The Contribution of Changes in Diet, Exercise, and Stress Management to Changes in Coronary Risk in Women and Men in the Multisite Cardiac Lifestyle Intervention Program

Jennifer J. Daubenmier, Ph.D., Gerdi Weidner, Ph.D., and Michael D. Sumner, Ph.D.
Preventive Medicine Research Institute

Nancy Mendell, Ph.D.
Department of Applied Mathematics and Statistics
State University of New York, Stony Brook

Terri Merritt-Worden, M.S.
Preventive Medicine Research Institute

Joli Studley, M.S.
Highmark, Inc.

Dean Ornish, M.D.
Preventive Medicine Research Institute and
Department of Medicine, University of California, San Francisco

ABSTRACT

Background: *The relative contribution of health behaviors to coronary risk factors in multicomponent secondary coronary heart disease (CHD) prevention programs is largely unknown.* ***Purpose:*** *Our purpose is to evaluate the additive and interactive effects of 3-month changes in health behaviors (dietary fat intake, exercise, and stress management) on 3-month changes in coronary risk and psychosocial factors among 869 nonsmoking CHD patients (34% female) enrolled in the health insurance-based Multisite Cardiac Lifestyle Intervention Program.* ***Methods:*** *Analyses of variance for repeated measures were used to analyze health behaviors, coronary risk factors, and psychosocial factors at baseline and 3 months. Multiple regression analyses evaluated changes in dietary fat intake and hours per week of exercise and stress management as predictors of changes in coronary risk and psychosocial factors.* ***Results:*** *Significant overall improvement in coronary risk was observed. Reductions in dietary fat intake predicted reductions in weight, total cholesterol, low-density lipoprotein cholesterol, and interacted with increased exercise to predict reductions in perceived stress. Increases in exercise predicted improvements in total cholesterol and exercise capacity (for women). Increased stress management was related to reductions in weight, total cholesterol/high-density lipoprotein cholesterol (for men), triglycerides, hemoglobin A1c (in patients with diabetes), and hostility.* ***Conclusions:*** *Improvements in dietary fat intake, exercise, and stress management were individually, additively and interactively related to coronary risk and psychosocial factors, suggesting that multicomponent programs focusing on diet, exercise, and stress management may benefit patients with CHD.*

(Ann Behav Med 2007, *33*(1):57–68)

INTRODUCTION

Coronary heart disease (CHD) is the leading cause of death among women and men in the United States, claiming 20% of deaths in 2002 (1). Several lifestyle factors influence development of CHD, including smoking; a high-fat diet; lack of exercise; and psychosocial factors such as stress, depression, and hostility (2,3). Accordingly, several secondary prevention programs for CHD aim to improve dietary, exercise, and stress management behaviors (4,5). Such programs have been found to enhance health-related quality of life (6), reduce cardiovascular risk factors (6,7), clinical events (7–9), coronary atherosclerosis (7–10), need for subsequent revascularization (9,11), and increase myocardial perfusion (12). Because a low-fat diet (13), exercise (14,15), and stress management (14,16,17) reduce cardiac risk individually, it is often assumed that the effects of multicomponent interventions on coronary risk are additive (18,19).

To date, little research has evaluated the relative contribution of individual behaviors targeted in multicomponent interventions to improvement in coronary risk factors (20). Often, the small sample sizes that characterize these clinical trial interventions do not permit multivariate analyses to disentangle the relative contribution of program components to reductions in coronary risk and psychosocial factors (10). In this report, we examine results of the on-going, Multisite Cardiac Lifestyle Intervention Program (MCLIP), a comprehensive lifestyle change program for primary and secondary prevention of CHD admin-

Jennifer J. Daubenmier is now at the University of California, San Francisco, Center for Health and Community. Michael D. Sumner is now at the Discrimination Research Center.

This study was supported in part by a grant from the Department of the Army (U.S. Army Medical Research Acquisition Activity W81XWH-06-2-0565) and the Department of Health and Human Services (Health Resources and Services Administration #4C76HF00803-01-01) and does not reflect the position or the policy of the government; Highmark, Inc.; Safeway, Inc.; and the PepsiCo Foundation.

Reprint Address: G. Weidner, Ph.D., Preventive Medicine Research Institute, 900 Bridgeway, Sausalito, CA 94965. E-mail: gerdi.weidner@pmri.org

istered by insurance companies. The efficacy of this intervention was previously established in phase III randomized clinical trials (10,12). A large number of women and men have completed the MCLIP to date, permitting exploration of additive and interactive associations of multiple health behaviors with changes in risk factors and psychosocial status. Specifically, the MCLIP assesses weight, blood pressure, lipids, exercise capacity, hemoglobin A1c (for patients with diabetes), psychosocial risk factors, including perceived stress, depression, and hostility, and adherence to program guidelines. We examine the relative contribution (i.e., additive and interactive effects) of dietary fat reduction, increased exercise, and increased stress management practice to changes in coronary and psychosocial risk factors in 293 female and 576 male patients with CHD participating in the MCLIP over a 3-month period.

METHOD

Patient Recruitment

Participants were enrolled in the MCLIP from January 1998 to September 2004 at 22 program sites in four states (see the Appendix). Program staff was trained at each site. Patients were members of Highmark, Inc. (56%), West Virginia Public Employees Insurance Agency (13%), Mountain State Blue Cross Blue Shield (5%), and other health care plans. Seven percent of participants paid for the program themselves.

Patients were referred to the program by their physicians or self-referred through advertising or media publicity. All patients received approval from their physician to enroll in the program. Participants completed informed consent and medical records release forms, demographic and psychosocial questionnaires, and a 3-day diet diary. Medication information was collected, blood was drawn for plasma analyses, and a maximal exercise stress test was performed. Medical, health behavior, and psychosocial variables were reassessed at 3 months.

Participants

A total of 293 women and 576 men enrolled in the program. The protocol was approved by the Committee on the Protection of Rights of Human Subjects and written informed consent was obtained from all participants. All patient identifiers were removed before analysis to maintain patient confidentiality and to adhere to the Health Information Portability and Accountability Act of 1996 standards and requirements.

Inclusion criteria. Patients were eligible for the program if they had been diagnosed with CHD by a physician or health plan, which was defined as one of the following: (a) ischemia documented with noninvasive testing, such as exercise testing, nuclear imaging, echocardiogram, or other test clearly demonstrating ischemia; (b) cardiac catheterization demonstrating CHD; (c) a history of percutaneous coronary intervention (PCI), coronary bypass surgery (CABG), or myocardial infarction (MI); or (d) eligibility for PCI or CABG.

Exclusion criteria. Exclusion criteria included (a) ischemic left main CHD, with an obstruction greater than 50%; (b) significant (> 70%) proximal left anterior descending artery and proximal left circumflex artery disease and an ejection fraction less than 50%; (c) unstable angina; (d) hypotensive response to exercise (> 20mm Hg drop in systolic BP); (e) history of exercise induced ventricular tachycardia or third degree heart block without evidence of current stability; (f) CABG or MI within 4 weeks, unless approved by medical director; (g) congestive heart failure with functional limitation and unresponsiveness to medications; (h) current tobacco user not concurrently enrolled in a smoking cessation program with 2-month history of smoking cessation; (i) uncontrolled malignant ventricular arrhythmia despite medications or implantable cardiac defibrillator, unless approved by medical director; (j) primary residence more than a 1-hr commute from the program site, unless approved; (k) history of substance abuse disorder without documentation of minimum 1-year abstinence; (l) history of a significant psychiatric disorder without documentation of minimum 1-year stability; (m) impaired cognitive function, such as dementia or delirium; (n) English language illiteracy unless program site could accommodate; (o) nonambulatory; (p) uncooperative spouse or partner, defined as obstructive in attitude or behavior; or (q) likely to be disruptive to group setting. Unfortunately, we cannot ascertain how many potential patients were excluded from participating in the intervention due to the inclusion and exclusion criteria as these data are not collected by health plans.

Lifestyle Change Program

Patients attended an onsite program twice a week for 3 months for a total of 104 hr. The program consisted of scientific lectures, demonstrations (e.g., cooking), 1 hr of supervised exercise, 1 hr of stress management, a meal consistent with diet guidelines, and 1 hr of group support (21).

Diet. The dietary guidelines consisted of a very low fat, plant-based, whole foods diet, high in complex carbohydrates, and low in simple carbohydrates. The diet included fruits, vegetables, grains, legumes, one cup of nonfat dairy, and egg whites. Caffeine was excluded, and alcohol was limited to no more than one drink (one cocktail, glass of wine, or beer) per day for those with no history of alcohol abuse. Sodium intake was restricted for patients who were sodium sensitive due to hypertension or diagnosed with congestive heart failure or renal disease. Participants were instructed to eat one serving of a soy product per day. The diet contained 10% daily calories from fat, 15% from protein, and 75% from complex carbohydrates. Calories were unrestricted unless the participant was overweight and not losing weight. A low-dose multivitamin and 3 g/day of fish oil (to provide omega-3 fatty acids) were recommended.

Exercise. The exercise prescription followed the guidelines of the American College of Sports Medicine (22). Patients were asked to exercise aerobically a minimum of 3 hr per week and to spend a minimum of 30 min per session exercising within their prescribed target heart rate or perceived exertion levels. Patients were also asked to perform strength-training activities a minimum of two times per week. Each patient was prescribed an exercise level according to a baseline exercise stress test. Target heart rate was calculated at 45% to 80% of maximal heart rate achieved during the test using the Karvonen formula (23). If ischemia occurred during the baseline stress test, the heart rate at which 1 mm of ST segment depression first occurred was designated the maximum heart rate. Most patients' exercise consisted of brisk walking. During onsite sessions, patients participated in traditional cardiac rehabilitation exercise sessions and were supervised by trained professionals.

Stress management. Stress management practices included gentle yoga poses, progressive muscle relaxation, breathing exercises, meditation, and guided imagery. Each technique was designed to enhance physical relaxation and awareness of internal states. Patients were asked to practice these stress management techniques for at least 1 hr per day and were provided an audiocassette/CD for home practice. Onsite sessions were led by a certified stress management specialist.

Group support. The group support sessions provided social support to facilitate adherence to the lifestyle change program. These sessions were directed by a licensed mental health professional who taught communication skills to enhance intimacy and encourage expression of feelings in a supportive, safe environment.

Assessments

Anthropometrics. Height and weight were measured with shoes and excess clothing removed on the same calibrated scale at baseline and 3-month follow-up. Blood pressure was measured by a trained health professional using a calibrated sphygmomanometer according to American Heart Association practice guidelines (24).

Plasma analyses. Fasting blood samples were collected at baseline and 3 months and analyzed by laboratories near each program site following the Clinical Laboratory Improvement Amendments of 1988 (25). Total cholesterol, HDL-C, and triglycerides were measured, and LDL-C was either measured or calculated depending on the site. Hemoglobin A1c was measured for patients with diabetes.

Exercise capacity. Exercise tolerance was assessed by maximal treadmill or by cycle ergometry testing when treadmill testing was contraindicated. The protocol for the exercise testing followed American Heart Association and American College of Sports Medicine guidelines. Peak workload was recorded for each participant in metabolic equivalents (METs), which are measurement units of energy expenditure and equivalent to approximately 3.5 ml of oxygen consumed per minute per kilogram of body weight.

Medications. Currently prescribed medications were documented at baseline, including lipid-lowering, antihypertensive, vasodilator (e.g., nitrates), and anticoagulant medications.

Psychosocial variables. Depressive symptoms were assessed by the Center for Epidemiological Scale–Depression scale (CES–D) (26). Participants were asked to indicate how often they experienced specific depressive symptoms during the past week. Total scores range from 0 to 60 with higher scores indicating endorsement of more symptoms. Hostility was evaluated using the Cook–Medley Hostility scale, a 27-item measure containing three subscales: cynicism, hostile affect, and aggressive responding (27). Total scores range from 0 to 27 with higher scores reflecting greater hostility. This scale has been related to all-cause mortality (27). Psychological stress was assessed by the 10-item Perceived Stress Scale, which measures the degree to which situations during the past month are appraised as stressful (28). Individual responses ranged from 0 (*never*) to 4 (*very often*) and total scores ranged from 0 to 40, with higher scores indicating greater perceived stress.

Health behaviors. Participants completed 3-day food diaries at baseline and 3 months to assess dietary adherence. Each site analyzed the diaries using nationally recognized software (Food Processor [ESHA Research, Inc., Salem, OR], Nutritionist Pro [Axxya Systems LLC, Stafford, TX] or older versions) to assess the daily percentage of total calories from fat. To assess adherence to exercise and stress management guidelines, participants were provided weekly adherence logs to record the amount of time they exercised and practiced stress management techniques. For each day of the week, participants indicated the type of physical activity they performed, duration, and the number of min they practiced the following stress management techniques: yoga poses, progressive muscle relaxation, breathing exercises, meditation, and guided imagery. Each week, adherence logs were collected and reviewed by program staff. Baseline and 3-month adherence to exercise and stress management guidelines were measured as the number of self-reported hours per week of practice during the previous week. These measures of adherence were validated in a randomized controlled trial in which adherence was related to regression of coronary atherosclerosis among experimental group participants (10).

ANALYSES

Baseline sex differences were analyzed using independent-sample t tests for continuous variables and chi-squared analyses for dichotomous variables. Analyses of variance for repeated measures tested the effects of sex, time (baseline, 3 months), and their interaction on health behaviors, coronary risk factors, and psychosocial factors.

Hierarchical multiple regression analyses were conducted to examine the additive and interactive effects of changes in the three health behaviors (diet, exercise, stress management) and sex on changes in coronary risk factors and psychosocial factors. Change scores of the three health behaviors were created so that higher values reflect greater improvement in each health behavior (i.e., for exercise and stress management, baseline values were subtracted from 3-month values; for dietary fat intake, 3-month values were subtracted from baseline values). The main effects of sex and changes in stress management, exercise, and dietary fat were entered on Step 1. All two-way interaction terms involving sex and changes in stress management, exercise, and dietary fat were entered on Step 2; all three-way interaction terms were entered on Step 3; and the four-way interaction term was entered on Step 4. The model was run separately for each outcome variable, including (3 month – baseline) changes in weight, systolic and diastolic blood pressure, METs, total cholesterol, LDL-C, total cholesterol/HDL-C ratio, triglycerides, hemoglobin A1c (for patients with diabetes), depression, hostility, and perceived stress. Whenever the highest order interaction term was not significant at the .10 level, the next highest order interactions terms were evaluated in the same manner until a significant effect was found. Given the controversy over whether to control for baseline values when predicting change (29–31), we followed the advice of Allison (29) to do the analyses both ways and computed a second set of regressions to control for baseline values of the criterion on Step 1. Only predictors that remained significant ($p < .10$) across regression approaches were included in the final model. Significant interactions involving sex were followed up with separate analyses for each sex. Significant interactions involving changes in health behaviors were solved for high and low levels of the change in health behavior variables (i.e., 1 *SD* above and below the mean). Statistical analyses were performed using SPSS 12.0 (SPSS Inc, Chicago, IL).

RESULTS

Baseline Characteristics

Baseline demographic characteristics, medical history, and medication information for women and men are presented in Table 1. Women compared with men were slightly older and less likely to be married, have a college degree, be employed, and have had a revascularization procedure. Twenty-six percent of men and 31% of women were diagnosed with diabetes mellitus; of this subset, 88% of men and 86% of women had type 2 diabetes. Patients' blood pressure and plasma lipid levels were mostly within normal limits, indicating adequate control with medication.

Baseline health behaviors, coronary risk factors, and psychosocial variables for men and women are presented in Table 2. Women had higher body mass indexes (BMIs), total cholesterol, LDL-C, lower exercise capacity (METs), and higher hemoglobin A1c (among patients with diabetes) than men. As expected, women had higher HDL-C levels compared with men. Women reported higher levels of depressive symptoms and perceived stress but lower levels of hostility, compared with men. Women also consumed a greater percentage of calories from fat and exercised less than men.

Lost to Follow-Up Analyses

Eighteen women and 22 men (4.5%) did not complete the 3-month follow-up. Women who did not complete the follow-up tended to have higher BMIs (35.1 ± 8.5 vs. 31.6 ± 10.9, $p = .05$) and consumed a greater percentage of total calories from fat (32.4 ± 15.3 vs. 25.6 ± 10.9, $p < .05$) than women who completed the follow-up. Men who did not complete the follow-up had higher HDL-C values compared to those who did (43.5 ± 11.2 mg/dL vs. 38.7 ± 10.2 mg/dL, $p < .05$). No other differences in demographic, health behavior, coronary risk, or psychosocial variables between those who completed the fol-

TABLE 1
Demographic Characteristics and Medical History at Baseline

Variable	*Men*[a] *n* %	*Women*[b] *n* %	*p*
Demographic			
Age ($M \pm SD$)	59 ± 8.9	60 ± 9.4	.03
Married	511 (88.9)	185 (63.8)	.001
Employment[c] (% employed)	282 (58.4)	113 (47.5)	.007
Education[d] (% college degree)	275 (52.8)	85 (32.2)	.001
Ethnicity (% White)	534 (94.2)	274 (95.1)	.64
Medical history			
Previous revascularization	487 (84.7)	219 (74.7)	.006
Previous cigarette smoker[c]	230 (47.5)	102 (42.9)	.27
Diabetes mellitus	148 (25.8)	92 (31.4)	.09
Type 2	129 (88.4)	77 (85.6)	.55
Medications[c]			
Lipid lowering	389 (81.0)	188 (81.0)	.92
Beta blockers	319 (67.0)	144 (62.0)	.21
ACE inhibitors	183 (39.0)	86 (37.0)	.15
Nitrates	110 (23.0)	53 (23.0)	.99
Anticoagulants	394 (82.0)	176 (76.0)	.05

[a]$n = 576$. [b]$n = 293$. [c]One site failed to collect information on employment status, history of cigarette smoking, and medication, therefore data are shown for 83% of male participants ($n = 476$) and 79% to 81% of female participants ($n = 231$ to $n = 238$), depending on the variable. [d]One site failed to collect information on education, therefore data are shown for 90% of male ($n = 521$) and female ($n = 264$) participants.

TABLE 2
Health Behaviors, Coronary Risk Factors, and Psychosocial Factors at Baseline

	Men[a]	*Women*[b]	*p*
Health behaviors			
Stress management (hr/week)	0.3 ± 1.1	0.4 ± 1.3	.20
Exercise (hr/week)	2.0 ± 2.2	1.2 ± 1.5	.001
Dietary fat (% total calories from fat)	24 ± 12	26 ± 11	.039
Coronary risk factors			
Weight (kg)	96.1 ± 18	83.4 ± 20	.001
Body mass index (kg/m^2)	31 ± 5	32 ± 7	.01
Systolic blood pressure (mmHg)	132 ± 18	131 ± 18	.29
Diastolic blood pressure (mmHg)	78 ± 10	76 ± 10	.054
Total cholesterol (mg/dl)	167 ± 38	193 ± 46	.001
LDL-C (mg/dl)	94 ± 32	107 ± 36	.001
HDL-C (mg/dl)	39 ± 10	49 ± 13	.001
Total cholesterol/HDL-C ratio	4.5 ± 1.5	4.2 ± 1.5	.003
Triglycerides (mg/dl)	176 ± 110	185 ± 112	.26
Exercise capacity (MET)	9.7 ± 3.1	7.4 ± 2.4	.001
HbA1c (%; patients with diabetes)	7.3 ± 1.6	7.9 ± 1.7	.01
Psychosocial factors			
CES–D	11.4 ± 8.8	13.5 ± 9.6	.002
Cook-Medley Hostility	9.1 ± 4.9	7.0 ± 4.4	.001
Perceived Stress Scale	14.3 ± 7.1	16.1 ± 8.1	.001

Note. CES–D = Center for Epidemiological Scale–Depression scale.
[a]$n = 576$. [b]$n = 293$.

low-up and those who did not were found. Intention-to-treat analyses (baseline values carried forward for 3-month missing values) were conducted to test the robustness of all final models. The pattern of findings was identical to the nonimputed analyses. The nonimputed results are presented in the following discussion.

Changes in Lifestyle Behaviors, Coronary Risk and Psychosocial Factors

Three-month changes in health behaviors, coronary risk factors, and psychosocial variables are shown in Table 3. Participants showed significant reductions in dietary fat intake, and increased hr per week of aerobic exercise and stress management. Seventy-four percent, 79%, and 47% of participants met guidelines for dietary fat intake, exercise, and stress management, respectively. For the coronary risk factors, significant improvements were observed in weight, systolic and diastolic blood pressure, total cholesterol, LDL-C, triglycerides, exercise capacity, and hemoglobin A1c (for patients with diabetes). As expected in the context of a low-fat diet, HDL-C levels were reduced; however, the ratio of total cholesterol to HDL-C improved (32). For psychosocial factors, participants reported significant improvements in depressive symptoms, hostility and perceived stress. Significant Sex × Time interactions revealed that men showed greater reductions in weight, systolic blood pressure, total cholesterol/HDL-C ratio, triglycerides, and hostility scores compared with women. Women showed greater improvement in depressive symptoms, perceived stress scores, but also a greater decrease in HDL-C than men.

Hierarchical Regression Analyses

Multiple regression analyses indicated that 3-month improvements in stress management, exercise, and dietary fat intake were significantly associated with 3-month improvements in coronary risk and psychosocial factors (see Table 4). Multicollinearity did not pose a problem among the three health behavior predictor variables as bivariate correlations ranged from –.13 to .24 ($ps < .001$). The final model for changes in weight indicated that improved stress management and dietary fat intake were additively related to weight loss ($p < .01$ and $p < .001$, respectively). Decreased total cholesterol was predicted by reduced dietary fat intake ($p < .001$) and a Sex × Exercise interaction ($p < .10$), indicating that increased exercise was significantly related to lower total cholesterol in women ($\beta = -.16$, $p < .05$) but not men ($\beta = -.05$, $p = .27$). A main effect for increased exercise on reduction of total cholesterol was significant in the first regression model ($\beta = -.09$, $p < .05$); however, the effect disappeared when controlling for baseline values of total cholesterol ($p = .27$). Reduced dietary fat intake was the only predictor related to improvement in LDL-C ($p < .001$). Increased stress management was related to a decrease in triglycerides ($p < .05$). For the total-cholesterol/HDL-C ratio, a significant Sex × Stress Management interaction indicated that increased stress management was related to decreased total-cholesterol/HDL-C ratio for men ($\beta = -.10$, $p < .05$) but not women ($\beta = .09$, $p = .16$). For changes in exercise capacity, a significant Sex × Exercise interaction ($p < .01$) indicated that increased exercise was related to improved exercise capacity for women ($\beta = .24$, $p < .001$) but not men ($\beta =$

TABLE 3

Health Behaviors, Coronary Risk Factors, and Psychosocial Factors at Baseline and 3 Months

	Baseline (M ± SD)	*3 Months (M ± SD)*	*p Value, Sex*	*p Value, Time*	*p Value, Time × Sex*
Health behaviors					
Dietary fat (% kcal of fat)					
Men	$24.2_a \pm 11.6$	$8.9_b \pm 2.5$	.030	.001	.43
Women	$25.5_a \pm 10.9$	$9.6_c \pm 3.2$			
Exercise (hr/wk)					
Men	$2.0_a \pm 2.2$	$3.9_b \pm 1.7$	.001	.001	.08
Women	$1.2_c \pm 1.5$	$3.5_d \pm 1.3$			
Stress management (hr/wk)					
Men	$0.3_a \pm 1.1$	$6.0_b \pm 2.2$	.029	.001	.46
Women	$0.5_a \pm 1.3$	$6.3_b \pm 2.0$			
Coronary risk factors					
Weight (kg)					
Men	$95.9_a \pm 18.2$	$90.4_b \pm 16.4$	.001	.001	.001
Women	$83.2_c \pm 19.8$	$79.1_d \pm 18.5$			
Systolic BP (mmHg)					
Men	$132_a \pm 18$	$120_b \pm 15$	.70	.001	.01
Women	$131_a \pm 18$	$122_b \pm 16$			
Diastolic BP (mmHg)					
Men	$78_a \pm 10$	$71_b \pm 9$	.09	.001	.20
Women	$76_a \pm 10$	$71_b \pm 9$			
Total chol. (mg/dl)					
Men	$167_a \pm 38$	$143_b \pm 34$	.001	.001	.24
Women	$192_c \pm 46$	$172_d \pm 42$			
LDL-C (mg/dl)					
Men	$94_a \pm 32$	$78_b \pm 29$	.001	.001	.47
Women	$107_c \pm 36$	$92_d \pm 34$			
HDL-C (mg/dl)					
Men	$39_a \pm 10$	$35_b \pm 9$	.001	.001	.003
Women	$49_c \pm 13$	$43_d \pm 11$			
Total chol./HDL-C ratio					
Men	$4.5_a \pm 1.5$	$4.3_b \pm 1.3$	.01	.001	.001
Women	$4.1_b \pm 1.4$	$4.1_b \pm 1.2$			
Triglycerides (mg/dl)					
Men	$175_a \pm 108$	$156_b \pm 77$	.005	.001	.007
Women	$185_a \pm 113$	$183_a \pm 104$			
Exercise capacity (MET)					
Men	$9.7_a \pm 3.0$	$11.5_b \pm 3.2$	.001	.001	.27
Women	$7.6_c \pm 2.4$	$9.3_d \pm 2.7$			
Hemoglobin A1c (%)[a]					
Men	$7.2_a \pm 1.5$	$6.4_b \pm 1.0$			
Women	$8.0_c \pm 1.7$	$7.1_d \pm 1.1$	.001	.001	.51
Psychosocial factors					
Depression (CES–D)					
Men	$11.4_a \pm 8.8$	$7.2_c \pm 6.8$	.04	.001	.001
Women	$13.5_b \pm 9.6$	$7.3_c \pm 6.8$			
Hostility (Cook–Medley)					
Men	$9.0_a \pm 4.9$	$7.4_b \pm 4.5$	.001	.001	.019
Women	$7.0_c \pm 4.4$	$6.1_d \pm 4.3$			
Perceived stress (PSS)					
Men	$14.3_a \pm 7.1$	$10.1_c \pm 5.8$	.014	.001	.002
Women	$16.2_b \pm 8.0$	$10.5_c \pm 6.4$			

Note. Subscripts denote comparisons within columns and rows. Means with different subscripts are significantly different from one another ($p < .05$, Bonferroni adjusted). BP = blood pressure; chol. = cholesterol; CES–D = Center for Epidemiological Scale–Depression scale; Cook–Medley = Cook–Medley Hostility scale; PSS = Perceived Stress Scale.

[a]This analysis includes patients with diabetes only.

TABLE 4

Final Models of Regression Analyses of Sex and 3-Month Changes in Health Behaviors on 3-Month Changes in Coronary Risk and Psychosocial Factors

	B	*β*	*Adj R^2*
Δ Weight			
Constant	−9.72		
Sex[a]	3.42	.19***	
Δ SM	−.45	−.12**	
Δ Fat	−.22	−.29***	
Total Adj R^2			.135***
Δ Total cholesterol			
1. constant	−16.48		
Sex	2.63	.04	
Δ Exercise[b]	−1.37	−.09*	
Δ Fat	−.49	−.16***	.037***
2. constant	−22.82		
Sex	7.91	.11*	
Δ Exercise	1.61	.11	
Δ Fat	−.50	−.17***	
Sex × Δ Exercise	−2.35	−.22†	.003†
Total Adj R^2			.04***
Δ LDL–C			
Constant	−9.69		
Δ Fat	−.43	−.18***	
Total Adj R^2			.031***
Δ Total cholesterol/HDL-C			
1. constant	−.43		
Sex	.25	.12**	
Δ SM	−.01	−.03	.012**
2. constant	.17		
Sex	−.20	−.10	
Δ SM	−.12	−.28**	
Sex × Δ SM	.08	.34*	.007*
Total Adj R^2			.019**
Δ Triglycerides			
Constant	2.26		
Δ SM	−2.85	−.08*	
Total Adj R^2			.005*
Δ Exercise capacity			
1. constant	1.95		
Sex	−.18	−.05	
Δ Exercise	.05	.06	.002
2. constant	2.53		
Sex	−.66	−.17**	
Δ Exercise	−.22	−.26*	
Sex × Δ Exercise	.22	.36**	.01**
Total Adj R^2			.002**
Δ Hemoglobin A1c[c]			
Constant	−.36		
Δ SM	−.08	−.19*	
Total Adj R^2			.029*
Δ Hostility			
Constant	−.30		
Δ SM	−.18	−.11**	
Total Adj R^2			.012**

(continued)

TABLE 4 *(Continued)*

	B	*β*	*Adj* R^2
Δ Perceived stress			
1. constant	−3.51		
Δ Exercise[b]	−.31	−.11**	
Δ Fat	−.04	−.07†	.016**
2. constant	−3.97		
Δ Exercise	−.08	−.03	
Δ Fat	.002	.00	
Δ Exercise × Δ Fat	−.02	−.13†	.003†
Total Adj R^2			.019**

Note. Higher numbers indicate greater improvement in health behaviors. Lower numbers indicate greater improvement for changes in coronary and psychosocial factors, with the exception of 3-month change in exercise capacity. SM = stress management; Δ SM = 3-month minus baseline changes in hours per week of SM; Δ exercise = 3-month minus baseline changes in hours per week of exercise; Δ fat = baseline minus 3-month changes in percentage of total calories from fat.

[a]For all analyses, men = 1, women = 2. [b]This effect is not significant when controlling for baseline values of the predicted variable. [c]This analysis includes patients with diabetes only.

†$p < .10$. *$p < .05$. **$p < .01$. ***$p < .001$.

.00, $p = .99$). For patients with diabetes, increased stress management was related to reductions in hemoglobin A1c ($p < .05$). Changes in health behaviors did not significantly predict improvements in systolic or diastolic blood pressure.

For the psychosocial variables, the final model for changes in hostility indicated that increased stress management was related to decreased hostility ($p < .001$). In addition, a significant Exercise × Dietary Fat interaction revealed that those who showed the greatest improvement in exercise and dietary fat reported the greatest decreases in perceived stress ($p < .01$). There was some indication that stress management and exercise predicted improvements in depressive symptoms and perceived stress, but these findings were not confirmed across both regression approaches.

DISCUSSION

Our results indicate that insurance companies can successfully implement a multicomponent secondary prevention program for CHD at multiple hospital sites around the country. Adherence to the program was high at 3 months, as 74%, 79%, and 47% of participants met guidelines for dietary fat intake (10% of calories from fat), exercise (3 hr/week), and stress management (7 hr/week), respectively. Further, both women and men showed significant improvement in coronary risk factors and psychosocial functioning. The magnitude of improvements observed in this study is similar to those found in other studies employing the same lifestyle intervention program (6,10,33,34). For example, for both sexes, there was significant reduction in body weight (men: −5.5 kg; women: −4.1 kg), systolic blood pressure (men: −12 mmHg; women: −9 mmHg), and total cholesterol (men: −24 mg/dL; women: −20 mg/dL). The reductions in blood pressure and cholesterol were remarkable considering that patients' levels were already well controlled at baseline. In addition, significant improvements in hemoglobin A1c were observed in both women and men with diabetes. HDL cholesterol levels decreased for participants in this study on a very low fat diet. However, lowering HDL cholesterol concentrations by reducing dietary fat intake does not confer the same CHD risk as low HDL cholesterol concentrations in persons eating a high-fat diet (32). Furthermore, the decline in HDL did not adversely affect the total cholesterol/HDL ratio, which remained the same for women and improved significantly for men.

The main purpose of this article is to examine the relative contribution of changes in targeted health behaviors to improvements in coronary risk factors and psychosocial variables for men and women enrolled in a multicomponent lifestyle intervention for secondary prevention of CHD. The results of this study indicate that the dietary, exercise, and stress management components are individually, additively, and interactively related to improvements in multiple coronary risk and psychosocial factors.

Reductions in dietary fat intake within the context of a low-cholesterol, plant-based, complex carbohydrate diet was associated with greater weight loss and improvements in total cholesterol and LDL-C. These findings concur with the well-established links between dietary fat, lipid levels, and CHD risk (35). In addition, reduced dietary fat intake was related to lower perceived stress in the presence of increased exercise. As participants complied with program guidelines, they may have experienced increased perceived control over their health, leading to reductions in overall perceived stress. Prior studies have found that participants who enrolled in a dietary intervention and successfully reduced dietary fat also reported increased psychological well-being (36,37).

The recommendation to increase aerobic exercise is standard of care for patients with CHD to facilitate or maintain weight loss and improve lipid profiles. However, the effect of exercise alone on weight loss in cardiac rehabilitation programs has been found to be minimal to moderate, with some studies showing no benefit at 3 months (4,38). In the MCLIP, exercise guidelines were designed to facilitate weight maintenance and improve prognosis (39). Therefore, it is not surprising that increased exercise was not associated with weight loss after accounting for changes in dietary fat intake and stress management. However, increased exercise was associated with reduced levels of total cholesterol for women but not men. It is noteworthy that this benefit occurred even though many women were already on lipid lowering medications. This finding corresponds with the conclusions of a recent meta-analysis that exercise-based cardiac rehabilitation programs continue to reduce total cholesterol in the present era of drug therapies for risk factor management (15). Increased exercise was also related to increased exercise capacity for women but did not significantly contribute to increases in exercise capacity in men. One explanation of these sex differences could be that women exercised less at baseline than men and thus had more room for improvement. However, when baseline exercise was controlled for in post hoc analyses, the interaction term of sex and changes in exercise remained significant in predicting improvements in exercise capacity and total cholesterol. It is possible that intensity rather than duration of exercise accounts for the observed improvements, and the two variables may have been more highly correlated in women than men, thereby explaining why increased exercise did not predict improvements in total cholesterol and exercise capacity in men. As exercise intensity was not measured, it is difficult to account for the sex differences. Exercise may also have psychological benefit for patients with CHD as increased exercise was associated with reduced levels of perceived stress when dietary fat intake was also reduced, echoing findings of research on the beneficial effect of exercise for depression (40,41). There was also some evidence for an exercise–depression link in our study; however, this effect did not remain statistically significant after controlling for baseline exercise levels.

In addition to a low-fat diet and exercise, stress management may be an important component of secondary prevention programs for CHD. Increased stress management, in the form of yoga and meditation techniques, was linked to a reduction in hostile attitudes, a risk factor for cardiovascular disease mortality (42,43). Stress management also showed some relation to decreased depressive symptoms, although the finding was not robust across regression approaches.

Stress management was also associated with improved metabolic function, as reflected by changes in components of the metabolic syndrome. In particular, increased stress management was linked to greater weight loss after accounting for changes in dietary fat intake and exercise. This finding replicates results of a recent observational study of over 15,000 middle-aged adults, which found that yoga was associated with attenuated weight gain over a 10-year period (44). The exact mechanisms to account for the association between stress management and weight control are not clear. The effect may be due to an increased ability to adhere to dietary recommendations through enhanced awareness of bodily cues such as hunger and satiety sensations (45) or diminished stress-related eating patterns (46). Stress management was further related to improvements in triglycerides for the entire sample and the total cholesterol/HDL-C ratio in men. Stress-induced activation of the sympathetic nervous system, as reflected by increased catecholamine and cortisol release, has been associated with elevated plasma lipid levels (47,48), whereas other studies suggest that stress management interventions improve lipid profiles (49). Furthermore, stress management was linked to improved glycemic control for patients with diabetes. These results are in line with a recent meta-analysis of randomized controlled trials, which determined that psychological interventions significantly reduce glycated hemoglobin (50). These findings indicate that stress management may be effective in reducing the release of stress hormones, which contribute to elevated glucose levels and impaired insulin response (51,52). Although it is impossible to determine mechanistic pathways in this intervention study, it is likely that stress management improved metabolic function, such as glucose control, through decreases in stress-related hormones, as attenuated cortisol stress responses have been found with other stress management interventions (53). Stress management may also be working through behavioral pathways, by facilitating greater adherence to dietary guidelines, such as increased fiber intake, which has been shown to yield significant improvements in glycemic control in patients with diabetes (54).

Although blood pressure was significantly reduced at 3 months, it was not associated with improvements in individual health behaviors. One possible explanation may be that the majority of participants were taking blood pressure medication at baseline and the mean diastolic blood pressure was already within the target range (< 80 mmHg) across the entire sample. Alternatively, other dietary factors not accounted for in these analyses may have contributed to decreased blood pressure (e.g., reduced sodium and alcohol intake).

Some health professionals do not encourage patients to make comprehensive lifestyle changes because they believe that such changes, such as following a very low fat diet, are unrealistic for most Americans (55). However, these results suggest that many Americans with CHD are motivated to make lifestyle changes to improve their health. Future research should identify barriers that limit participation in behavior change programs among patients with CHD as well as identify patients who are likely to succeed in making changes. One factor that may determine success in behavior change programs is degree of disease severity. In post hoc analyses, we found that participants who had a prior revascularization reported greater adherence to the low-fat diet than those without a previous revascularization, especially among women (9% vs. 11% calories from fat, $p < .001$). Similarly, patients with a smoking history reported more stress management practice (6.6 hr/week) compared with patients without a history of smoking (6.0 hr/week, $p < .001$), and participants with diabetes reported more stress management practice (6.3 hr/week) compared with participants without diabetes (6.0 hr/week, $p < .05$). These findings suggest that patients with greater disease severity may be more motivated to change their lifestyle, perhaps because they fear worse health outcomes than their relatively healthier counterparts.

Women comprised 34% of our sample. Several studies have noted that women are less likely to enroll in secondary prevention programs for CHD (one study reported that 12% of its participants were women [56]; for a review, see 57). Women's lower participation rate may be due to their worse prognosis after cardiac events (58), lower rates of physician referral (56,57,59), advanced age (57), or fewer personal resources (57). One explanation for the relatively higher participation rate among women in the MCLIP may be due to the group support and stress management components, which may appeal more to women than exercise-based cardiac rehabilitation programs (60). Given that CHD is the leading cause of death among women in the United States (1), future research should identify barriers and strategies for enrolling women into secondary prevention programs for CHD.

One limitation of this study is its reliance on self-report measures of health behaviors. Participants may have inflated their self-reported adherence for social desirability reasons. However, the adherence measures used in this study were previously validated in a randomized controlled trial in which adherence was related to regression of coronary atheroscerosis among experimental group participants (10). Notwithstanding, if objective measures of health behaviors were employed in this study, stronger relations between changes in health behaviors and coronary risk and psychosocial factors may have been detected. A second limitation is that we cannot conclude that improvements in health behaviors are directly responsible for observed improvements in coronary risk and psychosocial factors. It is possible that other factors played a role in patients' improved coronary risk profiles, such as regression to the mean for participants with high baseline risk factor levels. However, regression to the mean would only be a factor to the extent that those who showed the most risk factor improvement also reported the greatest improvement in health behaviors. It should also be noted that the improvements observed in this large-scale feasibility study are similar to those in the experimental group of a randomized clinical trial evaluating the efficacy of the same lifestyle change program (10). Furthermore, the primary focus of this study is to examine the relative association of changes in individual health behaviors to changes in coronary risk and psychosocial factors using a conservative statistical approach (we only considered findings that occurred with and without controlling for baseline values of the predicted variable).

In conclusion, these results highlight the value of modifying multiple health behaviors to reduce coronary risk factors and enhance psychosocial functioning in patients with CHD. Improvements in dietary fat intake, exercise, and stress management were individually, additively, and interactively related to coronary risk and psychosocial factors. The importance of targeting multiple health behaviors in secondary CHD risk prevention has been recognized by the U.S. Centers for Medicare and Medicaid Services, which have included this program as a defined cardiac rehabilitation benefit for Medicare beneficiaries with coronary heart disease (61).

REFERENCES

(1) American Heart Association: *Heart Disease and Stroke Statistics—2005 Update*. Dallas, TX: Author, 2005.

(2) Yusuf S, Hawken S, Ounpuu S, et al.: Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART Study): Case-control study. *Lancet*. 2004, *364*:937–952.

(3) Rozanski A, Blumenthal JA, Davidson KW, Saab PG, Kubzansky L: The epidemiology, pathophysiology, and management of psychosocial risk factors in cardiac practice: The emerging field of behavioral cardiology. *Journal of the American College of Cardiology*. 2005, *45*:637–651.

(4) Ades PA: Cardiac rehabilitation and secondary prevention of coronary heart disease. *New England Journal of Medicine*. 2001, *345*:892–902.

(5) van Dixhoorn J, White A: Relaxation therapy for rehabilitation and prevention in ischaemic heart disease: A systematic review and meta-analysis. *European Journal of Cardiovascular and Preventive Rehabilitation*. 2005, *12*:193–202.

(6) Koertge J, Weidner G, Elliott-Eller M, et al.: Improvement in medical risk factors and quality of life in women and men with coronary artery disease in the Multicenter Lifestyle Demonstration Project. *American Journal of Cardiology*. 2003, *91*:1316–1322.

(7) Haskell WL, Alderman EL, Fair JM, et al.: Effects of intensive multiple risk factor reduction on coronary atherosclerosis and clinical cardiac events in men and women with coronary artery disease. The Stanford Coronary Risk Intervention Project (SCRIP). *Circulation*. 1994, *89*:975–990.

(8) Linden W: Psychological treatments in cardiac rehabilitation: review of rationales and outcomes. *Journal of Psychosomatic Research*. 2000, *48*:443–454.

(9) Lisspers J, Sundin O, Ohman A, et al.: Long-term effects of lifestyle behavior change in coronary artery disease: Effects on recurrent coronary events after percutaneous coronary intervention. *Health Psychology*. 2005, *24*:41–48.

(10) Ornish D, Scherwitz LW, Billings JH, et al.: Intensive lifestyle changes for reversal of coronary heart disease: Five-year follow-up of the Lifestyle Heart Trial. *Journal of the American Medical Association*. 1998, *280*:2001–2007.

(11) Ornish D: Avoiding revascularization with lifestyle changes: The Multicenter Lifestyle Demonstration Project. *American Journal of Cardiology*. 1998, *82*:72T–76T.

(12) Gould KL, Ornish D, Scherwitz L, et al.: Changes in myocardial perfusion abnormalities by positron emission tomography after long-term, intense risk factor modification. *Journal of the American Medical Association*. 1995, *274*:894–901.

(13) Denke MA: Cholesterol-lowering diets. A review of the evidence. *Archives of Internal Medicine*. 1995, *155*:17–26.

(14) Blumenthal JA, Sherwood A, Babyak MA, et al.: Effects of exercise and stress management training on markers of cardiovascular risk in patients with ischemic heart disease: A randomized controlled trial. *Journal of the American Medical Association*. 2005, *293*:1626–1634.

(15) Taylor RS, Brown A, Ebrahim S, et al.: Exercise-based rehabilitation for patients with coronary heart disease: Systematic review and meta-analysis of randomized controlled trials. *American Journal of Medicine*. 2004, *116*:682–692.

▶(16) Frasure-Smith N, Prince R: The ischemic heart disease life stress monitoring program: Impact on mortality. *Psychosomatic Medicine.* 1985, *47:*431–445.

▶(17) Friedman M, Thoresen CE, Gill JJ, et al.: Alteration of type A behavior and its effect on cardiac recurrences in post myocardial infarction patients: Summary results of the recurrent coronary prevention project. *American Heart Journal.* 1986, *112:*653–665.

▶(18) Pickering TG: Lifestyle modification and blood pressure control: Is the glass half full or half empty? *Journal of the American Medical Association.* 2003, *289:*2131–2132.

▶(19) Gordon NF, Scott CB, Levine BD: Comparison of single versus multiple lifestyle interventions: Are the antihypertensive effects of exercise training and diet-induced weight loss additive? *American Journal of Cardiology.* 1997, *79:*763–767.

▶(20) Jakicic JM, Wing RR, Winters-Hart C: Relationship of physical activity to eating behaviors and weight loss in women. *Medicine and Science in Sports and Exercise.* 2002, *34:*1653–1659.

▶(21) Billings JH: Maintenance of behavior changes in cardiorespiratory risk reduction: A clinical perspective from the Ornish Program for reversing coronary heart disease. *Health Psychology.* 2000, *19:*70–75.

(22) Franklin B, Whaley M, Howley E (eds): *ACSM's Guidelines for Exercise Testing and Prescription* (4th Ed.). Philadelphia: Lippincott, 1991.

▶(23) Karvonen MJ, Kentala E, Mustala O: The effects of training on heart rate: A longitudinal study. *Annales Medicinae Experimentalis et Biologiae Fenniae.* 1957, *35:*307–15.

▶(24) Perloff D, Grim C, Flack J, et al.: Human blood pressure determination by sphygmomanometry. *Circulation.* 1993, *88:*2460–70.

▶(25) Medicare, Medicaid and CLIA programs: Regulations implementing Clinical Laboratory Improvement Amendments of 1988 (CLIA). *Federal Register.* 1992, *57:*7002

(26) Radloff LS: The CES-D Scale: A self-report depression scale for research in the general population. *Applied Psychological Measurements.* 1977, *1:*385–401.

▶(27) Barefoot JC, Dodge KA, Peterson BL, Dahlstrom WG, Williams RB Jr: The Cook–Medley hostility scale: Item content and ability to predict survival. *Psychosomatic Medicine.* 1989, *51:*46–57.

▶(28) Cohen S, Kamarck T, Mermelstein R: A global measure of perceived stress. *Journal of Health and Social Behavior.* 1983, *24:*385–396.

▶(29) Allison PD: Change scores as dependent variables in regression analysis. *Sociological Methodology.* 1990, *20:*93–114.

▶(30) Cronbach LJ, Furby L: How should we measure change—or should we? *Psychological Bulletin.* 1970, *74:*68–80.

▶(31) Glymour MM, Weuve J, Berkman LF, Kawachi I, Robins JM: When is baseline adjustment useful in analyses of change? An example with education and cognitive change. *American Journal of Epidemiology.* 2005, *162:*267–278.

▶(32) Brinton EA, Eisenberg S, Breslo JL: A low fat diet decreases high density lipoprotein (HDL) cholesterol concentrations by decreasing HDL apolipoprotein transport rates. *Journal of Clinical Investigation.* 1990, *85:*144–151.

▶(33) Ornish D, Brown SE, Scherwitz LW, et al.: Can lifestyle changes reverse coronary heart disease? The Lifestyle Heart Trial. *Lancet.* 1990, *336:*129–133.

▶(34) Ornish D, Scherwitz LW, Doody RS, et al.: Effects of stress management training and dietary changes in treating ischemic heart disease. *Journal of the American Medical Association.* 1983, *249:*54–59.

▶(35) Hu FB, Willett WC: Optimal diets for prevention of coronary heart disease. *Journal of the American Medical Association.* 2002, *288:*2569–2578.

▶(36) Weidner G, Connor SL, Hollis JF, Connor WE: Improvements in hostility and depression in relation to dietary change and cholesterol lowering. The Family Heart Study. *Annals of Internal Medicine.* 1992, *117:*820–823.

▶(37) Griffin KW, Weidner G: Cholesterol-lowering and psychological well-being. *Comprehensive Therapy.* 1994, *20:*518–522.

▶(38) Brochu M, Poehlman ET, Savage P, et al.: Modest effects of exercise training alone on coronary risk factors and body composition in coronary patients. *Journal of Cardiopulmonary Rehabilitation.* 2000, *20:*180–188.

▶(39) Berlin JA, Colditz GA: A meta-analysis of physical activity in the prevention of coronary heart disease. *American Journal of Epidemiology.* 1990, *132:*612–628.

▶(40) Lawlor DA, Hopker SW: The effectiveness of exercise as an intervention in the management of depression: Systematic review and meta-regression analysis of randomised controlled trials. *British Medical Journal.* 2001, *322:*763–767.

▶(41) Blumenthal JA, Babyak MA, Moore KA, et al.: Effects of exercise training on older patients with major depression. *Archives of Internal Medicine.* 1999, *159:*2349–2356.

▶(42) Matthews KA, Gump BB, Harris KF, Haney TL, Barefoot JC: Hostile behaviors predict cardiovascular mortality among men enrolled in the Multiple Risk Factor Intervention Trial. *Circulation.* 2004, *109:*66–70.

▶(43) Barefoot JC, Larsen S, von der Lieth L, Schroll M: Hostility, incidence of acute myocardial infarction, and mortality in a sample of older Danish men and women. *American Journal of Epidemiology.* 1995, *142:*477–484.

▶(44) Kristal AR, Littman AJ, Benitez D, White E: Yoga practice is associated with attenuated weight gain in healthy, middle-aged men and women. *Alternative Therapies in Health and Medicine.* 2005, *11:*28–33.

▶(45) Daubenmier JJ: The relationship of yoga, body awareness, and body responsiveness to self-objectification and disordered eating. *Psychology of Women Quarterly.* 2005, *29:*207–219.

▶(46) Epel E, Lapidus R, McEwen B, Brownell K: Stress may add bite to appetite in women: A laboratory study of stress-induced cortisol and eating behavior. *Psychoneuroendocrinology.* 2001, *26:*37–49.

▶(47) Black PH, Garbutt LD: Stress, inflammation and cardiovascular disease. *Journal of Psychosomatic Research.* 2002, *52:*1–23.

▶(48) Stoney CM, Bausserman L, Niaura R, Marcus B, Flynn M: Lipid reactivity to stress: II. Biological and behavioral influences. *Health Psychology.* 1999, *18:*251–261.

▶(49) Linden W, Stossel C, Maurice J: Psychosocial interventions for patients with coronary artery disease: A meta-analysis. *Archives of Internal Medicine.* 1996, *156:* 745–752.

▶(50) Ismail K, Winkley K, Rabe-Hesketh S: Systematic review and meta-analysis of randomised controlled trials of psychological interventions to improve glycaemic control in patients with type 2 diabetes. *Lancet.* 2004, *363:*1589–1597.

▶(51) Surwit RS, Schneider MS: Role of stress in the etiology and treatment of diabetes mellitus. *Psychosomatic Medicine.* 1993, *55:*380–393.

▶(52) Rosmond R: Role of stress in the pathogenesis of the metabolic syndrome. *Psychoneuroendocrinology.* 2005, *30:*1–10.

►(53) Hammerfald K, Eberle C, Grau M, et al.: Persistent effects of cognitive-behavioral stress management on cortisol responses to acute stress in healthy subjects: A randomized controlled trial. *Psychoneuroendocrinology.* 2005, *31:*333–339.

►(54) Chandalia M, Garg A, Lutjohann D, et al.: Beneficial effects of high dietary fiber intake in patients with type 2 diabetes mellitus. *New England Journal of Medicine.* 2000, *342:*1392–1398.

►(55) Atkins RC, Ornish D, Wadden T: Low-carb, low-fat diet gurus face off. *Journal of the American Medical Association.* 2003, *289:*1767–1773.

►(56) Caulin-Glaser T, Blum M, Schmeizl R, et al.: Gender differences in referral to cardiac rehabilitation programs after revascularization. *Journal of Cardiopulmonary Rehabilitation.* 2001, *21:*24–30.

(57) Scott LA, Ben-Or K, Allen JK: Why are women missing from outpatient cardiac rehabilitation programs? A review of multilevel factors affecting referral, enrollment, and completion. *Journal of Women's Health.* 2002, *11:*773–791.

►(58) Mosca L, Manson JE, Sutherland SE, et al.: Cardiovascular disease in women: A statement for healthcare professionals from the American Heart Association. *Circulation.* 1997, *96:*2468–2482.

►(59) Evenson, KR, Rosamond, WD, Luepker, RV: Predictors of outpatient cardiac rehabilitation utilization: The Minnesota Heart Survey Registry. *Journal of Cardiopulmonary Rehabilitation.* 1998, *18:*192–198.

►(60) Moore SM, Kramer FM: Women's and men's preferences for cardiac rehabilitation program features. *Journal of Cardiopulmonary Rehabilitation.* 1996, *16:*163–168.

(61) Centers for Medicare and Medicaid Services: *Decision Memo for Cardiac Rehabilitation Programs (CAG-00089R).* Retrieved January 3, 2007 from http://www.cms.hhs.gov/mcd/viewdecisionmemo.asp?id=164.

APPENDIX

We gratefully acknowledge staff from the following program sites and participating health insurance companies (indicated by asterisks; Highmark, Inc was also a program site) for their contributions to the Multisite Cardiac Lifestyle Intervention Program: Alegent Health, Omaha NE; Allegheny General Hospital, Pittsburgh, PA; Charleston Area Medical Center, Inc. Charleston, WV; Dubois Regional Hospital, Dubois, PA; Good Samaritan Health System, Kearny, NE; Hamot Medical Center, Hamot, PA; *Highmark, Inc, Pittsburgh, PA; Jameson Health System, New Castle, PA; Lehigh Valley Hospital, Lehigh, PA; Monongahela Valley Hospital, Monongahela, PA; *Mountain State Blue Cross Blue Shield, Charleston, WV; Ohio Valley Medical Center, Wheeling, WV; *Public Employee Insurance Agency of West Virginia, Charleston, WV; Princeton Community Hospital Association, Inc. Princeton, WV; St. Joseph's Hospital/Camden Clark Memorial Hospital, Parkersburg, WV; St. Mary's Hospital, Huntington, WV; Swedish American Health System, Rockford, IL; United Hospital Center, Clarksburg, WV; The Wellness Center at City Hospital, Martinsburg, WV; West Virginia University Hospitals, Inc. Morgantown, WV; Westmoreland Regional Hospital, part of Excela Health, Greensburg, PA; Wheeling Hospital, Wheeling, WV; and Windber Medical Center, Windber, PA.