Better Diet Quality and Decreased Mortality Among Myocardial Infarction Survivors

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**IMPORTANCE** Information about diet after myocardial infarction (MI) and mortality is limited, despite the growing number of MI survivors in the United States.

**OBJECTIVE** To examine the association of post-MI dietary quality and changes from pre- to post-MI with all-cause and cardiovascular mortality among MI survivors.

**DESIGN, SETTING, AND PARTICIPANTS** We included 2258 women from the Nurses’ Health Study and 1840 men from the Health Professionals Follow-up Study. Participants had survived an initial MI during the study follow-up period and completed the pre- and post-MI food frequency questionnaire. Diet quality was measured using Alternative Healthy Eating Index 2010 (AHEI2010), which consists of food and nutrients associated with the risk of chronic disease reported in the literature. We adjusted for medication use, medical history, and lifestyle risk factors using Cox proportional hazards regression models.

**MAIN OUTCOMES AND MEASURES** All-cause and cardiovascular mortality.

**RESULTS** During follow-up, we confirmed 682 all-cause deaths for women and 451 for men. The median survival time after the initial MI onset was 8.7 years for women and 9.0 years for men. When the results were pooled, the adjusted hazard ratio (HR) was 0.76 (95% CI, 0.60-0.96) for all-cause mortality and 0.73 (95% CI, 0.51-1.04) for cardiovascular mortality, comparing the extreme quintiles of post-MI AHEI2010. A greater increase in the AHEI2010 score from pre- to post-MI was significantly associated with lower all-cause mortality (pooled HR, 0.71; 95% CI, 0.56-0.91) and cardiovascular mortality (pooled HR, 0.60; 95% CI, 0.41-0.86), comparing the extreme quintiles. The adjusted HRs associated with post-MI AHEI2010 were 0.73 (95% CI, 0.58-0.93) for all-cause mortality and 0.81 (95% CI, 0.64-1.04) for cardiovascular mortality when the alcohol component was excluded.

**CONCLUSIONS AND RELEVANCE** Myocardial infarction survivors who consume a higher-quality diet, which has been associated with a lower risk of coronary heart disease in primary prevention, have lower subsequent all-cause mortality.


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Patients with coronary heart disease (CHD) have a substantially greater risk of cardiovascular events and death compared with the general population. Lifestyle changes in myocardial infarction (MI) survivors that include smoking cessation, regular physical activity, and dietary improvements may reduce mortality by 20% to 35%. In the United States, approximately 80,000 lives per year could be saved through optimizing secondary prevention strategies.

In epidemiologic studies and clinical trials, a Mediterranean-style diet was beneficial in primary and secondary prevention of CHD. Despite these potential benefits, patients report poor dietary quality 1 year after the initial MI. Worldwide, 43.4% of patients with CHD in high-income countries eat a healthy diet, and only 25.8% do so in low-income countries. Even though patients often receive information about a balanced diet, some perceive it as simply to “cut things out” of their diet. Likewise, the American College of Cardiology and American Heart Association updated their guidelines for clinicians on secondary prevention of MI in 2012, but continued to use diet recommendations from 2007 that focus on reducing saturated and trans fat intake and do not address unsaturated fats, the quality of carbohydrates, sugar-sweetened beverages, and red and processed meat. The traditional low-fat diet has failed to improve cardiovascular risk profiles and MI prognosis.

A composite score to reflect overall diet quality is easy for clinicians and dietitians to determine and communicate with patients. The Alternative Healthy Eating Index 2010 (AHEI2010) was defined a priori based on previous knowledge, through a comprehensive review of studies of foods and nutrients most consistently associated with lower chronic disease risk in recent literature. In the general population, a higher AHEI2010 score is associated with a 16% lower risk of chronic disease and a 23% lower risk of cardiovascular disease. The index includes 11 components, many of which are known to be associated with CHD risk among a healthy population: vegetables, fruits, nuts and legumes, red meat and processed meats, sugar-sweetened beverages, alcohol, polyunsaturated fat, trans fat, ω-3 fat (eicosapentaenoic acid and docosahexaenoic acid), whole grains, and sodium intake.

Long-term effects of overall diet quality among MI survivors are not well studied. Previous studies measured post-MI diet at only one point in time and could not assess changes in diet from pre- to post-MI. At an advanced stage of the atherosclerotic process, whether and, if so, to what degree dietary changes from pre- to post-MI improve prognosis is unclear. Two large prospective cohort studies, the Nurses’ Health Study and the Health Professionals Follow-up Study, have repeated dietary, lifestyle, and medication use measurements with long duration of follow-up. This provides a unique opportunity to investigate dietary changes from pre- to post-MI. We therefore examined post-MI AHEI2010 and changes in AHEI2010 from pre-to post-MI in relationship to all-cause and cardiovascular mortality.

Methods

Study Population

The Nurses’ Health Study is a prospective cohort of 121,700 registered female nurses, aged 30 to 55 years at baseline in 1976. The Health Professionals Follow-up Study is a prospective cohort of 51,529 US male health professionals, aged 40 to 75 years at baseline in 1986. Information on lifestyle and medical history was assessed through biennial questionnaires. This study was approved by the institutional review boards of Brigham and Women’s Hospital and the Harvard School of Public Health.

We included 2258 women and 1840 men who were free of cardiovascular disease, stroke, or cancer at the time of enrollment, survived a first MI during follow-up, and had no history of stroke at the time of initial MI onset. They all provided a pre-MI and at least 1 post-MI food frequency questionnaire (FFQ). The median time from initial MI onset to the first post-MI FFQ return date was 2 years.

Exposure Assessment

Diet was assessed using a validated FFQ every 4 years. Nutrient intake was calculated by multiplying the nutrient content for each food (obtained from the Harvard University Food Composition Database) by the frequency of consumption, and then summing across all food items. A valid FFQ was defined as reporting intake within a preset estimated caloric range (600-3500 kcal/d for women and 800-4200 kcal/d for men) and missing data on fewer than 70 food items.

Diet quality was measured using the AHEI2010 score, which was developed based on a comprehensive review of the relevant literature to determine scores for foods and nutrients most consistently associated with lower chronic disease risk a priori. The score for each of the 11 components ranged from 0 (worst) to 10 (best), and the total AHEI2010 score ranged from 0 (minimal adherence) to 110 (maximum adherence).

Identification of Incident MI

Medical records were reviewed by study physicians blinded to the participants’ exposure status. Myocardial infarction was defined based on symptoms plus either diagnostic electrocardiographic changes or elevated cardiac-specific enzyme levels.

Outcome Assessment

Our outcomes were all-cause and cardiovascular mortality. Deaths occurring during follow-up were identified from vital records, the National Death Index, reports by the participants’ next of kin, or the postal system. Cardiovascular mortality consisted of fatal CHD and fatal stroke confirmed through medical records review or autopsy reports.

Covariate Assessment

Covariates were chosen a priori based on subject knowledge. We considered medication use, medical history, and lifestyle factors previously associated with MI risk. All covariates were updated with each subsequent questionnaire cycle. We included only the key predictors of MI sur-
vival and confounders (>10% change in regression coefficients for main effects). Physical activity was measured using a self-administered questionnaire every 2 years. Time spent per week in each of the activities reported (walking, jogging, running, bicycling, lap swimming, tennis, squash or racquetball, and other aerobic exercise) and total metabolic-equivalent task hours per week were calculated. Questions on physical activity have been shown in previous studies26-28 to have good reproducibility and validity.

### Statistical Analysis

We defined the post-MI period as the time from the return of the first post-MI FFQ until death or the end of the study period (June 30, 2008). Dietary intake pre-MI was estimated from the most recent FFQ before initial MI onset. Dietary intake post-MI was modeled first as a simple time-varying exposure and then as a running cumulative average exposure of all post-MI FFQs. The cumulative average was calculated as the average of all available data post-MI up to the...
current questionnaire cycle. The results were similar between the simple time-varying post-MI diet and the cumulative average post-MI diet, so we used the former for simplicity.29 We defined change from pre-MI to post-MI as quintiles of the absolute difference of the AHEI2010 (post-MI AHEI2010 − pre-MI AHEI2010). We categorized AHEI2010 (post-MI and changes from pre- to post-MI) into quintiles. For missing covariate data, we used the value reported on the previous post-MI questionnaire.

A Cox proportional hazards regression model was used with times since the return of the first post-MI FFQ as the underlying time scale. For analyses of trends, we fit a continuous variable assigning each participant the median level of his or her respective quintile. We constructed adjusted survival curves using an inverse probability weighting method.30 To identify key components of the AHEI2010 associated with post-MI prognosis, we modeled the 11 individual components simultaneously. When assessing the association of changes in AHEI2010 from pre- to post-MI with mortality, we adjusted for changes in covariates from pre- to post-MI to better capture the fact that dietary changes and other healthy behaviors are correlated. We evaluated heterogeneity of hazard ratios (HRs) from men and women using Cochrane Q statistics and conducted a meta-analysis of the results using fixed-effect models.31,32

Moderate alcohol consumption is inversely associated with total mortality among MI survivors,33,34 but may not be an appropriate recommendation for some patients. We performed secondary analyses in which we removed the alcohol component to evaluate the contribution of a healthy diet independent of alcohol intake.

We evaluated whether the associations differed by lipid-lowering medication use, aspirin use, and age of the individual at the initial MI onset, using the likelihood ratio test. To avoid possible misclassification of diet pre- and post-MI, we further excluded FFQs returned within 12 months of initial MI onset (remaining sample size, 1689 men and 2059 women). In addition, physical activity level could be an indicator of underlying disease severity, and MI survivors may avoid certain activity because of symptoms. To reduce this potential bias, in sensitivity analysis, we adjusted for physical activity level pre-MI, with a 2-year lag for post-MI physical activity level, and also after further excluding participants in the lowest quintile of physical activity.

We did not have information about acute characteristics of the index MI in women, but we collected this information from hospital discharge records for men. We compared the results in men with and without adjusting for heart failure, left-ventricular ejection fraction, acute therapy received during hospitalization, and self-reported β-blocker medication in the sensitivity analyses. We tested for proportional hazard assumption by adding an interaction term between the AHEI2010 score and time since enrollment in the study, and used the likelihood ratio test to determine significance.

### Table 1. Age-Standardized Baseline Characteristics of 2258 Post-MI Women in the Nurses’ Health Study and 1840 Post-MI Men in the Health Professionals Follow-up Study by Quintiles of AHEI2010* (continued)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Women</th>
<th></th>
<th></th>
<th>Men</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Changes in physical activity, MET h/wk</td>
<td>Q1</td>
<td>Q3</td>
<td>Q5</td>
<td>Q1</td>
<td>Q3</td>
<td>Q5</td>
</tr>
<tr>
<td>Changes in smoking status</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% of current smokers pre-MI (1-14 cigarettes/d) who quit post-MI</td>
<td>29</td>
<td>30</td>
<td>26</td>
<td>36</td>
<td>42</td>
<td>49</td>
</tr>
<tr>
<td>% of current smokers pre-MI (≥15 cigarettes/d) who quit post-MI</td>
<td>71</td>
<td>70</td>
<td>74</td>
<td>64</td>
<td>58</td>
<td>51</td>
</tr>
<tr>
<td>Changes in aspirin use, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never user</td>
<td>27</td>
<td>27</td>
<td>30</td>
<td>13</td>
<td>12</td>
<td>11</td>
</tr>
<tr>
<td>New user</td>
<td>28</td>
<td>29</td>
<td>28</td>
<td>41</td>
<td>46</td>
<td>42</td>
</tr>
<tr>
<td>New quitter</td>
<td>14</td>
<td>11</td>
<td>12</td>
<td>5</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Always user</td>
<td>31</td>
<td>33</td>
<td>30</td>
<td>41</td>
<td>38</td>
<td>40</td>
</tr>
<tr>
<td>Changes in lipid-lowering medication use, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never user</td>
<td>45</td>
<td>41</td>
<td>41</td>
<td>54</td>
<td>51</td>
<td>45</td>
</tr>
<tr>
<td>New user</td>
<td>38</td>
<td>41</td>
<td>44</td>
<td>37</td>
<td>36</td>
<td>44</td>
</tr>
<tr>
<td>New quitter</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Always user</td>
<td>16</td>
<td>17</td>
<td>15</td>
<td>8</td>
<td>12</td>
<td>10</td>
</tr>
</tbody>
</table>

Abbreviations. AHEI2010, Alternative Healthy Eating Index 2010; BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); CABG, coronary artery bypass graft; MET, metabolic-equivalent task; MI, myocardial infarction; PMH, postmenopausal hormone; Q, quintile.

* Values were standardized to the age distribution of the study population.
* Age and changes in smoking status were not age-standardized.
* Change of diet from pre- to post-MI was calculated as: change = (post-MI diet − pre-MI diet).
* Changes in covariates from pre- to post-MI periods were standardized according to the age distribution of the study population and by quintiles of changes of AHEI2010 from pre- to post-MI.

Diet Quality and Mortality Among MI Survivors

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Results

During follow-up, we confirmed 682 all-cause deaths and 336 cardiovascular deaths for women, and 451 all-cause deaths and 222 cardiovascular deaths for men. Participants on average improved diet quality from pre- to post-MI, with a greater increase of the AHEI2010 score in men (median change, 5.5) compared with women (median change, 2.1) (Table 1). For both men and women, the greatest improvement of diet quality from pre- to post-MI was an increase in whole grain intake and a reduction in consumption of trans fat and red and processed meat. The lowest score for a diet component in the post-MI period was sugar-sweetened beverage consumption (Figure 1). The median survival time after initial MI onset was 8.7 years for women and 9.0 years for men.

Post-MI Diet Quality and Prognosis

Comparing the highest vs lowest quintiles, the AHEI2010 score was highly significantly associated with lower all-cause mortality in women (HR, 0.66; 95% CI, 0.49-0.88; P < .001 for trend) (Table 2) but not in men (HR, 0.98; 95% CI, 0.66-1.44; P = .72 for trend). After pooling of the results from men and women (P = .11 for heterogeneity), overall, the AHEI2010 score was inversely associated with all-cause mortality (pooled HR, 0.76; 95% CI, 0.60-0.96; P = .02 for trend, for the fifth vs first quintile). Physical activity appeared to be the strongest confounder for men and women. During the post-MI period, MI survivors who were in the fifth quintile of the AHEI2010 had a better prognosis (P < .001) compared with those in the first quintile for men and women (Figure 2). Higher whole grain consumption (P < .001) was associated with better post-MI survival in women; for men, none of the individual components alone was associated with all-cause mortality.

The AHEI2010 score was marginally significantly inversely associated with cardiovascular mortality (pooled HR between extreme quintiles of post-MI diet quality, 0.73; 95% CI, 0.51-1.04; P = .08 for trend). The post-MI AHEI2010 score was associated with lower cardiovascular mortality for women (P = .03 for trend), with whole grain consumption (P = .002) being the strongest individual contributor to post-MI survival; the post-MI AHEI2010 score was not associated with lower cardiovascular mortality for men (P = .84 trend) (Table 2) and none of the 11 individual components was significant.

Change in Diet Quality and Prognosis

The Spearman correlation coefficients between pre- and post-MI AHEI2010 scores were 0.49 for women and 0.56 for men. A greater increase in the AHEI2010 score from pre- to post-MI was significantly associated with lower all-cause and cardiovascular mortality (Table 3).
Secondary Analyses

After the alcohol component was removed, the pooled HR for all-cause mortality was 0.73 (95% CI, 0.58-0.93; \( P = .01 \) for trend, comparing extreme quintiles). An association with changes from pre- to post-MI was attenuated but remained inverse (pooled HR, 0.81; 95% CI, 0.64-1.04; \( P = .12 \) for trend for all-cause mortality comparing extreme quintiles) (eTable in the Supplement). Associations with cardiovascular mortality were attenuated without the alcohol component in the AHEI2010 score (eTable in the Supplement).

Results were similar after FFQs returned within 12 months of the initial MI were excluded. We adjusted for physical activity level pre-MI, included a 2-year lag after the first post-MI dietary assessment, and excluded participants in the lowest quintile of physical activity; in these analyses we found similar, albeit slightly stronger, inverse associations for the basic model-adjusted HR (95% CI) \( = .08 \) for trend, \( P = .11 \).
AHEI2010 with all-cause mortality. Results were very similar after further adjustment for β-blocker use, antihypertensive medication use, and clinical characteristics. We did not observe a significant effect modification by use of lipid-lowering medication, aspirin, or age at initial MI onset (data not shown). No significant violation of proportional hazard assumption was detected.

**Discussion**

In our prospective study of diet quality among MI survivors, we found that the AHEI2010 score post-MI was associated with 24% lower all-cause mortality and 26% lower cardiovascular mortality, comparing extreme quintiles. Greater improvement of diet quality would be expected to result in better long-term survival.
quality from pre- to post-MI was associated with 30% lower all-cause mortality and 40% lower cardiovascular mortality. Sugar-sweetened beverages and fruit juice had the lowest component score on the post-MI diet. In addition to reducing saturated

Table 3. Multivariate-Adjusted HRs for All-Cause and Cardiovascular Mortality According to Changes From Pre- to Post-MI Period of AHEI2010

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Quintile</th>
<th>P Value for Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All-Cause Mortality</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women (n = 502)a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of cases</td>
<td>133</td>
<td>98</td>
</tr>
<tr>
<td>Person-years</td>
<td>3368</td>
<td>3359</td>
</tr>
<tr>
<td>Change in AHEI2010 score, median (range)</td>
<td>-9.64 (-34.48 to -4.99)</td>
<td>-1.95 (-4.99 to 0.62)</td>
</tr>
<tr>
<td>Basic model-adjusted HR (95% CI)a</td>
<td>1</td>
<td>0.84 (0.64 to 1.10)</td>
</tr>
<tr>
<td>Multivariate-adjusted HR (95% CI)b</td>
<td>1</td>
<td>0.83 (0.63 to 1.11)</td>
</tr>
<tr>
<td>Men (n = 451)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of cases</td>
<td>114</td>
<td>110</td>
</tr>
<tr>
<td>Person-years</td>
<td>3202</td>
<td>3216</td>
</tr>
<tr>
<td>Change in AHEI2010 score, median (range)</td>
<td>-8.12 (-40.31 to -3.71)</td>
<td>-0.7 (-3.70 to 2.08)</td>
</tr>
<tr>
<td>Basic model-adjusted HR (95% CI)a</td>
<td>1</td>
<td>0.96 (0.72 to 1.28)</td>
</tr>
<tr>
<td>Multivariate-adjusted HR (95% CI)b</td>
<td>1</td>
<td>0.93 (0.69 to 1.25)</td>
</tr>
<tr>
<td><strong>Cardiovascular Mortality</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women (n = 232)b</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of cases</td>
<td>59</td>
<td>47</td>
</tr>
<tr>
<td>Person-years</td>
<td>3368</td>
<td>3359</td>
</tr>
<tr>
<td>Change in AHEI2010 score, median (range)</td>
<td>-9.64 (-34.48 to -4.99)</td>
<td>-1.95 (-4.99 to 0.62)</td>
</tr>
<tr>
<td>Basic model-adjusted HR (95% CI)a</td>
<td>1</td>
<td>0.88 (0.59 to 1.31)</td>
</tr>
<tr>
<td>Multivariate-adjusted HR (95% CI)b</td>
<td>1</td>
<td>0.96 (0.63 to 1.46)</td>
</tr>
<tr>
<td>Men (n = 222)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of cases</td>
<td>56</td>
<td>49</td>
</tr>
<tr>
<td>Person-years</td>
<td>3202</td>
<td>3216</td>
</tr>
<tr>
<td>Median change (range) in AHEI2010 score</td>
<td>-8.12 (-40.31 to -3.71)</td>
<td>-0.7 (-3.70 to 2.08)</td>
</tr>
<tr>
<td>Basic model-adjusted HR (95% CI)a</td>
<td>1</td>
<td>0.95 (0.64 to 1.41)</td>
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<tr>
<td>Multivariate-adjusted HR (95% CI)b</td>
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<td>0.89 (0.58 to 1.35)</td>
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<tr>
<td><strong>Pooled</strong></td>
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<td></td>
</tr>
<tr>
<td>Multivariate-adjusted HR (95% CI)</td>
<td>1</td>
<td>0.88 (0.72 to 1.08)</td>
</tr>
</tbody>
</table>

Abbreviations: AHEI2010, Alternative Healthy Eating Index 2010; HR, hazard ratio; MI, myocardial infarction.

*Adjusted for time since MI onset, age at diagnosis (continuous), and calendar year (questionnaire cycle, continuous, 2-year period).

†Additionally adjusted for aspirin use (never user, new user, always user), diabetes mellitus (no diabetes, new diabetes, always diabetes), hypertension (no hypertension, new hypertension, always hypertension), lipid-lowering medication use (never user, new user, always user), married (never married, always married, not married anymore), coronary artery bypass (CABG) surgery (never CABG, always CABG, new CABG), changes in smoking status (always never smoker, always current smoker 1-15 cigarettes/d post-MI period, always current smoker ≥15 cigarettes/d pre-MI period), quit smoking after MI 1-15 cigarettes/d pre-MI period, and pre-MI AHEI2010 diet score (quintiles). For women, additionally adjusted for changes in total caloric intake (quintiles of kilocalories), changes in physical activity (quintiles of changes in metabolic equivalents/wk), changes in body mass index (quintiles of changes in metabolic equivalents/wk), WHI estrogen (tertiles of changes in WHI estrogen), and WHI progesterone (tertiles of changes in WHI progesterone). For men, additionally adjusted for changes in total caloric intake (tertiles of kilocalories), changes in physical activity (tertiles of changes in metabolic equivalents/wk), changes in body mass index (tertiles of changes in metabolic equivalents/wk), changes in WHI estrogen (tertiles of changes in WHI estrogen), and WHI progesterone (tertiles of changes in WHI progesterone). For women, additionally adjusted for changes in total caloric intake (quintiles of kilocalories), changes in physical activity (quintiles of changes in metabolic equivalents/wk), changes in body mass index (quintiles of changes, calculated as weight in kilograms divided by height in meters squared), and postmenopausal hormone use status (simple updated, premenopause, postmenopausal hormone never user, postmenopausal hormone current user, postmenopausal hormone past user). For men, additional adjusted for changes in total caloric intake (tertiles of kilocalories), changes in physical activity (tertiles of changes in metabolic equivalents/wk), changes in body mass index (tertiles of changes, calculated as weight in kilograms divided by height in meters squared), and postmenopausal hormone use status (simple updated, premenopause, postmenopausal hormone never user, postmenopausal hormone current user, postmenopausal hormone past user).

‡AHEI2010 was calculated since 1984 in the Nurses’ Health Study. Therefore, participants who had initial MI before 1984 have pre-MI AHEI2010 missing and changes from pre- to post-MI missing.

§Fixed-effect model for heterogeneity, P = .31.

Fixed-effect model for heterogeneity, P = .66.
Heart Study reported a 70% reduction in CHD deaths among MI survivors randomized to a Mediterranean-type diet, which was rich in fruit, vegetables, and a-linolenic acid.7,35 The trial was stopped after a mean of 4 years because of the significant difference in recurrence rates.7,35 Additionally, the association between a modified Mediterranean diet and post-MI survival was evaluated in 2 prospective cohort studies, which reported a 27% lower all-cause mortality and 31% lower cardiovascular mortality in Greece,6 and 18% lower all-cause mortality in a European study (per 2-unit increment based on a 10-unit Mediterranean diet score).3 Dehghan et al36 reported that a higher score for diet quality was associated with a 35% reduction of cardiovascular death among participants with cardiovascular disease. However, this study reported limited details about many aspects of diet, and information on specific fatty acids including trans isomers was unavailable. Most importantly, previous studies did not include dietary information both before and after MI. Finally, the median follow-up time in these studies was relatively short (3.78 years, 6.7 years, and 4.6 years46).

Nevertheless, the results from our study are consistent with those from the Lyon Diet-Heart Study and previous observational studies. The AHEI2010 shares some components with the Mediterranean diet but has the specific components more relevant to Western diets, such as trans fat, sugar-sweetened beverages, and red and processed meat. The stronger association of the AHEI2010 score with all-cause and cardiovascular mortality than those for individual components suggests that the AHEI2010 captures the synergistic or interactive effects of dietary components. To our knowledge, our study provides the first evidence that a substantial improvement in diet quality from pre- to post-MI is markedly associated with significantly lower all-cause and cardiovascular mortality.

The development of atherosclerotic disease is complicated and likely has origins in lipids, inflammation, coagulation, and endothelial reactivity.37-41 Although not all of the mechanisms are fully understood, it is likely that many of the underlying biological pathways are similar in the pre- and post-MI periods. Consumption of a Mediterranean-style diet improved endothelial function and reduced systemic inflammation markers among patients with metabolic syndrome.42-43 Panagiotakos et al44 found that among post-MI patients in various European countries, higher adherence to a Mediterranean diet was independently associated with lower levels of C-reactive protein and interleukin 6. The PREDIMED (Prevención con Dieta Mediterránea) study, thus far the largest clinical trial investigating the effects of the Mediterranean diet for CHD primary prevention,44,45,46 showed that among participants at high cardiovascular risk, those who followed a Mediterranean diet supplemented with extra-virgin olive oil or nuts had a reduced incidence of major cardiovascular events, better lipid profiles, better antioxidant capacity, lower insulin resistance, lower inflammatory markers, and lower blood pressure.4,46

We found that the association between post-MI diet quality and changes from pre- to post-MI with mortality were stronger for women than for men, which is different from previous studies of diet and primary prevention of CHD from these 2 cohorts.15,47 Although the difference in heterogeneity between sexes was not significant, the weaker results among men may be the result of a limited number of events in the extreme categories. The observed sex difference for diet in secondary prevention also could be the result of a greater case fatality rate among women.48-50 as well as differences in MI development and progression.51,52 Clinical presentation, or initial management and prognosis.53 Younger women have a lower risk of MI but worse short- and long-term prognosis after MI onset compared with men or older women.48 Men usually have more advanced and worse composition of coronary atherosclerotic plaques, more plaque vulnerability, and extensive coronary calcium compared with women.51,52 Overall, our study found a sex difference for diet among MI survivors. Future studies are needed to investigate this difference to confirm the results.

In our study of men, the association between change in the AHEI2010 score from pre- to post-MI period and all-cause and cardiovascular mortality was attenuated after the alcohol component was removed. This is consistent with a previous finding33 from this cohort that moderate alcohol intake is an important contributor to the AHEI score and is associated with lower all-cause and cardiovascular mortality post-MI.

Our study has several limitations. The validity and reproducibility of the AHEI2010 as assessed by our FFQ are unknown among patients post-MI. However, the components of the AHEI2010 have been validated in previous studies19,21,51,55 and it is highly likely that the AHEI2010 has a high degree of validity and reproducibility for our study populations. Even though we adjusted for major confounders, residual and unmeasured confounding may affect results. For example, we do not have detailed information on medication adherence or underlying severity of the disease, although these are unlikely to be strongly associated with the AHEI2010 score. Physical activity level may be an indication of underlying disease severity. In sensitivity analyses, we adjusted for activity level pre-MI, included a 2-year lag for post-MI reporting of physical activity, and further excluded participants in the lowest quintile of physical activity to reduce this potential bias. The inverse association between AHEI2010 score and mortality became stronger, although the qualitative conclusions remained the same. Finally, our cohorts consisted of female and male health professionals; thus, substantial unmeasured confounding by socioeconomic status is unlikely to explain our results. Although similar socioeconomic status among participants is a strength of our findings, we recognize that our results are not necessarily generalizable to all post-MI patients. In addition, our study population was mainly non-Hispanic white, which might limit generalizability of our results to other ethnic populations. Further studies in other ethnicities and, in particular, with greater numbers of men are necessary to confirm our findings.

In our study, diet was assessed using a self-reported FFQ, which has modest measurement error. However, our diet information was collected prospectively, and thus any error is likely to be nondifferential with respect to mortality. We modeled the AHEI2010 using both simple-updated and cumulative average and the results were similar. We were concerned that FFQs returned within 1 year post-MI may not reflect the participants’ post-MI diet accurately, because the time frame...
bridged the pre- and post-MI periods. However, the results were similar after exclusion of post-MI FFQs that were returned within 1 year of the initial MI onset.

We did not have enough power to examine associations between post-MI AHEI2010 score or changes from pre- to post-MI among patients with specific clinical characteristics. Ma et al.² reported lower adherence to a healthy diet among smokers and more obese patients. Studies regarding targeted or personalized dietary recommendations for post-MI patients are needed. The use of lipid-lowering medication may reduce patients’ efforts at dietary control,⁸ and few studies have investigated the interaction between diet and medication. We did not observe a significant interaction between the post-MI AHEI2010 score and use of lipid-lowering medication, although we had limited power to explore this issue in detail.

In conclusion, our results suggest that post-MI patients who consume a higher quality diet have lower all-cause mortality. Greater improvements from the pre- to post-MI period were strongly associated with lower all-cause and cardiovascular mortality. Further studies on the effects of dietary changes from pre- to post-MI are needed because of the direct clinical relevance of our findings. Dietary recommendations for secondary prevention need to place more emphasis on polyunsaturated fat intake and reduced consumption of sugar-sweetened beverages and fruit juice.

REFERENCES


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