Journal of the American Heart Association

ORIGINAL RESEARCH

Dietary Cholesterol and Myocardial Infarction in the Million Veteran Program

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BACKGROUND: Coronary artery disease is a leading cause of morbidity and mortality in the United States. Coronary artery disease can lead to major complications including myocardial infarction (MI). The association of dietary cholesterol with coronary artery disease remains inconsistent. We examined the relation of dietary cholesterol with the incidence of MI among participants of the Million Veteran Program.

METHODS AND RESULTS: The Million Veteran Program is a prospective cohort database collecting genetic and nongenetic factors influencing chronic diseases. We analyzed data from 180 156 veterans with complete information on relevant dietary intake. The association between dietary cholesterol and MI risk was assessed using both linear and nonlinear models. Statistical significance was determined using the Wald test for linear trends and the likelihood ratio test for nonlinearity, alongside comparisons between high (≥300 mg/d) and low (<300 mg/d) cholesterol intake groups. In this study of 180 156 veterans with mean follow-up of 3.5 years, we observed a linear, dose–response association between dietary cholesterol intake and risk of MI, with every 100-mg/d increment in cholesterol intake associated with a 5% higher MI risk (relative risk [RR], 1.05 [95% CI, 1.02–1.08]). Subjects consuming >300 mg/d of cholesterol had a 15% increased MI risk compared with those consuming less (RR, 1.15 [95% CI, 1.06–1.25]).

CONCLUSIONS: We found that dietary cholesterol intake was linearly associated with greater risk of MI. These findings contribute to the growing literature highlighting the impact dietary cholesterol has on cardiovascular health. Reductions in cholesterol intake, which can be achieved by decreasing the intake of meat and eggs, may reduce the risk of incident MI.

Key Words: dietary cholesterol ■ Million Veteran Program ■ myocardial infarction ■ nutritional epidemiology ■ population health

Coronary artery disease (CAD) remains the leading cause of morbidity and mortality in the United States.[1,2] Myocardial infarction (MI) is a complication of CAD that causes ischemia and eventual necrosis of the myocardium. The majority of these infarcts are due to the complete occlusions of coronary arteries from atherosclerotic lesions. In the United States, MI has an annual incidence of 605 000 new cases and 200 000 recurrent cases.[3] Approximately 659 000 people die from heart disease in the United States annually, which is about 1 in 4 Americans. In addition, heart disease costs the United States medical system $363 billion, including the cost of health care and medications.[4]

According to the American Heart Association, focusing on a healthy diet and lifestyle can dramatically reduce the risk of CAD.[5] Studies have shown that diets such as the Mediterranean diet, which is rich in olive oil,

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This article was sent to Mahasin S. Mujahid, PhD, MS, FAHA, Associate Editor, for review by expert referees, editorial decision, and final disposition.

Supplemental Material is available at https://www.ahajournals.org/doi/suppl/10.1161/JAHA.124.036819

For Sources of Funding and Disclosures, see page 8.

JAHA is available at: www.ahajournals.org/journal/jaha

CLINICAL PERSPECTIVE

What Is New?

- Dietary cholesterol intake >300 mg/d was associated with a 15% increased risk for myocardial infarction (MI), and for each additional 100 mg/d of cholesterol intake, there was an added 5% increased risk for MI.
- Poor adherence to the Dietary Approaches to Stopping Hypertension diet (ie, Dietary Approaches to Stopping Hypertension score in the lower 60%) and high dietary cholesterol intake (ie, 300 mg/d) were independently associated with a higher risk of MI, whereas individually, each factor was associated with an approximately 20% higher risk of MI and together, both factors were associated with a 36% higher risk.

What Are the Clinical Implications?

- Lifestyle modification with dietary changes aligned with the DASH diet and reductions in cholesterol intake, which can be achieved by decreasing the intake of meat and eggs, may reduce the risk of incident MI.

Nonstandard Abbreviations and Acronyms

ATBC	Alpha-Tocopherol, Beta-Carotene Cancer Prevention
DASH	Dietary Approaches to Stopping Hypertension
MVP	Million Veteran Program
VA	Department of Veterans Affairs

fruits, and nuts, are associated with lower cardiovascular risk.[6–8] Meta-analyses have shown that greater adherence to the Mediterranean diet can reduce cardiovascular mortality by 10%.[9] Meanwhile, foods rich in cholesterol have been implicated in worsening CAD. More specifically, low-density lipoprotein increases the risk of cardiovascular disease, whereas high-density lipoprotein decreases the risk. Because dietary cholesterol has been implicated in the pathophysiology of CAD,[10] current American Heart Association guidelines recommend dietary patterns, such as the Mediterranean diet and Dietary Approaches to Stop Hypertension (DASH) diet, that are low in dietary cholesterol.[11,12]

The association between dietary cholesterol and CAD risk is inconclusive. Several studies suggest limiting dietary cholesterol to reduce the risk of CAD. In a Swedish study of 34 670 women, aged 49 to 83 years, increased dietary cholesterol intake was found to increase the risk of stroke.[13] In a study of 10 802 participants in the United Kingdom, increased mortality from ischemic heart disease was seen in those with increased dietary cholesterol and saturated fat.[14] Meanwhile, other studies report no associated risk between dietary cholesterol and CAD. A study of 1941 participants, aged 70 to 79 years, found no association between dietary cholesterol and cardiovascular risk.[15] Similarly, a study revealed that increased dietary cholesterol does not impact plasma low-density lipoprotein if accompanied by energy restriction.[16] In a clinical trial of 52 patients, no association between examining dietary cholesterol and subsequent low-density lipoprotein levels was found.[17] Some studies have also found that dietary cholesterol intake carries a greater risk of CAD in younger patients.[18] In 2019, American College of Cardiology/American Heart Association guidelines on primary prevention of cardiovascular disease discussed studies that investigated the differences between plant-based and animal-based protein diets and concluded that diets with reduced amounts of cholesterol and sodium may be beneficial in decreasing the risk of atherosclerotic cardiovascular disease.[19] The current American Heart Association recommendations for healthy dietary patterns are characterized by fruits, vegetables, whole grains, low-fat or fat-free dairy, lean protein sources, nuts, seeds, and vegetable oils, which are consistent with the Dietary Guidelines for Americans in 2020.[11,12]

Given these conflicting findings, further studies are needed to understand the role of dietary cholesterol on CAD and MI. Furthermore, it is unknown if a relationship exists between dietary cholesterol and the risk of MI in a large cohort of US veterans. Therefore, the primary aim of this study was to characterize the extent of cholesterol intake and risk for MI in the Department of Veterans Affairs (VA) Million Veteran Program (MVP).

METHODS

Data Availability Statement

Data used in this study cannot be shared publicly because of VA policies on data privacy and security. Data contain potentially identifying and sensitive patient information. All relevant summary-level data are included in the article. For investigators with appropriate authorizations within the VA, requests for data access can be made to the corresponding author.

Study Population

MVP is a nationally representative, prospective cohort study of veterans designed to investigate genetic and nongenetic determinants of chronic diseases.

Recruitment and enrollment for the MVP began in 2011. Eligible veterans include those receiving routine primary care within the United States Department of Veterans Affairs Healthcare System. All participants signed informed consent that was approved by the Veterans Affairs Central Institutional Review Board. Participant data are collected through self-reported surveys and electronic health records and stored in the VA Corporate Data Warehouse.[18] Details of the MVP were published in 2016.[20]

As of 2020, the MVP consisted of 819 417 enrollees, of whom 379 852 participants completed the MVP Lifestyle Survey, which included a semiquantitative food frequency questionnaire with a total of 61 food items. For the current analysis, we excluded participants with a history of cancer (n=100 994) or cardiovascular disease (n=52 913) at baseline. We also excluded participants who responded to the MVP Lifestyle Survey after December 2018 (n=28 854), whose last clinical visit was before or on the date of MVP Baseline Survey completion (n=4827), and those who did not provide dietary information or reported implausible dietary intakes at baseline (n=12 108), which resulted in a final population of 180 156 participants.[21]

Assessment of Exposure

Dietary food intake was collected by a self-reported semiquantitative food frequency questionnaire, which asked how often a standard portion of each of the 61 food items was consumed in the past year. Prespecified responses were: never or less than once per month, 1 to 3 per month, once a week, 2 to 4 per week, 5 to 6 per week, once a day, 2 to 3 per day, 4 to 5 per day, and ≥6 per day. The average daily intake for each participant was converted from the frequencies and portions of all food items and used to calculate the nutrient intake, including dietary cholesterol and alcohol intake, and total energy intake, by multiplying the frequency of consumption for each food item by its energy and nutrient content from the Harvard University Food Composition Database and summing across all foods.[22] The major food sources that contributed to dietary cholesterol intake based on the semiquantitative food frequency questionnaire were eggs, chicken or turkey, and beef, pork, or lamb as a main dish.). Energy-adjusted nutrients were adjusted for total energy intake using a residual method.[23]

Assessment of Covariates

Baseline data on age, sex, race, family history of heart disease, baseline comorbidities, and medications were taken from the self-reported MVP Baseline Survey. Body mass index (weight [kilograms] divided by height squared [meters squared]) was calculated by self-reported weight and height at baseline. For the physical activity variable, subjects were asked the following question: How often do you exercise vigorously enough to work up a sweat? Prespecified responses were daily, 5 to 6 times a week, 2 to 4 times a week, once a week, 1 to 3 times a month, and rarely/never. Information on whether the participants followed a physician-prescribed special diet of low cholesterol was collected by the MVP Lifestyle Survey. The use of statins and other lipid medications was obtained using the VA prescription database.

Smoking status was determined using an algorithm developed for VHA electronic health record that classifies individuals as current, former, or never smokers.[24]

Overall dietary quality was estimated with the DASH score based on the following 8 components: fruits, vegetables, nuts and legumes, low-fat dairy products, whole grain, sweetened beverages, sodium, and red and processed meats. We created quintiles for each of the 8 components and assigned quintile rankings for those that are encouraged in the DASH diet (fruits, vegetables, nuts and legumes, low-fat dairy products, and whole grain). For sodium, meats, and sweetened beverages, where low intake is desired in the DASH diet, we assigned the lowest value for quintile 5 and the highest value for quintile 1. The final DASH score was a sum of the component scores with a range from 8 to 40.

Assessment of Incident MI

Assessment of incident MI was derived combined information from the VA Corporate Data Warehouse (ie, VA electronic health records), the Centers for Medicare and Medicaid Services database, and the National Death Index database. MI cases were identified by applying the Surrogate-Assisted Feature Extraction method, a validated high-throughput phenotyping algorithms approach, using a combination of *International Classification of Diseases* (*ICD*) codes, natural language processing, and medical record review labels.

Statistical Analysis

We categorized dietary cholesterol intake into quartiles (<200, 200–299, 300–399, and ≥400 mg/d). Person-years of follow-up were calculated from baseline to the earliest time of death, the first occurrence of MI, the end of follow-up (December 31, 2018), or the last visit recorded in the Corporate Data Warehouse. Cox proportional hazard models were applied to estimate relative risk (RR) and their 95% CIs for MI comparing participants in each category to the lowest category of dietary cholesterol intake (<200 mg/d) with simultaneous adjustment for covariates. To quantify a linear trend, we used the median within each category

as a score variable and included it as a continuous variable in the model; the Wald test was used for statistical significance. We also modeled the dietary cholesterol intake continuously and calculated RRs associated with every 100-mg/d increment in dietary cholesterol. To quantify the nonlinear dose–response relationship, restricted cubic splines with 3 knots were applied to flexibly model the association between dietary cholesterol and risk of MI with the first percentile of dietary cholesterol intake as the reference level. We tested nonlinearity in the dose–response relationship of the dietary cholesterol intake with MI by comparing the model with the linear term to the model with the linear and cubic spline terms using the likelihood ratio test. We also compared the dichotomy group of dietary cholesterol intake ≥300 mg/d to dietary cholesterol intake <300 mg/d.

The main analysis simultaneously adjusted for age (continuous), sex (men or women), race (White or not-White), smoking status (current, former, or never smoking), alcohol consumption (continuous), frequency of vigorous exercise (never/rarely, 1–4 times per month, 2–4 times per week, or ≥5 times per week), use of statins (yes or no), use of other lipid medications (yes or no), family history of heart disease (yes or no), cholesterol-lowering diet (yes or no), body mas index (continuous), total energy intake (continuous), and baseline history of diabetes, hypertension, and hypercholesterolemia (each yes or no).

In the secondary analysis, we examined the joint associations between dietary cholesterol intake (<300 and ≥300 mg/d) and DASH score (low DASH score [lower 60%] and high DASH score [top 40%]). We tested for interactions between dietary cholesterol intake (<300 and ≥300 mg/d) and group DASH score (low versus high) by adding a product term of the 2 variables in addition to their main effects in the multivariable model. All data analyses were performed using SAS software version 9.4 (SAS Institute, Cary, NC) at a 2-tailed α value of 0.05.

RESULTS

Baseline Characteristics

A total of 180 156 veterans were included in this study. Baseline characteristics of participants according to quartiles (<200, 200–299, 300–399, ≥400 mg/d) of energy-adjusted dietary cholesterol intake are presented in Table 1. In brief, mean age across all cholesterol categories was 62 years, with most participants identifying as men (90%) and White (80%). The proportion of men increased with increasing dietary cholesterol intake quartiles (87% in the lowest cholesterol quartile versus 92% in the highest cholesterol quartile). On average, increased dietary cholesterol intake was associated with decreased frequency of vigorous exercise.

Dietary Habits of Participants

The proportion of participants following a low-cholesterol diet in quartiles was 7.4% to 8.3%. Participants with the lowest cholesterol intake (<200 mg/d) had the lowest percentage of adherence to a low cholesterol diet (7.4%). As dietary intake of cholesterol increased, the proportion of participants taking statin medication and additional lipid medications increased. Greater consumption of eggs, chicken or turkey, processed meats, cheese, and fish was seen with increasing dietary cholesterol. DASH score decreased with the increasing cholesterol intake (Table 1).

Dietary Cholesterol and Risk of MI

We observed a linear dose–response association between dietary cholesterol intake and the risk of MI (*P* for linear trend =0.003, Figure 1). When adjusting for age and sex (Table 2, Model 1), every 100-mg/d increase in dietary cholesterol was associated with a 9% increased risk of MI (RR, 1.09 [95% CI, 1.06–1.12]). When adjusting for age, sex, family history of MI and stroke, smoking status, total physical activity, body mass index, alcohol intake, total calorie intake, cholesterol-lowering diet, and current cholesterol-lowering medication use (Table 2, Model 2), the risk for developing MI was increased by 5% (RR, 1.05 [95% CI, 1.02–1.08]). Additional adjustments for baseline diabetes and hypertension did not significantly change the risk of developing MI (Table 2, Models 3 and 4). Compared with participants with cholesterol intake <200 mg/d, RR of MI was 1.02 (95% CI, 0.92–1.13), 1.11 (95% CI, 0.99–1.25), and 1.27 (95% CI, 1.11–1.46) among participants with cholesterol intake of 200 to 299, 300 to 399, and ≥400 mg/d, respectively (*P* for trend=0.004). Participants with a cholesterol intake ≥300 mg/d had a 15% higher risk of MI compared with participants whose cholesterol intake was not >300 mg/d (RR, 1.15 [95% CI, 1.06–1.25]) in the fully adjusted model (Table 2).

There were 68 080, 39 850, 51 274, and 20 952 participants with low DASH and cholesterol <300 mg/dL, low DASH and cholesterol ≥300 mg/dL, high DASH and cholesterol <300 mg/dL, and high DASH and cholesterol ≥300 mg/dL, respectively. Both poor adherence to the DASH diet (ie, DASH score in the lower 60%) and high dietary cholesterol intake (ie, ≥300 mg/d) were independently associated with a higher risk of MI (*P* for interaction=0.2). Individually, each factor was associated with an approximate 20% higher risk of MI, and together, both factors were associated with a 36% higher risk. Compared with participants with greater adherence to the DASH diet (ie, DASH score

Table 1. VA Million Veteran Program Participant Characteristics According to Energy-Adjusted Dietary Cholesterol Level

Characteristic	Energy-adjusted cholesterol intake, mg/d			
	<200	200–299	300–399	≥400
Energy-adjusted cholesterol intake, mg/d, mean±SD	155.1±36.6	249.1±28.3	341.2±27.6	530.2±157.1
Age, y, mean±SD	62.8±12.5	62.2±12.4	61.7±12.4	61.7±12.5
Men, %	87.0	89.2	90.6	91.5
White, %	84.1	83.0	79.5	78.6
Body mass index, %				
<25 kg/m^2	25.2	18.5	15.5	14.1
25 to <30 kg/m^2	42.3	41.3	37.3	34.7
≥30 kg/m^2	32.5	40.1	47.2	51.2
Smoking status, %				
Never	32.9	32.7	32.2	32.2
Former	60.0	59.6	60.1	60.5
Current: <15 cigarettes/d	5.2	5.9	5.9	5.8
Current: ≥15 cigarettes/d	1.6	1.5	1.4	1.2
Multivitamin supplement use	55.6	55.2	54.3	54.5
Alcohol intake, g/d, mean±SD	12.0±20.6	7.6±13.3	5.6±10.2	5.0±10.2
Exercise, %				
Never/rarely exercise vigorously	29.1	27.1	28.6	31.2
Exercise vigorously 1–4/mo	25.1	27.4	27.7	25.8
Exercise vigorously 2–4/wk	29.9	31.4	30.7	28.3
Exercise vigorously ≥5/wk	16.0	14.1	13.1	14.8
Cholesterol-lowering diet, %	7.4	7.5	8.0	8.3
Statin usage, %	57.5	59.5	61.1	61.9
Other lipid medication usage, %	10.1	11.1	11.9	13.1
Eggs, servings per d, mean±SD	0.1±0.1	0.3±0.2	0.6±0.3	1.4±1.1
Chicken or turkey, servings/d, mean±SD	0.3±0.2	0.5±0.4	0.7±0.5	0.9±1.0
Beef, pork, or lamb as main dish, servings/d, mean±SD	0.2±0.2	0.3±0.3	0.4±0.4	0.5±0.6
Hamburger, servings/d, mean±SD	0.1±0.1	0.2±0.2	0.2±0.2	0.2±0.3
Processed meats, servings/d, mean±SD	0.3±0.4	0.4±0.5	0.5±0.5	0.6±0.7
Cheese (other than ricotta or cottage), servings/d, mean±SD	0.4±0.4	0.5±0.6	0.5±0.6	0.5±0.7
Fish, servings/d, mean±SD	0.1±0.2	0.2±0.2	0.2±0.2	0.2±0.3
Beef, pork, or lamb as a sandwich or mixed dish, servings/d mean±SD	0.1±0.1	0.2±0.2	0.2±0.3	0.2±0.3
Ice cream, servings/d mean±SD	0.2±0.3	0.2±0.4	0.2±0.4	0.1±0.3
DASH score, mean±SD	22.2±5.4	21.7±4.9	21.1±4.7	20.5±4.5

DASH indicates Dietary Approaches to Stop Hypertension; and VA, Department of Veterans Affairs.

in the top 40%) and low dietary cholesterol intake (ie, <300 mg/day), the risk of MI was 1.22 (95% CI, 1.06–1.40) among participants with greater adherence to the DASH diet and high dietary cholesterol intake and 1.25 (95% CI, 1.12–1.39) among participants with poor adherence to the DASH diet and dietary cholesterol intake <300 mg/d. If participants had both poor adherence to the DASH diet in addition to high dietary cholesterol intake, risk of MI increased to 36% (RR, 1.36 [95% CI, 1.21–1.52]) compared with participants with greater adherence to the DASH diet and low dietary cholesterol intake (Figure 2).

To test the robustness of our findings, we conducted 2 sensitivity analyses. In the first, we stratified by baseline status of statin usage. The hazard ratio of MI comparing participants with dietary cholesterol intake ≥300 mg/d to <300 mg/d was 1.15 (95% CI, 1.05–1.25; *P* for trend =0.002, n=107 415, MI cases=2364)

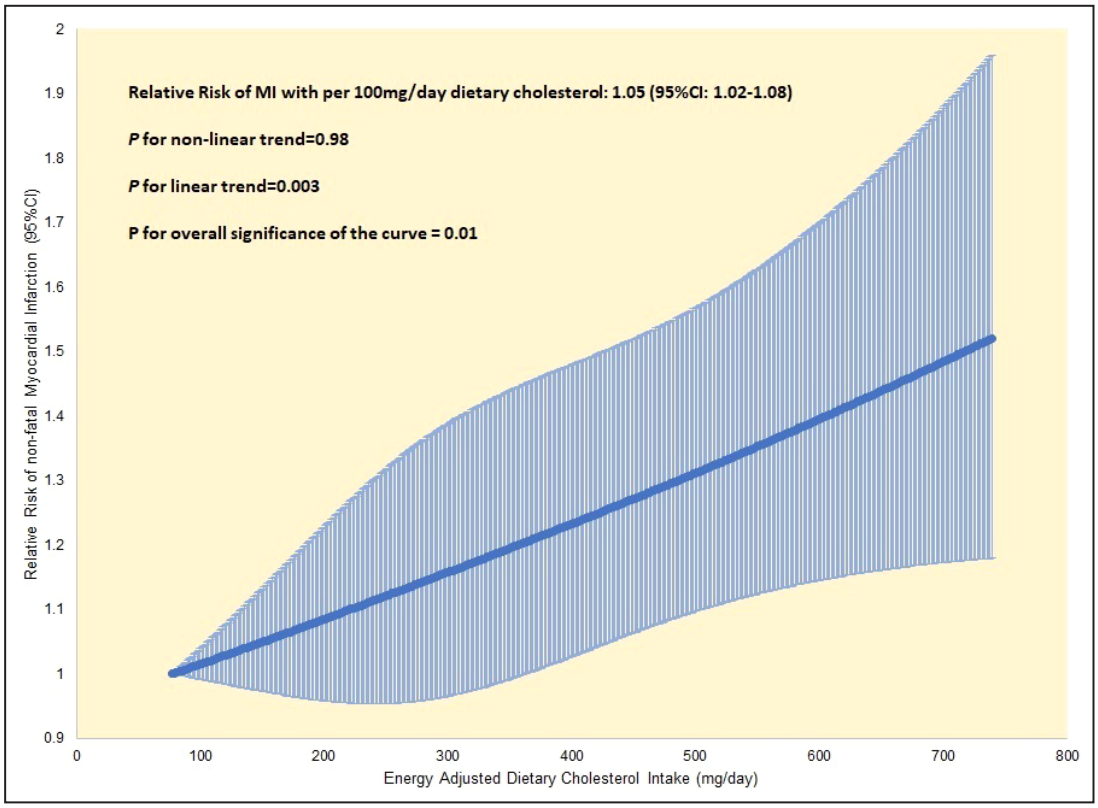

Figure 1. Dose–response relationship between dietary cholesterol intake and risk of MI in the VA Million Veteran Program.
Adjusted for age, sex, family history of heart disease, smoking status, total physical activity, body mass index, alcohol intake, total calorie intake, cholesterol-lowering diet and current cholesterol-lowering medication use, and baseline history of diabetes, hypertension, and high cholesterol. MI indicates myocardial infarction; and VA, Department of Veterans Affairs.

among statin users and 1.23 (95% CI, 0.86–1.77; *P* for trend =0.25, n=72 741, MI cases=135) among nonstatin users, with a *P* for interaction between statin use and dietary cholesterol of 0.82. In a second sensitivity analysis, we further adjusted for dietary intake of fruits, vegetables, whole grains, and polyunsaturated fatty acids, and the RR of MI associated with 100 mg/d of dietary cholesterol intake was 1.05 (95% CI, 1.02–1.08; *P* for trend=0.003). Additional adjustment for saturated fat intake attenuated the RR of MI associated with 100 mg/d dietary cholesterol intake to 1.04 (95% CI, 1.01–1.08; *P* trend=0.009).

DISCUSSION

In this prospective cohort study of 180 156 participants with a mean follow-up of 3.5 years, a higher dietary

Table 2. Relative Risk of Myocardial Infarction According to Dietary Cholesterol Intake in the VA Million Veteran Program

Models	Energy adjusted dietary cholesterol intake, mg/d				*P* for trend	RR (95% CI)	RR (95% CI) ≥300 vs <300 mg/d cholesterol
	<200	200–299	300–399	≥400		Per 100 mg/d	
MI cases	572	990	592	345			
Model 1	1.0	1.09 (0.98–1.20)	1.26 (1.12–1.41)	1.50 (1.32–1.72)	<0.0001	1.09 (1.06–1.12)	1.27 (1.17–1.38)
Model 2	1.0	1.03 (0.93–1.14)	1.13 (1.01–1.27)	1.31 (1.14–1.50)	0.0007	1.05 (1.02–1.08)	1.17 (1.08–1.27)
Model 3	1.0	1.03 (0.93–1.14)	1.13 (1.01–1.27)	1.31 (1.14–1.50)	0.0007	1.05 (1.02–1.08)	1.17 (1.08–1.27)
Model 4	1.0	1.02 (0.92–1.13)	1.11 (0.99–1.25)	1.27 (1.11–1.46)	0.004	1.05 (1.02–1.08)	1.15 (1.06–1.25)

Model 1: adjusted age and sex. Model 2: adjusted for age, sex, family history of heart disease, smoking status, total physical activity, body mass index, alcohol intake, total calorie intake, cholesterol-lowering diet, and current cholesterol-lowering medication use. Model 3: model 2 + baseline diabetes. Model 4: model 3 + baseline hypertension and high cholesterol. MI indicates myocardial infarction; RR, relative risk; and VA, Department of Veterans Affairs.

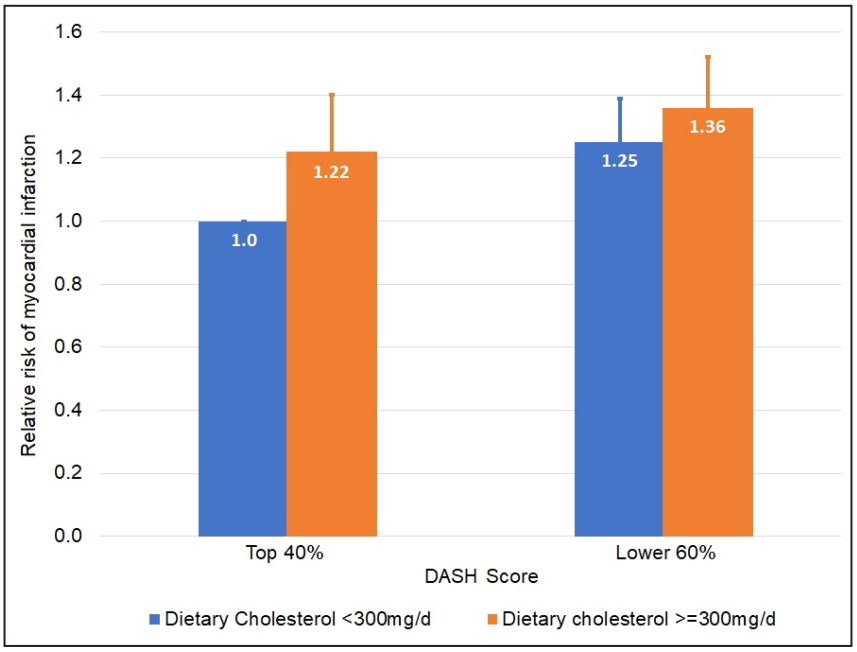

Figure 2. Joint effect between dietary cholesterol and overall dietary quality on risk of myocardial infarction in the VA Million Veteran Program.
Adjusted for age, sex, family history of heart disease, smoking status, total physical activity, body mass index, alcohol intake, total calorie intake, cholesterol-lowering diet, and current cholesterol-lowering medication use, and baseline history of diabetes, hypertension, and high cholesterol. DASH indicates Dietary Approaches to Stopping Hypertension; and VA, Department of Veterans Affairs.

cholesterol intake >300 mg/day was associated with a 15% increase in the incidence of MI. Cholesterol intake among veterans was primarily attributed to a high consumption of meat and eggs.

In our study, for every 100-mg/d increment in dietary cholesterol intake there was a 5% significant increased risk of MI. Similarly, in a study of 7088 men with 10-year follow-up, decreased dietary cholesterol was seen in participants free of CAD.[25] In a study of 1824 men, the incidence of cardiovascular morbidity and mortality increased with dietary cholesterol.[26] Other studies have seen an association between dietary cholesterol and the incidence of cardiovascular disease.[27] Meanwhile, a study of 1032 men found no significant association between dietary cholesterol and risk of CAD.[28] Another study of 80 082 women found no association between dietary cholesterol and the risk of coronary artery disease.[29] The lack of association in some studies can be attributed to confounding factors. For example, women generally have a lower risk of coronary artery disease. Because our study is 90% men, it is possible that a portion of the risk can be attributed to biological sex.

Secondary analysis examined the role of the DASH diet and the incidence of MI. In our study, participants with greater adherence to the DASH diet and low dietary cholesterol diet had a lower risk of developing MI. Similarly, studies have shown that adherence to the DASH diet reduces the risk of CAD.[30] In another study of 57 708 participants, greater adherence to the DASH diet reduced the risk of CAD by 24%.[31] In addition to the DASH diet reducing the risk of CAD, studies have revealed a lower incidence of MI in those who adhere to the DASH diet. For example, in a study of 88 517 female nurses, there was a 14% decreased risk of MI when adhering to the DASH diet,[32] which was slightly lower than what was observed in our study.

The current study has several strengths including a prospective cohort design with a large sample size. Additionally, the participants have diverse socioeconomic backgrounds. This study is not without limitations. One major limitation is the use of survey data that can be influenced by response bias. Another limitation is generalizability to the overall US population, because the MVP study population consists primarily of men and White subjects. As an observational study based on nutrient intake derived from foods, no causal effect can be distinguished or implied when interpreting our findings. In a previous study, we found that red and processed meats, major contributors of dietary cholesterol and saturated fat, were significantly associated with an increased risk of cardiovascular diseases among veterans in the MVP.[33] However, when we further adjusted for saturated fats, polyunsaturated fatty

acids, fruits, vegetables, and whole grain intake in this current study, our finding was attenuated but remained statistically significant. Despite these limitations, our study findings add to the growing evidence that adhering to the DASH diet and limiting dietary cholesterol may protect against incident MI.

Adherence to the DASH diet with reduced intake of dietary cholesterol improved outcomes compared with DASH diet adherence with a high intake of dietary cholesterol. A recent prospective analysis of 27 078 men in the ATBC (Alpha-Tocopherol, Beta-Carotene Cancer Prevention) study investigated the relationship between dietary cholesterol, serum cholesterol, and egg consumption with cause-specific mortality.[34] This study showed greater dietary cholesterol and egg consumption were associated with an increased risk of cardiovascular disease-related mortality. Another study of 30 000 participants from the United States followed for 31 years included a more diverse population including 31% Black and 55% female subjects. Their findings showed that with each additional 300 mg of dietary cholesterol daily, there was a 17% increased risk for cardiovascular disease.[35] They also found that the dietary cholesterol mortality risk estimates were higher in women. These studies with more diverse subject populations correlate with the results found in this study, where we observed that higher dietary cholesterol intake was significantly associated with a higher risk of MI in a large cohort of US veterans. Although recommendations on dietary cholesterol intake for improving cardiovascular outcomes have been highly debated, there has been expanding evidence correlating with the findings of this study. Further large interventional studies need to be conducted to further uncover this association.

Maintaining healthy dietary patterns, such as the DASH and Mediterranean diets, which are both low in dietary cholesterol, should remain as one of the primary focuses to optimize cardiovascular health, because this lifestyle habit may be easier for individuals to independently implement.[18,36,37] Additionally, reductions in cholesterol intake, which can be achieved by lowering the intake of meat and eggs, may reduce the risk of incident MI. Encouraging such dietary recommendations to target reduced cholesterol intake may potentially improve cardiovascular fitness for veterans.

ARTICLE INFORMATION

Received May 28, 2024; accepted December 16, 2024.

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Acknowledgments

The authors thank the members of the Million Veteran Program Core, those who have contributed to the Million Veteran Program, and especially the veteran participants for their generous contributions. This work was supported using resources and facilities of the VA Informatics and Computing Infrastructure, VA HSR RES 13-457.

Sources of Funding

This research is based on data from MVP supported by the MVP#001 (I01-BX003340 and I01-BX004821) and MVP#000 awards from the Department of Veterans Affairs. This research was also supported by the Department of Veterans Affairs VA Merit Award I01 BX00334001 and I01BX004821. This publication does not represent the views of the VA or the US government.

Disclosures

None.

Supplemental Material

Data S1

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