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Dietary Quality 1 Year after Diagnosis of Coronary Heart Disease

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Abstract

Objective—The purpose of this ancillary study is to determine the quality of diets in patients with documented coronary heart disease (CHD).

Design—Dietary data were originally collected using a 24-hour dietary recall in 555 patients with CHD, 1 year after a diagnostic coronary angiography. Data used for this investigation were collected between March 2001 and November 2003.

Subjects/setting—Patients were participants in a clinical trial to improve adherence to lipid-lowering medications. The Alternate Healthy Eating Index, an instrument designed to evaluate the degree to which a diet has the potential to prevent cardiovascular disease, measured dietary quality.

Main outcome measures—Linear regression models were used to assess the association of dietary quality with patients' sociodemographic and clinical characteristics.

Results—Mean age of participants was 61 years, with an average body mass index of 30 (calculated as kg/m²). Sixty percent were men. Average daily caloric intake was 1,775 kcal, with 50% of calories derived from carbohydrates, 18% from protein, and 32% from total fat. Average Alternate Healthy Eating Index score was 30.8 out of a possible maximum score of 80. Only 12.4% of subjects met the recommended consumption of vegetables, 7.8% for fruit, 8% for cereal fiber, and 5.2% for *trans*-fat intake. Lower dietary quality was associated with lower total caloric intake, as well as with smoking, obesity, and lower educational level.

Conclusions—A high proportion of patients reported poor dietary quality 1 year after experiencing a coronary event. Our data support continued efforts to enhance healthful dietary changes over time for secondary prevention of CHD. Dietary change should be emphasized with CHD patients who are less educated, smokers, or obese.

Coronary heart disease (CHD) is the number one cause of mortality in Americans (1). It is estimated that over 13 million Americans have survived a heart attack or currently have symptoms of CHD (2). Risk factors for CHD include smoking, hypertension, obesity, diabetes, and hyperlipidemia, which are all modifiable with behavioral changes (1,3). Efforts at secondary prevention of CHD have substantial public health implications. In addition to effective cardiac medications, lifestyle modifications have been shown to reduce the risk of future cardiac events (3–5).

Studies of diet quality and CHD have focused largely on determining dietary risk factors for CHD (6–12). Dietary risk factors for CHD have been well-established and include a diet high in saturated and *trans* fat and low in beneficial fats, fruit, vegetables, and fiber (13–20). These dietary risk factors are also associated with a higher consumption of calories from fat, which indirectly increases risk for CHD through higher rates of obesity and type 2 diabetes (21–26). The Alternate Healthy Eating Index was developed by McCullough and colleagues (27) to improve upon the Healthy Eating Index, which measured adherence to the 1995 US Department of Agriculture Food Guide Pyramid dietary guidelines (28), but failed to distinguish among different types of fat and carbohydrates, which are important considerations in cardiovascular disease. Dietary quality, as measured by the Alternate Healthy Eating Index, has been shown to be associated with cardiovascular outcomes (27,29). Using data from the Nurses' Health Study and the Health Professional's Follow-up Study, McCullough and colleagues found that men with highest Alternate Healthy Eating Index had a 39% lower risk of developing cardiovascular disease compared to those with the lowest Alternate Healthy Eating Index; women with the highest Alternate Healthy Eating Index had a 28% lower risk than those with lowest Alternate Healthy Eating Index (27).

However, few studies have looked at the dietary quality of individuals who have established CHD and whether a healthful diet has been achieved as part of the secondary prevention efforts. The purpose of this study is to determine the dietary quality of patients 1 year after being diagnosed with CHD by coronary angiography.

METHODS

Subjects

The study population consisted of 689 patients recruited from the cardiac catheterization laboratories of University of Massachusetts Memorial Health Care, who participated in a randomized controlled trial to improve adherence to lipid-lowering medications. The overall goal of the original study was to implement and evaluate the efficacy of a systems-based and pharmacist-mediated program designed to improve adherence for patients with known CHD to lipid-lowering pharmacologic therapy. A patient was eligible for this study if he/she met the following criteria: was between 30 and 85 years of age; had symptomatic heart disease, which required cardiac catheterization and was subsequently diagnosed with CHD, defined as the presence of at least one coronary lesion at coronary angiography of $\geq 50\%$. Therefore, participants were patients with at least one CHD event, such as angina, arrhythmia, myocardial infarction. A patient was excluded if he/she had any of the following characteristics: was unable or unwilling to give informed consent; had a history of intolerance to two or more statin drugs; planned to move out of the area within 1 year of recruitment; had a poor prognosis such that life expectancy was thought to be fewer than 5 years; had a psychiatric illness that limited ability to participate; or had no telephone. Subjects were recruited between March 2001 and November 2003. Patients were randomly assigned to a usual care condition consisting of patients provided with usual care only, or to the special intervention condition. Patients in the special intervention condition received five telephone-counseling contacts conducted by pharmacists to enhance lipid-lowering medication compliance. Pharmacists did not provide or assess nutrition education as part of the intervention. Patients in the usual care condition received standard care, which was whatever their physicians thought was appropriate. Each subject was in the study for a 1-year period. Dietary data was collected at 1 year from the diagnosis of CHD on 555 subjects. The Institutional Review Boards of the University of Massachusetts Medical School approved all subject recruitment and data collection procedures.

Assessment of Participants' Characteristics

Data on demographic variables were collected by a self-administered questionnaire at the baseline clinic visit. Smoking status and physical activity status were collected at 1-year using “yes/no” questions. Question used for smoking status was “In the last 3 months, have you smoked any cigarettes, cigars, pipes, or other tobacco products?” and the question for physical activity was “In the last 3 months, have you exercised at least 20 minutes on one occasion without stopping?”

Assessment of Body Weight

Body weight and height were measured using standard methodology (30) by a trained research assistant with the subject wearing light clothing only and no shoes at the 1-year follow-up visit. They were measured once using a Detecto scale (Webb City, MO). Relative mass was expressed as body mass index (BMI; calculated as kg/m^2).

Assessment of Diet

Dietary data was collected using a multiple-pass approach of the 24-hour dietary recall at 1-year using a telephone interview by trained registered dietitians (RDs). The 24-hour dietary recall method probes for complete food descriptions, detailed food preparations methods, and diverse amount descriptions (31). Each patient received food models with pictures of different foods and serving sizes prior to 24-hour dietary recall to assist in reporting portion sizes of food intake, and were instructed to have these available for the calls. The 24-hour dietary recall has been validated against measured food intake (32), and is the most widely used dietary assessment method in research (33–35).

Few studies have looked at the dietary quality of individuals who have established CHD and whether a healthful diet has been achieved as part of the secondary prevention efforts.

The dietary data were directly entered into a computer using the Nutrition Data System for Research software (version 4.05_33, 2002, Nutrition Coordinating Center, Minneapolis, MN). The 24-hour dietary recall was conducted over the phone by an RD. The 24-hour dietary recall data were sent to a nutritionist supervisor monthly, who reviewed them for completeness and accuracy of data. Ten percent of all calls are subjected to additional quality control measures. All missing foods (foods not found in the Nutrition Data System database) are resolved through matching similar nutrient content, or through Nutrition Coordinating Center resolutions. Nutrient values included total calories; percent calories from carbohydrate, fat, and protein; number of servings of vegetables, fruits, nuts, soy, meat, and cereal fiber (referred to fiber from grains throughout this article); percent of energy from saturated and monounsaturated fat, *trans* fat; and n-3 fatty acid; total fiber; and sodium. They were analyzed using the Nutrition Data System for Research software.

Dietary quality of 24-hour diet recall was measured by the Alternate Healthy Eating Index, an instrument designed to evaluate nine criteria of a healthful cardiovascular diet (27,29), including: (a) fruit, (b) vegetables, (c) nuts and soy, (d) ratio of white to red meat, (e) cereal fiber, (f) *trans* fat, (g) ratio of polyunsaturated fat to saturated fat, (h) alcohol, and (i) duration of multivitamin use.

Eight of the nine Alternate Healthy Eating Index components were used to calculate the Alternate Healthy Eating Index score (27). Duration of multivitamin use was not used because it was not collected in the study. Each component received a score from 0 to 10, with 10 being the highest and 0 being the lowest. Detailed scoring algorithms are described elsewhere (27, 36). In summary, higher scores are generated with a greater intake of protective foods, such as fruit; vegetables; fish; nuts; and whole grains, and a lower intake of red meat and *trans* fat.

In order to provide a comprehensive view of dietary quality and enhance understanding of the Alternate Healthy Eating Index, several nutrients important for CHD risk reduction are incorporated in a separate analysis. These include: macronutrient composition, percent of energy from saturated and monounsaturated fat, n-3 fatty acids, total fiber, and sodium. Saturated fat (15,37) and elevated sodium intake (38) increase risk of CHD. Monounsaturated and n-3 fatty acids and high fiber diets have cardioprotective effects (16–20).

Statistical Analysis

Participants' characteristics and nutritional variables were summarized using mean and standard deviation for continuous variables and number and percent for categorical variables. Linear regression models were used to assess the associations of Alternate Healthy Eating Index score with patients' sociodemographic and clinical characteristics. To develop the final model, sociodemographic and nutritional variables, including daily caloric intake, percent calories from carbohydrate, fat, and protein were included. A backward stepwise process was then used to eliminate the non-significant ($P > 0.10$) covariates. The Alternate Healthy Eating Index was separately examined for the two randomized arms and determined that there was no difference in Alternate Healthy Eating Index, thus, the analyses were based on data with two arms combined. The data was also analyzed by sex, however, because the results were similar, only combined results are presented.

RESULTS

Participants had an average age of 61 years, 60% were men, half were married or lived with someone, and 65% were white. Forty-four percent had education levels beyond high school. Sixty-nine percent were overweight or obese with an average BMI of 30 (Table 1). At the 1-year visit, nearly 20% reported smoking in the last 3 months, and 50% reported not having performed at least one 20-minute session of continued exercise in the previous 3 months. Alternate Healthy Eating Index total, Alternate Healthy Eating Index components, and selected nutrient scores are presented in Table 2. The average Alternate Healthy Eating Index score was 30.8 (standard deviation [SD] = 13.1) out of a possible maximum score of 80, with a range from 5.1 to 69.8. Assessed by the Nutrition Data System, daily consumption of vegetable was 2.43 servings, 1.4 servings for fruit, 0.67 servings for nut and soy protein, and 3.67 g for cereal fiber. The consumption of *trans* fat was 3.41% of calories. The mean scores of Alternate Healthy Eating Index components were low. For example, Alternate Healthy Eating Index component score for vegetables was 4.38, 3.00 for fruit, 2.22 for nut and soy protein, and 2.13 for *trans* fat (out of the maximum of 10).

Only 12.4% of subjects met or exceeded recommended consumption of vegetables (≥ 5 serving/day); and only 7.8% for fruit consumption (≥ 4 serving/day). The recommendation for cereal fiber was met by <8% of the study population. *Trans*-fat intake was higher than recommended, only 5.2% of this population limited *trans* fat to 0.5% of total calories or less. Average daily caloric intake was 1,775 kcal, with 50% from carbohydrate, 18% from protein, and 32% from total fat. Percent of calories from saturated fat was 10.7 (SD = 4.45), and total fiber was 16.81 g/day. The polyunsaturated fat to saturated fat ratio was 0.76. The polyunsaturated fat included both n-3 fatty acids and n-6 fatty acids.

Results from multivariable linear regression model for the Alternate Healthy Eating Index are presented in Table 3. Low dietary quality was associated with smoking in the previous 3 months, lower educational level, obesity (referent: normal weight), high-fat intake, and a lower calorie intake. The average overall Alternate Healthy Eating Index score in smokers was six units lower than that in nonsmokers. Participants with education beyond high school had Alternate Healthy Eating Index scores an average of three units higher than those with a high

school education. Obese participants had Alternate Healthy Eating Index scores that were an average of four units lower than those of subjects with normal weight.

DISCUSSION

The major finding of this ancillary study was the poor quality of diet among a sample of patients 1 year after being diagnosed with CHD. The mean Alternate Healthy Eating Index score in the study population was poorer than scores reported for samples of healthy individuals (27). The study population had a mean Alternate Healthy Eating Index score of 31 (SD = 13.1), compared to 45.0 (SD = 11.1) for healthy men in the Health Professional's Follow-up Study, and 38.4 (SD = 10.3) for healthy women in the Nurses' Health Study (27). Although the dietary characteristics of participants before their CHD event were not known, these data highlight the poor quality of their current diet and the need for increased surveillance and lifestyle recommendations by physicians and health professionals to decrease future CHD event risk for patients with established CHD. The observation that only half of these patients had engaged in at least one 20-minute session of uninterrupted physical activity in the past 3 months, 1 year after a coronary event, corroborates the need for close monitoring of these patients in order to assess compliance with lifestyle interventions, which includes physical activity.

In a previous study, the Alternate Healthy Eating Index of several popular weight loss plans was calculated; the highest scoring diet was the Ornish Diet (Alternate Healthy Eating Index = 64.6) and lowest scoring diet was the Atkins diet (Alternate Healthy Eating Index = 42.3) (36). The fact that patients with known CHD, 1 year after a coronary event, still have lower Alternate Healthy Eating Index scores than any of these popular diets may be indicative of the complex issues of affecting and sustaining behavioral change and the confusion patients may face in navigating through dietary recommendations (39,40). On the other hand, use of lipid-lowering medications may disinhibit dietary control if the patient assumes that blood lipid levels are being controlled.

A recent study examined secular trends in overall diet quality for CHD prevention during the past 2 decades (1980–1982 through 2000–2002) (41). Using dietary quality scores that are similar to the Alternate Healthy Eating Index, the investigators found an improvement in dietary quality during the past 2 decades, particularly driven by intake improvements in total grain, whole grain, total fat, saturated fat, *trans* fat, and cholesterol. However, overall dietary quality improvement appears to have leveled off during the last 5-year period, when low carbohydrate diets were popular (42–44). This study was conducted during this period and may in part reflect this trend.

A recent meta-analysis and systematic review by Dauchet and colleagues (11) confirmed that fruit and vegetable consumption is inversely associated with the risk of CHD. Daily consumption of 5 servings of vegetables and 4 servings of fruits is recommended, reflecting the upper range of current dietary guidelines. These recommendation are consistent with intervention studies of intermediate CHD risk factors (27). In this population, the fruit and vegetable components of Alternate Healthy Eating Index are also poor compared to the Nurses' Health Study and the Health Professional's Follow-Up Study (27). In the current study, the average daily consumption was 2.4 servings for vegetables, 1.4 servings for fruits, compared to 3.2 servings per day of vegetables, 2.3 servings per day of fruits in the study by McCullough and colleagues (27). The popular diets analyzed previously had higher intake of vegetables, fruit, and cereal intake than intake from the present study. For example, the Atkins Plan recommends 6.6 and 1.9 vegetable and fruit servings/day, respectively (36).

Recent metabolic studies showed detrimental effects of *trans* fat on inflammatory factors, which are associated with CHD (14). Epidemiological studies have indicated that the

magnitude of association between *trans* fat and CHD is stronger than for saturated fat (45). The intake of *trans* fat in the present study is 3.41% compared to 1.3% to 1.9% in the study by McCullough and colleagues (27). This is a disturbing finding, indicating these patients are at increased risk for a CHD event recurrence. The current recommendation for *trans* fat is <1% calories (38). The lower than ideal polyunsaturated to saturated fat ratio, in conjunction with higher than desired *trans*-fat intake observed in this population, may exert deleterious effects in the lipid profile of these patients.

Overall poor dietary quality, as determined by a low Alternate Healthy Eating Index score, was associated with current smoking, higher BMI, higher percent caloric intake from fat, lower total caloric intake, and lower educational level. Consistent with these findings, a recent population-based study in Brazil (46) found that dietary quality, measured by the Healthy Eating Index, was inversely associated with smoking and BMI. Using data from the Behavioral Risk Factor Surveillance System, Rafferty and colleagues (47) also found that dietary quality was related to educational level. Participants with a low educational level may require specific intervention tools to improve dietary quality. It is particularly important to consider issues related to health literacy (39,48) and make sure patients can understand and comprehend material provided to them.

There are several strengths to this investigation. Alternate Healthy Eating Index had been computed from food frequency questionnaires (FFQs) querying either the past month or previous year (27,29); however, the 24-hour dietary recall utilized in the present study provides more accurate data for computing the Alternate Healthy Eating Index. The 24-hour dietary recalls have greater specificity allowing for a better measure of factors related to the Alternate Healthy Eating Index, including identification of a variety of individual foods, portion sizes, and food preparation methods. By contrast, FFQs must estimate nutrient intakes from a composite listing of only about 100 foods, rely on a small number (usually three) of comparisons with standard portion sizes, and they are either self- or interviewer-administered. In addition, interviewer-administered FFQs allow for careful probing by an RD (49,50).

There are also several limitations to the study. First, only one unannounced 24-hour dietary recall was collected in this study, as opposed to three unannounced 24-hour dietary recalls, which are recommended to capture individual habitual diet (51). Thus, dietary data were examined at the patient population level and not at the individual level. However, one 24-hour dietary recall has been used in the National Health and Nutrition Examination Survey to categorize dietary intake in the United States population (52). In addition, calories are frequently under reported when dietary data are collected by any methodology including 24-hour dietary recall, 3-day or 4-day food records or by FFQs. Caloric intake may also get underreported due to social desirability especially by overweight people (53,54). A second limitation is that the study results may not generalize to minority populations. Participants in this study were between ages 30 and 85 years and predominantly white. The third limitation is the broad classification of smokers. Any amount of smoking in the past 3 months was considered smoking, which would include social and occasional smokers, although this type of misclassification would bias our results toward the null. A similar limitation also applies to physical activity measures. Fourth, a cross-sectional analysis of dietary quality and its association was conducted. As such, temporal or causal associations cannot be established. Finally, data do not exist on dietary quality prior to CHD event, or whether the patient attended cardiac rehabilitation to examine differences before and after CHD event. However, cardiac rehabilitation programs generally have greater focus on exercise, not on nutrition counseling (55–58).

CONCLUSION

In conclusion, this ancillary study found that the quality of diets among patients with a recent CHD event was poor. It may be helpful for physician and health care providers to refer CHD patients to behavioral interventions that include both diet and physical activity components, such as cardiac rehabilitation. In addition, they may need to see an RD for their dietary modifications. To improve the quality of dietary intake of CHD patients, future studies should evaluate: (a) the dissemination of nutrition education materials to CHD patients tailored to appropriate educational levels; and (b) the impact of these materials on dietary intake.

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Table 1Selected demographic characteristics of adults with established coronary heart disease 1 year after diagnosis^a

	Mean no.	% (Standard deviation)
Sex		
Female	220	39.64
Male	335	60.36
Age (y)	60.78	10.29
Marital status		
Single	121	21.80
Married or lived with someone	285	51.35
Unknown	149	26.85
Race		
White	363	65.41
Nonwhite	41	7.39
Unknown	151	27.21
Work status		
Employed	284	51.17
Retired	136	24.50
Disabled/unable to work	47	8.47
Other	88	15.86
Highest education level		
Less than high school	40	7.21
High school	158	28.47
Higher than high school	246	44.32
Unknown	111	20.00
BMI ^b at 1 year ^c	29.96	5.53
BMI category		
Normal (<25)	79	14.39
Overweight (25–29.9)	167	30.42
Obesity (≥30)	213	38.80
Unknown	90	16.39
Exercised at least 20 min on one occasion without stopping in the last 3 months at 1 year ^c ?		
Yes	277	49.91
No	278	50.09
Smoking in the last 3 months at 1 year ^c		
Yes	107	19.28
No	448	80.72

^aPharmacist Assisted Compliance Trial, Worcester Massachusetts, 2001 to 2003 (n = 555).^bBMI = body mass index; calculated as kg/m².^c1 year post-coronary heart disease event.

Table 2

Alternate Healthy Eating Index, components, and selected nutrient scores among adults with established coronary heart disease 1 year after diagnosis^a

	Score	Daily intake	Daily intake criteria for maximum score of 10	% of Subjects with maximum score of 10
← mean + standard deviation →				
Overall Alternate Healthy Eating Index score ^b	30.84 ± 13.10			
Component of Alternate Healthy Eating Index ^c assessed by NDS ^d				
Vegetable (serving/d)	4.38 ± 3.32	2.43 ± 2.22	5	12.43
Fruit (serving/d)	3.00 ± 3.34	1.40 ± 2.18	4	7.75
Nuts and soy protein (serving/d)	2.22 ± 4.05	0.67 ± 1.74	1	19.82
White/red meat	5.00 ± 4.67	2.21 ± 1.94	4 ^e	49.73
Trans fat (% energy)	2.13 ± 3.23	3.41 ± 2.96	≤0.5	5.23
Cereal fiber (g/d)	6.61 ± 3.06	3.67 ± 6.22	15	7.39
P/S ratio ^f	6.00 ± 3.10	0.76 ± 0.53	≥1	23.06
Alcohol (serving/day)	1.50 ± 3.35	0.40 ± 1.01	Men: 1.5–2.5 Women: 0.5–1.5	6.31
Recommended values				
Total caloric intake (kcal/d) assessed by NDS ^d		1,775 ± 700		
Nutrition composition				
% Carbohydrate		49.85 ± 11.89	45–65	
% Fat		31.92 ± 9.89	25–30	
% Protein		17.77 ± 5.52	~15	
Other important nutrients				
Saturated fat (% energy)		10.67 ± 4.45	<7	
Monounsaturated fat (% energy)		11.74 ± 4.41	Substitute for saturated fat, up to 20% of kcal	
n-3 Fatty acids (g/d)		1.84 ± 1.95	0.06% to 0.12% of kcal, or ~900 mg/d	
Total fiber (g/d)		16.81 ± 10.24	14 g/1,000 kcal	
Sodium (mg/d)		3,062 ± 1,727	2,300 mg	

^aPharmacist Assisted Compliance Trial, Worcester Massachusetts, 2001 to 2003 (n = 555).

^bOf a maximum score of 80 points.

^cOf maximum of 10.

^dNDS = Nutrition Data System for Research software (version 4.05_33, 2002, Nutrition Coordinating Center, Minneapolis, MN).

^eAlternate Healthy Eating Index component score = 10 if no red meat consumed.

^fP/S = polyunsaturated fat/saturated fat.

Table 3Multivariable linear regression model for the Alternate Healthy Eating Index^a

	Coefficient	Standard error	P value^b
Smoking in the last 3 months at 1 year (referent: nonsmokers)	−6.06	1.64	0.0003
Highest education level (referent: high school)			
Less than high school	0.72	2.43	0.78
Higher than high school	3.22	1.37	0.02
Body mass index ^c category (referent: normal weight, <25)			
Overweight (25–29.9)	−2.26	1.87	0.23
Obese (≥30)	−3.94	1.84	0.03
% of calories from fat	−0.37	0.07	<0.0001
Total caloric intake	0.004	0.00	<0.0001

^aPharmacist Assisted Compliance Trial, Worcester Massachusetts, 2001 to 2003 (n = 367).^bP value < 0.05 is considered statistically significant.^cCalculated as kg/m².