0003
NVET*YEARS 2003-04: changes in HEI for veterans from base year 2015-16	0.0198*	0.0433*	-0.0013
NVET*YEARS 2005-06: changes in HEI for veterans from base year 2015-16	0.0153*	0.0204*	-0.0013
NVET*YEARS 2007-08: changes in HEI for veterans from base year 2015-16	0.0187*	0.0195*	-0.0003
NVET*YEARS 2009-10: changes in HEI for veterans from base year 2015-16	0.0117*	0.0118*	0.001
NVET*YEARS 2011-12: changes in HEI for veterans from base year 2015-16	0.0094*	0.0002	-0.0009
NVET*YEARS 2013-14: changes in HEI for veterans from base year 2015-16	0.0078*	0.0009	-0.0002
NVET*YEARS 2015-16: changes in HEI for veterans from base year 2015-16	0.1259*	0.1417*	0.011*
VET*YEARS 2003-04: changes in HEI for veterans from base year 2015-16	0.0031	0.0052	0.0001
VET*YEARS 2005-06: changes in HEI for veterans from base year 2015-16	0.0059	0.0116*	0.0014
VET*YEARS 2007-08: changes in HEI for veterans from base year 2015-16	-0.0033	0.0111*	0.0006
VET*YEARS 2009-10: changes in HEI for veterans from base year 2015-16	0.0063	0.0094*	-0.0019
VET*YEARS 2011-12: changes in HEI for veterans from base year 2015-16	0.0129*	0.0072	0
VET*YEARS 2013-14: changes in HEI for veterans from base year 2015-16	0.0029	0.0129*	-0.0012
VET*YEARS 2015-16: changes in HEI for veterans from nonveterans for year 2015-16	0.0223*	0.0173*	-0.0006

*Indicates statistically significant at the 5% level.

Source: USDA, Economic Research Service analysis of National Health and Nutrition Examination Survey–What We Eat In America (NHANES-WWEIA) data, 2003-2016.