Effects of a Dietary Portfolio of Cholesterol-Lowering Foods vs Lovastatin on Serum Lipids and C-Reactive Protein

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Most dietary manipulations result in modest cholesterol reductions of 4% to 13%,1-10 and diet has been considered by some as a relatively ineffective therapy.11 In contrast, 3-hydroxy-3-methylglutaryl coenzyme A reductase inhibitors (statins) repeatedly have been shown to reduce mean serum low-density lipoprotein cholesterol (LDL-C) concentrations by 28% to 35% in long-term trials,12-14 with corresponding reductions in cardiovascular death of 23% to 32% in both primary and secondary prevention trials.13,14 Recently, to boost effectiveness of diet for primary prevention of cardiovascular disease, the Adult Treatment Panel (ATP III) of the National Cholesterol Education Program has recommended addition of plant sterols (2 g/d) and viscous fibers (10-25 g/d) to the diet.15 The American Heart Association has also drawn atten-

Context To enhance the effectiveness of diet in lowering cholesterol, recommendations of the Adult Treatment Panel III of the National Cholesterol Education Program emphasize diets low in saturated fat together with plant sterols and viscous fibers, and the American Heart Association supports the use of soy protein and nuts.

Objective To determine whether a diet containing all of these recommended food components leads to cholesterol reduction comparable with that of 3-hydroxy-3-methylglutaryl coenzyme A reductase inhibitors (statins).

Design Randomized controlled trial conducted between October and December 2002.

Setting and Participants Forty-six healthy, hyperlipidemic adults (25 men and 21 postmenopausal women) with a mean (SE) age of 59 (1) years and body mass index of 27.6 (0.5), recruited from a Canadian hospital-affiliated nutrition research center and the community.

Interventions Participants were randomly assigned to undergo 1 of 3 interventions on an outpatient basis for 1 month: a diet very low in saturated fat, based on milled whole-wheat cereals and low-fat dairy foods (n=16; control); the same diet plus lovastatin, 20 mg/d (n=14); or a diet high in plant sterols (1.0 g/1000 kcal), soy protein (21.4 g/1000 kcal), viscous fibers (9.8 g/1000 kcal), and almonds (14 g/1000 kcal) (n=16; dietary portfolio).

Main Outcome Measures Lipid and C-reactive protein levels, obtained from fasting blood samples; blood pressure; and body weight; measured at weeks 0, 2, and 4 and compared among the 3 treatment groups.

Results The control, statin, and dietary portfolio groups had mean (SE) decreases in low-density lipoprotein cholesterol of 8.0% (2.1%) (**P**<.001), 30.9% (3.6%) (**P**<.001), and 28.6% (3.2%) (**P**<.001), respectively. Respective reductions in C-reactive protein were 10.0% (8.6%) (**P**=.27), 33.3% (8.3%) (**P**=.002), and 28.2% (10.8%) (**P**=.02). The significant reductions in the statin and dietary portfolio groups were all significantly different from changes in the control group. There were no significant differences in efficacy between the statin and dietary portfolio treatments.

Conclusion In this study, diversifying cholesterol-lowering components in the same dietary portfolio increased the effectiveness of diet as a treatment of hypercholesterolemia.

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In turn, the US Food and Drug Administration now permits health claims for coronary heart disease (CHD) risk reduction, based on cholesterol lowering, for foods delivering adequate amounts of plant sterols, viscous fibers (oat β-glucan and psyllium), and soy protein, and a health claim for nuts is being considered. Despite the large potential for cholesterol reduction, this dietary combination has never been compared directly with a statin. To assess the effectiveness of this dietary portfolio approach, we therefore studied a group of hyperlipidemic adults who were randomized to 1 of 3 treatments: the combination dietary portfolio, a diet lacking the additional active dietary ingredients but with a similar very low-saturated-fat content (control), or the same low-saturated-fat diet with addition of a statin.

**METHODS**

**Participants**

Fifty-five participants were recruited from hyperlipidemic patients attending the Clinical Nutrition and Risk Factor Modification Center at St Michael’s Hospital, Toronto, Ontario, and from newspaper advertisements. Postmenopausal women were recruited because of the increase in LDL-C and CHD risk in women in this age group and to avoid possible fluctuations in blood lipids related to the menstrual cycle. All participants were reluctant to take statins and wished to determine the relative effectiveness of diet. Four participants who were randomized did not start the study. Additionally, 3 withdrew during the first study week because of family ill health, job relocation, or time commitment required by the metabolic diet, and 2 were withdrawn because of either a transient elevation of liver enzymes or symptoms of muscle discomfort (FIGURE 1). Forty-six healthy, hyperlipidemic participants completed the study (25 men and 21 postmenopausal women); the mean (SE) age was 59 (1) years (range, 36-85 years) and mean (SE) body mass index (calculated as weight in kilograms divided by the square of height in meters) was 27.6 (0.5) (range, 20.5-35.5) (TABLE 1). All participants had previously high LDL-C levels (>158 mg/dL [>4.1 mmol/L]). No participants had a history of cardiovascular disease, untreated hypertension (blood pressure >140/90 mm Hg), diabetes, or renal or liver disease, and none were taking medications known to influence serum lipids apart from 3 women who were taking stable doses of thyroxine, 1 of whom was also taking estrogen therapy. Twenty-one participants had started statins and had discontinued them at least 2 weeks prior to the study (9 control participants, 7 dietary portfolio participants, and 5 statin participants). Five participants were taking antihypertensive medications at a constant dose prior to and during the study. The majority (n=26) were taking vitamin preparations. Other, more commonly used nonprescription drugs and supplements taken throughout the study period included aspirin and anti-inflammatory drugs (n=5), calcium (n=8), glucosamine (n=3), grapeseed oil (n=2), saw palmetto (n=2), garlic (n=2), and magnesium (n=2).

**Study Protocol**

The study followed a randomized parallel design and was carried out between October and December 2002. Participants followed their own low-saturated-fat therapeutic diets for 1 month prior to the start of the study. They were then stratified based on sex and pretreatment LDL-C level and were randomized to a very low-saturated-fat dairy and whole-grain cereal diet either with or without a statin or a diet containing viscous fibers, plant sterols, soy foods, and almonds. Each treatment lasted for 1 month. All foods were provided except for fresh fruits and vegetables. Body weight was measured weekly and blood samples were obtained after 12-hour overnight fasting at 2-week intervals. On each clinic visit, blood pressure was measured twice in the nondominant arm using a mercury sphygmomanometer by the same observer. Seven-day diet histories were obtained for the week prior to the 1-month treatment period. Completed menu checklists were returned at weekly intervals during the 4-week diet period and checked by dietitians, who also recorded the participants’ previous week’s exercise and ensured that it was constant over the course of the study period.

At weekly intervals, participants recorded their overall feeling of satiety using a 9-point bipolar semantic scale in which −4 was excessively hungry, 0 was neutral, and +4 was discomfort due to excess food intake.
Participants were randomized by the statistician using a random number generator and SAS version 6.12 software (SAS Institute Inc, Cary, NC) in a separate location from the clinic. The statistician held the code for the placebo and statin tablets provided with the control and statin diets, respectively. This aspect of the study was therefore double-blind. The dietitians were not blinded to the diet because they were responsible for patients' diets and for checking diet records. The laboratory staff responsible for analyses were blinded to treatment and received samples labeled with name codes and dates.

The study was approved by the ethics committees of the University of Toronto and St Michael's Hospital. Written informed consent was obtained from all participants.

**Diets**

The diets eaten before the 4-week study were the participants' routine therapeutic low-fat diets, which were similar to current National Cholesterol Education Program guidelines (<7% energy from saturated fat and <200 mg/d of dietary cholesterol) and previously referred to as a Step II diet (Table 2).

During the 4-week study period, weight-maintaining diets were provided based on estimated caloric requirements using foods available in supermarkets and health food stores. All diets were vegetarian. The aim of the dietary portfolio was to provide 1.0 g of plant sterols per 1000 kcal of diet in a plant sterol ester–enriched margarine; 9.8 g of viscous fibers per 1000 kcal of diet from oats, barley, and psyllium; 21.4 g of soy protein per 1000 kcal as soy milk and soy meat analogs; and 14 g of whole almonds per 1000 kcal of diet. Emphasis was placed on eggplant and okra as additional sources of viscous fiber (0.2 g/1000 kcal and 0.4 g/1000 kcal, respectively). Thus, 200 g of eggplant and 100 g of okra were prescribed to be eaten as part of a 2000-kcal diet on alternate days. Eggs (1/wk) and butter (9 g/d) were also provided in the dietary portfolio to balance the saturated fat and dietary cholesterol in the control diet. This di-
dietary portfolio has been described in
detail previously.\textsuperscript{22}

The control diet used skim milk, fat-
free cheese and yogurt, and egg substi-
tute and liquid egg white to achieve low
intake of saturated fat. High fiber in-
take was obtained by use of whole-
grain breakfast cereals (fiber, 2.5 g/1000
kcal of diet) and bread (fiber, 2.0 g/1000
kcal of diet) made from 100% whole-
wheat flour and wheat bran added to a
high-dairy-protein muffin (fiber, 7.3
g/1000 kcal of diet). This diet therefore
lacked sources of viscous fibers, plant ster-
ols, and almonds. Skim-milk products
replaced the soy and vegetable protein
foods consumed as part of the dietary
portfolio, and high monounsaturated
sunflower oil (9 g/1000 kcal) and saf-
flower oil (5 g/1000 kcal) were incorpo-
rated into the control diet (eg, muffins)
to balance the fatty acid profile of the di-
etary portfolio. The macronutrient pro-
file of the diets recorded as consumed in
week 4 is shown in Table 3. Typical
1-day menus for the control diet and di-
etary portfolio are shown in Table 4.

Participants were provided with self-
taring electronic scales (Salter House-
wares, Kent, England) and asked to
take returning food items. Compliance
was assessed from the completed weekly
checklists and from the return of uneaten
food items.

| Table 3. Nutritional Profiles of Diets Provided and Recorded as Eaten at Week 4 |
|---------------------------------|-----------------|-----------------|-----------------|
|                                | Control (n = 16) | Statin (n = 14) | Dietary Portfolio (n = 16) |
| Energy, kcal/d                 | 2421            | 2519            | 2385            |
| Total protein                  | 134 (22.2)      | 131 (21.0)      | 128 (21.7)      |
| Vegetable protein              | 26 (4.4)        | 28 (4.4)        | 127 (21.3)      |
| Available carbohydrate         | 319 (52.8)      | 340 (53.8)      | 286 (48.0)      |
| Total dietary fiber (g/1000 kcal) | 57 (23.4)   | 57 (22.9)       | 78 (33.1)       |
| Total fat                      | 67 (24.6)       | 70 (24.9)       | 80 (30.0)       |
| Saturated fatty acids          | 12 (4.5)        | 13 (4.6)        | 17 (6.3)        |
| Monounsaturated fatty acids    | 28 (10.3)       | 28 (10.0)       | 34 (12.7)       |
| Polyunsaturated fatty acids    | 23 (8.4)        | 26 (9.2)        | 27 (10.1)       |
| Dietary cholesterol, mg/d (mg/1000 kcal) | 28 (11.8) | 31 (12.4)       | 54 (22.6)       |
| Alcohol                        | 0.3 (0.1)       | 0.24 mmol/L     | 0.4 (0.1)       |

*Data are expressed as mean grams per day (percentage of calories) unless otherwise noted.

Analyses
All samples from a given individual were
labeled by code and analyzed in the same
batch. Serum was analyzed according to
the Lipid Research Clinics protocol\textsuperscript{23} for
total cholesterol, triglycerides, and high-
density lipoprotein cholesterol (HDL-C)
after dextran sulphate–magnesium chlo-
ride precipitation.\textsuperscript{24} Low-density lip-
protein cholesterol was calculated.\textsuperscript{25} Se-
rum apolipoprotein A1 and B were
measured by nephelometry (intra-
assay coefficient of variation, 2.2% and
1.9%, respectively).\textsuperscript{26} Serum samples,
stored at −70°C, were analyzed for C-
reactive protein by end-point nephelo-
metry (coefficient of variation, 3.5%) (Be-
hring BN-100, N high-sensitivity
C-reactive protein reagent, Dade-
Behring, Mississauga, Ontario).

Dietary intake was analyzed using a pro-
gram based on US Department of Ag-
riculture data and developed in our
laboratory to allow addition of data on
foods relevant to ongoing studies after
analysis in the laboratory for protein,
total fat, and dietary fiber using Ameri-
can Organization of Analytical Chem-
ists methods and fatty acids by gas chro-
matography.\textsuperscript{22} More than half of the
foods used in the diets had been ana-
lyzed in the laboratory.

Statistical Analysis
Results were calculated as mean (SE).
The mean differences in blood lipid val-
ues between week 2 and week 4 were not
greater than 9.3 mg/dL (±0.24 mmol/L)

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EFFECT OF A DIETARY PORTFOLIO VS LOVASTATIN

Double-fruit jam Oat bran bread Fat-free vanilla yogurt Sugar and psyllium Strawberries Strawberries Skim milk Soy beverage Raisin bran cereal Hot oat bran cereal Egg omelette (egg white, egg substitute, light margarine, Soy beverage Bran muffin Almonds Fresh fruit Fresh fruit Light margarine Soy beverage Fresh fruit Italian noodle soup with vegetables Spicy black bean soup Sandwich (grilled fat-free cheese, whole-wheat bread, light margarine) Sandwich (soy deli slices, oat bran bread, enriched margarine†, lettuce, tomato, cucumber) Salad (mixed greens and lettuce, tomato, cucumber, oil and vinegar dressing) Snack† Bran muffin Almonds Light margarine Soy beverage Fresh fruit Fresh fruit Breakfast Dinner

†Snacks could be eaten with meals if desired. †Margarine was enriched with plant sterols.

Table 4. Representative Diets Followed in Control/Statin and Dietary Portfolio Treatment Groups

<table>
<thead>
<tr>
<th>Control/Statin</th>
<th>Dietary Portfolio</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Breakfast</strong></td>
<td></td>
</tr>
<tr>
<td>Raisin bran cereal</td>
<td>Hot oat bran cereal</td>
</tr>
<tr>
<td>Skim milk</td>
<td>Soy beverage</td>
</tr>
<tr>
<td>Strawberries</td>
<td>Strawberries</td>
</tr>
<tr>
<td>Fat-free vanilla yogurt</td>
<td>Sugar and psyllium</td>
</tr>
<tr>
<td>Double-fruit jam</td>
<td>Oat bran bread</td>
</tr>
<tr>
<td></td>
<td>Enriched margarine†</td>
</tr>
<tr>
<td>Snack†</td>
<td></td>
</tr>
<tr>
<td>Bran muffin</td>
<td>Almonds</td>
</tr>
<tr>
<td>Light margarine</td>
<td>Soy beverage</td>
</tr>
<tr>
<td>Fresh fruit</td>
<td>Fresh fruit</td>
</tr>
<tr>
<td>Italian noodle soup</td>
<td>Spicy black bean soup</td>
</tr>
<tr>
<td>with vegetables</td>
<td></td>
</tr>
<tr>
<td>Lunch</td>
<td></td>
</tr>
<tr>
<td>Sandwich (grilled fat-</td>
<td>Sandwich (soy deli slices</td>
</tr>
<tr>
<td>free cheese, whole-</td>
<td>, oat bran bread,</td>
</tr>
<tr>
<td>wheat bread, light</td>
<td>enriched margarine†,</td>
</tr>
<tr>
<td>margarine)</td>
<td>lettuce, tomato,</td>
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<tr>
<td></td>
<td>cucumber)</td>
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<tr>
<td>Salad (mixed greens and</td>
<td></td>
</tr>
<tr>
<td>lettuce, tomato,</td>
<td></td>
</tr>
<tr>
<td>cucumber, oil and vinegar dressing)</td>
<td></td>
</tr>
<tr>
<td>Snack†</td>
<td></td>
</tr>
<tr>
<td>Bran muffin</td>
<td>Almonds</td>
</tr>
<tr>
<td>Light margarine</td>
<td>Psyllium</td>
</tr>
<tr>
<td>Fresh fruit</td>
<td>Fresh fruit</td>
</tr>
<tr>
<td>Dinner</td>
<td></td>
</tr>
<tr>
<td>Egg omelette (egg white,</td>
<td>Tofu bake with ratatouille</td>
</tr>
<tr>
<td>egg substitute, fat-free</td>
<td>(firm tofu, eggplant,</td>
</tr>
<tr>
<td>cheese, green peppers,</td>
<td>onions, sweet peppers)</td>
</tr>
<tr>
<td>onions, safflower oil)</td>
<td></td>
</tr>
<tr>
<td>Pasta primavera</td>
<td>Pearl barley</td>
</tr>
<tr>
<td>Vegetables (eg, broccoli,</td>
<td>Vegetables (eg, broccoli,</td>
</tr>
<tr>
<td>cauliflower)</td>
<td>cauliflower)</td>
</tr>
<tr>
<td>Snack†</td>
<td></td>
</tr>
<tr>
<td>Fresh fruit</td>
<td>Fresh fruit</td>
</tr>
<tr>
<td>Skim milk</td>
<td>Psyllium</td>
</tr>
<tr>
<td>Soy beverage</td>
<td></td>
</tr>
</tbody>
</table>

Blood Lipids and C-Reactive Protein

No differences were observed among the 3 treatment groups in baseline blood measurements. In the control group, percentage changes from baseline to week 4 were as follows: LDL-C, −8.0% (2.1%) (P = .002); LDL-C–HDL-C ratio, +3.0% (2.8%) (P = .31); and C-reactive protein, −10.0% (8.6%) (P = .27). In the statin and dietary portfolio groups, the respective data were as follows: LDL-C, −30.9% (3.6%) (P < .001) and −28.6% (3.2%) (P < .001); LDL-C–HDL-C ratio, −28.4% (4.2%) (P < .001) and −23.5% (3.2%) (P < .001); and C-reactive protein, −33.3% (8.3%) (P = .002) and −28.2% (10.8%) (P = .02), with no differences between week 2 and week 4 values (FIGURE 2). The reduc-
tions in blood lipids in both the dietary portfolio and statin groups were significantly greater \((P<.005)\) than the respective changes in the control group for total cholesterol, LDL-C, apolipoprotein B, and the ratios of total cholesterol to HDL-C, LDL-C to HDL-C, and apolipoprotein B to apolipoprotein A1, with no significant differences between the dietary portfolio and statin groups (Table 5). No differences in response were observed between sexes. In both the dietary portfolio and statin groups, C-reactive protein was reduced significantly more than in the control group \((P<.005)\), but again, no difference was observed between the dietary portfolio and statin groups.

**Blood Pressure**

No significant treatment differences were observed in blood pressure (Table 5).

**Calculated CHD Risk**

In the dietary portfolio and statin groups, the calculated CHD risk was reduced similarly \((24.9\% [5.5\%]; P<.001\) and \(25.8\% [4.4\%]; P<.001\), respectively). These reductions were also significantly different from the reduction \((3.0\% [5.2\%]; P=.57)\) in the control group \((P<.005)\) (Table 5). The risk reductions were largely due to the reductions in blood lipids. When blood pressure was held constant at 120 mm Hg in the risk equations, the blood lipid changes accounted for 70% and 82% of the risk reduction in the dietary portfolio and statin groups, respectively.

**Intention-to-Treat Analysis**

This study was also analyzed on the basis of intention to treat, including the 5 individuals with baseline values who dropped out or were withdrawn during the first and second weeks (before the week 2 and week 4 samples were taken for determination of blood lipids). (The 4 randomized participants for whom no baseline samples were obtained could not be included in this analysis.) Irrespective of whether it was assumed that the additional participants would have shown no response or 50% or 100% of the observed mean response, the same differences in blood lipid levels were preserved as significantly different among the treatment groups, as observed when these participants were not included in the analysis. Furthermore, the mean reductions across treatments in LDL-C were still significant at \(-7.5\% [2.0\%]\) \((P=.002)\) for control; \(-28.6\% [3.2\%]\) \((P<.001)\) for dietary portfolio; and \(-24.0\% [4.2\%]\) \((P<.001)\) for statin when it was assumed that the 5 additional participants showed no change in response to the treatments. Only for C-reactive protein and CHD risk was the significance level reduced (from \(P<.005\) to \(P<.05\)) for the differences between control and both dietary portfolio and statin treatments.

**COMMENT**

These data confirm that use of a particular formulation of more recent general recommendations (ATP III, American Heart Association)\(^{15,16}\) can greatly enhance the cholesterol-lowering effect of diet. The reductions in blood lipids were not significantly smaller than those achieved with the initial dose of lovastatin.

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**Figure 2. Change From Baseline in LDL-C, LDL-C-HDL-C Ratio, and C-Reactive Protein**

[Graphs showing changes in LDL-C, LDL-C-HDL-C ratio, and C-Reactive Protein over time for control, statin, and dietary portfolio groups.]
tatin, the first-generation statin marketed for cholesterol reduction. The dietary components used in our portfolio are all well recognized for their cholesterol-lowering properties.

Meta-analyses have indicated reductions in serum LDL-C of 6% to 7% for 9 to 10 g/d of psyllium, with smaller reductions for other viscous fibers; 13% for 1 to 2 g/d of plant sterols; 12.5% for 45 g/d of soy protein; and 1% for 10 g/d of almonds. Lower intakes of saturated fat may lead to smaller reductions in cholesterol for soy protein, and the same may be true for other interventions, including plant sterols.

A reduction in LDL-C of 4% to 7% may therefore be more appropriate for each component when taken with very low-saturated-fat diets and account for the decrease in LDL-C of 28% observed in this dietary portfolio. In this study, the fatty acid and cholesterol intakes were relatively low saturated-fat diets and account for the reductions observed in serum cholesterol in the control, statin, and dietary portfolio groups.

The different modes of action of the components on the dietary portfolio may have contributed to the additive effect. Viscous fibers increase bile acid losses, plant sterols reduce cholesterol absorption, and soy proteins reduce hepatic cholesterol synthesis and increase LDL receptor messenger RNA and so potentially increase uptake of cholesterol. Almonds contain a monounsaturated fatty acid– and plant sterol–rich oil that has been shown to lower LDL-C together with vegetable proteins, fiber, and other phytochemicals, which are likely to operate through a range of mechanisms.

Another feature of interest relating to the dietary portfolio was its ability to reduce C-reactive protein concentrations. This function, also observed with statins, has been related to their direct anti-inflammatory effect and has been considered possibly responsible for some of the reduction in CHD observed with statin use, best demonstrated in women with normal LDL-C levels. C-reactive protein reductions have not previously been reported with conventional cholesterol-lowering diets. It is therefore possible that lower C-reactive protein concentrations are a general consequence of effective cholesterol reduction, but in the present study, in common with other studies, C-reactive protein change was not significantly related to the change in LDL-C (r = 0.20; n = 46; P = .17). Also, in the present study, caution must be

**Table 5. Effect of Control, Statin, and Dietary Portfolio Treatments on Blood Lipids, C-Reactive Protein, and Blood Pressure**

<table>
<thead>
<tr>
<th></th>
<th>Control (n = 16)</th>
<th>Statin (n = 14)</th>
<th>Dietary Portfolio (n = 14)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Body weight, kg</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 0</td>
<td>77.4</td>
<td>77.1</td>
<td>79.6</td>
</tr>
<tr>
<td>Week 4</td>
<td>77.1</td>
<td>79.4</td>
<td>74.3</td>
</tr>
<tr>
<td><strong>Cholesterol, mmol/L†</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>6.37</td>
<td>5.97</td>
<td>6.64</td>
</tr>
<tr>
<td>LDL-C</td>
<td>4.29</td>
<td>3.93</td>
<td>4.46</td>
</tr>
<tr>
<td>HDL-C</td>
<td>1.19</td>
<td>1.07</td>
<td>1.18</td>
</tr>
<tr>
<td>Triglycerides</td>
<td>1.96</td>
<td>2.15</td>
<td>2.21</td>
</tr>
<tr>
<td><strong>Apolipoproteins, g/L‡</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apo A1</td>
<td>1.54</td>
<td>1.44</td>
<td>1.56</td>
</tr>
<tr>
<td>B</td>
<td>1.38</td>
<td>1.30</td>
<td>1.43</td>
</tr>
<tr>
<td><strong>Ratios</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total cholesterol to HDL-C</td>
<td>5.53</td>
<td>5.78</td>
<td>5.75</td>
</tr>
<tr>
<td>LDL-C to HDL-C</td>
<td>3.73</td>
<td>3.78</td>
<td>3.85</td>
</tr>
<tr>
<td>Apolipoprotein B to A1</td>
<td>0.91</td>
<td>0.92</td>
<td>0.92</td>
</tr>
<tr>
<td><strong>C-reactive protein, mg/L</strong></td>
<td>1.36</td>
<td>1.08</td>
<td>1.43</td>
</tr>
<tr>
<td><strong>Blood pressure, mm Hg</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systolic</td>
<td>120</td>
<td>113</td>
<td>124</td>
</tr>
<tr>
<td>Diastolic</td>
<td>75</td>
<td>77</td>
<td>81</td>
</tr>
<tr>
<td><strong>10-Year coronary heart disease risk,%§</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.6</td>
<td>12.3</td>
<td>12.3</td>
<td>11.3</td>
</tr>
</tbody>
</table>

*Comparisons of statin and dietary portfolio differences with control differences are statistically significant (P < .005) as assessed by Student-Neuman-Keuls procedure, but statin and dietary portfolio differences are not significantly different from each other.

*To convert total cholesterol, low-density lipoprotein cholesterol (LDL-C), and high-density lipoprotein cholesterol (HDL-C) to mg/dL, divide by 0.0259; to convert triglycerides to mg/dL, divide by 0.0113.

*To convert apolipoprotein A1 and B to mg/dL, multiply by 100.

§Coronary heart disease risk was estimated using the Framingham cardiovascular risk equation.

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taken specifically in interpreting the C-reactive protein findings because of the substantial but nonsignificant differences between treatment baseline values and, more generally, because no intervention studies exist specifically to test the effect of C-reactive protein reduction on CHD risk.

The data currently available from clinical trials demonstrating reductions in cardiovascular disease risk support an important role for dietary change, which includes increased intakes of fiber, vegetable oils, and proteins from soy and other legumes, nuts, fruits, and vegetables. 30-41 Furthermore, in large cohort studies, high fiber intakes have consistently been associated with reduction in CHD risk 30 and CHD risk factors 42; more recently, so has increased nut consumption. 43-45 In this respect, the recent dietary recommendations (ATPI II, American Heart Association, US Food and Drug Administration) may further increase the effectiveness of diet in reducing the risk of cardiovascular disease. In the future, other plant food components with specific mechanisms of action may be added to this portfolio. 46-48

Despite the effectiveness and safety of statins, there are still some individuals for whom physicians are reluctant to prescribe statins because of elevations of muscle or liver enzymes. 49 There are also those who would prefer nonpharmacological means, particularly in view of recent, less satisfactory outcomes with statin use in older people. 50,51 For such individuals, the dietary portfolio approach might provide a therapeutic option.

From our participants’ perspective, of the 36 (78%) who completed the study and provided formal comments, 40% found the dietary portfolio acceptable with little further modification; however, an equal number thought that a greater variety of foods was required, 27% thought that the food volume was too great, and 13% required meat as part of their meals. The 5 most popular foods were almonds, ground soy (simulated ground beef), oat bran cereal, oat bran bread, and plant sterol margarine.

In conclusion, current dietary recommendations 13 focusing on diets low in saturated fat have been expanded to include foods high in viscous fibers (eg, oats and barley) and plant sterols. These guidelines, together with additional suggestions to include vegetable protein foods (soy) 52 and nuts (almonds), appear to reduce LDL-C levels similarly to the initial therapeutic dose of a first-generation statin. However, before the true effectiveness of this dietary change can be assessed, studies must be undertaken in patients who assemble the diets for themselves on a routine basis. Using the experience gained, further development of this approach may provide a potentially valuable dietary option for cardiovascular disease risk reduction in primary prevention.

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