Randomized controlled trial on the long-term efficacy of a multifaceted, interdisciplinary lifestyle intervention in reducing cardiovascular risk and improving lifestyle in patients at risk of cardiovascular disease

Lysanne Goyer, Robert Dufour, Caroline Janelle, Chantal Blais, Christine L'Abbé, Émilie Raymond, et al.

Journal of Behavioral Medicine

ISSN 0160-7715

J Behav Med
DOI 10.1007/s10865-012-9407-3

Springer

J Behav Med
DOI 10.1007/s10865-012-9407-3

Randomized controlled trial on the long-term efficacy of a multifaceted, interdisciplinary lifestyle intervention in reducing cardiovascular risk and improving lifestyle in patients at risk of cardiovascular disease

Lysanne Goyer · Robert Dufour · Caroline Janelle · Chantal Blais · Christine L'Abbé · Émilie Raymond · Jacques de Champlain · Pierre Larochelle

Received: March 29, 2011 / Accepted: February 9, 2012

Abstract The objective of the study was to evaluate the efficacy of an interdisciplinary intervention known as Educoeur in reducing cardiovascular risk and improving health behaviors in people without evidence of cardiovascular disease and to compare the Educoeur program to interventions in a specialized clinic and in usual care family practice. In a parallel, randomized, controlled trial of 185 adults with at least two modifiable cardiovascular risk factors, patients were randomly assigned to either Educoeur, specialized clinic or usual care. Cardiovascular risk, biological and lifestyle measures were assessed at baseline and at 2 years. In Educoeur, measurements were also taken before and after the lifestyle group treatment program. In 12 weeks, patients in Educoeur significantly lowered their cardiovascular risk, weight, body mass index, waist circumference, systolic blood pressure, kilocalories intake and improved their VO_2 Max and mental health. Changes remained significant at 2 years. Between group comparisons at 2 years demonstrated that Educoeur was significantly better in reducing cardiovascular risk than interventions in usual care. Together, these results highlight the importance of providing interdisciplinary programs that optimize cardiovascular risk reduction and promote active lifestyles in patients at risk of cardiovascular disease.

Keywords Cardiovascular risk factors · Primary prevention · Cardiovascular disease · Hypertension · Interdisciplinary lifestyle intervention · Health behavior · Nutritional intervention · Exercise

Introduction

An estimated 16.7 million of total global deaths result from various forms of cardiovascular disease (World Health Organization, 2003), and several very well-identified lifestyle factors influence the development of coronary heart disease. In 2004, the worldwide INTERHEART case–control study (Yusuf et al., 2004) reported that 90% of the population-attributable risk (PAR) of an initial acute myocardial infarction could be ascribed to nine modifiable risk factors: elevated ApolipoproteinB (ApoB)/ApoA1 ratio, smoking, psychosocial factors, abdominal obesity, hypertension, insufficient daily fruit and vegetable consumption, physical inactivity, diabetes and alcohol consumption (Lloyd-Jones et al., 2010; Yusuf et al., 2004). Hypercholesterolemia accounted for a PAR of 49.2% with an odds ratio (OR) of 3.25 (99% CI 2.81–3.79) while smoking represented a PAR of 35.7% with an OR of 2.87 (99% CI 2.58–3.19) and hypertension for a PAR of 17.9% with an OR of 1.91 (99% CI 1.74–2.10). Newer risk factors

Jacques de Champlain: Deceased after completion of this study.

L. Goyer · R. Dufour · C. Janelle · C. Blais · C. L'Abbé · É. Raymond · J. de Champlain · P. Larochelle (✉)
Institut de Recherches Cliniques de Montréal, 110 Avenue des Pins Ouest, Montreal, QC H2W 1R7, Canada
e-mail: pierre.larochelle@ircm.qc.ca

R. Dufour
Department of Nutrition, Université de Montréal, Montreal, QC, Canada

P. Larochelle
Department of Pharmacology, Université de Montréal and Centre Hospitalier de l'Université de Montréal (CHUM), Montreal, QC, Canada

Published online: 09 March 2012

such as psychosocial stress was associated with a PAR of 32.5% and an OR of 2.67 (99% CI 2.21–3.22) while regular physical activity was linked with a PAR of 12.2% and an OR of 0.86 (99% CI 0.76–0.97), and a diet rich in fruits and vegetables with a PAR of 13.6% and an OR of 0.70 (99% CI 0.62–0.79) (Yusuf et al., 2004).

Scientific evidence also shows that lifestyle interventions, risk factor management and cardioprotective medications can reduce cardiovascular morbidity and mortality (Graham et al., 2007) but that cardiovascular disease prevention in routine clinical practice is not adequate (Kotseva et al., 2009). Cardiac rehabilitation programs have yielded positive results and therefore been recommended in clinical guidelines for all patients with coronary artery disease and include the following core components: cardiovascular risk assessment and management (weight, lipids, blood pressure, diabetes mellitus, and smoking), nutritional and physical activity counseling as well as psychosocial interventions (Balady et al., 2007). These programs reduce the cardiovascular risk factors (Daubenmier et al., 2007; Eriksson et al., 2006; Haskell et al., 1994; Koertge et al., 2003), clinical events (Haskell et al., 1994; Linden, 2000; Lisspers et al., 2005; Sdringola et al., 2003), coronary atherosclerosis (Haskell et al., 1994; Linden, 2000; Lisspers et al., 2005; Ornish et al., 1998) and enhance health-related quality of life (QoL) (Koertge et al., 2003). Researchers argue that the effects of multicomponent interventions on coronary risks are additive (Gordon et al., 1997; Pickering, 2003) because a low-fat diet (Denke, 1995) exercise (Blumenthal et al., 2005; Taylor et al., 2004) and stress management (Blumenthal et al., 2005) reduce coronary risk individually and additively (Daubenmier et al., 2007). Accordingly, secondary prevention comprehensive cardiac rehabilitation programs that aim to improve diet, exercise and stress management have been recommended in clinical guidelines for all patients with coronary artery disease (Balady et al., 2000; Giannuzzi et al., 2003; Leon et al., 2005; Stone et al., 2001) based on studies that have demonstrated their efficacy in reducing morbidity and mortality (Gaede et al., 2003; Haskell et al., 1994; Ornish et al., 1990, 1998; Sdringola et al., 2003).

Altering cardiovascular risk factors through exercise and diet is essential but psychosocial factors which can influence the course of cardiovascular disease (Goyer, 2004; Rozanski et al., 2005) also need to be included. A variety of behavioral and psychosocial interventions have been implemented in cardiac patients and have yielded positive results (Berkman et al., 2003; Frasure-Smith & Prince, 1985; Friedman et al., 1986). It would appear from these studies and a meta-analysis of psychosocial interventions on cardiovascular outcomes (Dusseldorp et al., 1999) that the benefits depended on the efficacy of the psychosocial interventions and when psychological distress was reduced, the odds ratio for mortality and recurrent myocardial infarction was also reduced. Nordmann et al. (2001) have however concluded that low intensity interventions addressing the modification of multiple cardiovascular risk factors can improve awareness but rarely show clinical benefits. Commonality in successful programs seems to be an intense and comprehensive format in combination with long duration of contact and follow-up (Lisspers et al., 2005).

A systematic review of counseling and educational methods to prevent cardiovascular diseases (Ebrahim & Smith, 1997) and a more recent Cochrane review by the same authors (Ebrahim et al., 2011) reported that interventions using counseling and education aimed at behavior change may be effective in high risk hypertensive or diabetic populations but did not appear to reduce coronary artery disease mortality or clinical events in general populations possibly because only small changes in risk factors were reported in these studies and these changes were not maintained.

These results of INTERHEART and cardiovascular risk intervention studies imply that implementing preventive strategies on modifiable factors could avert some premature coronary heart disease worldwide. In addition to studies comparing the efficacy of different treatment modalities in reducing cardiovascular risk, different approaches to behavioral change are needed and should be tested before they are promoted and then compared to other treatment approaches in randomized controlled trials (Ebrahim et al., 2011). It then becomes important to demonstrate that an interdisciplinary intervention can reduce cardiovascular risk, improve health behaviors and add to the benefit of medical and pharmaceutical interventions. The period from progression of atherosclerosis to clinical disease provides an excellent opportunity for health professionals to modify risk factors by promoting multifaceted intervention programs (nutrition, physical activity and psychosocial management) to help people lower their cardiovascular risk.

The objective of this study was therefore to evaluate the efficacy of an interdisciplinary primary prevention program known as Educoeur to reduce cardiovascular risk and improve health behaviors at 6 and 24 months in people without evidence of cardiovascular disease. The efficacy of this program was also compared to an intervention in a specialized clinic and usual care on the cardiovascular risk, biological markers and health behaviors in patients at 24 months. Our hypothesis was that the Educoeur program would reduce cardiovascular risk, improve health behaviors at 6 months and would be more effective than both medical interventions in reducing cardiovascular risk and improving health behaviors at 2 years.

Methods

Participants

Men and women aged 35–70 years were recruited through newspaper advertisements in Montreal, Canada, from October 2004 to October 2007. Initially, 1,580 subjects inquired about the study and were screened by a nurse for study participation. They were informed that there would be a randomization to three possible treatment alternatives, that a signed consent would be required along with a physical exam, blood work, questionnaire completion, and that a second visit would be required to provide them with their lab results which would be sent to their family doctor. They were also informed that if they were randomized to usual care, they would have to come back for reevaluation at the two-year follow-up. 404 patients were accepted for a physical exam with blood analysis to determine if they met eligibility criteria for inclusion in a parallel, randomized, controlled trial (Fig. 1). Patients had to have at least 2 cardiovascular risk factors: systolic blood pressure (SBP) $\geq$ 140 mmHg; diastolic blood pressure (DBP) $\geq$ 90 mmHg; elevated low-density lipoprotein-cholesterol (LDL-C) ($\geq$2.5 mmol/l if Framingham cardiovascular risk over 10 years was $\geq$20%, $\geq$3.5 mmol/l if risk was between 11 and 19%, and $\geq$4.5 mmol/l if risk was $\leq$10%); elevated total cholesterol/high-density lipoprotein-cholesterol (HDL-C) ($\geq$4.0 if risk was $\geq$20%, $\geq$5.0 if risk was between 11 and 19%, and $\geq$6.0 if risk was $\leq$10%); uncontrolled type 2 diabetes (glycated hemoglobin $\geq$ 7%); smoking; and body mass index (BMI) $\geq$ 30 kg/m^2. Subjects were excluded if they had: coronary artery disease, heart failure, renal insufficiency, intermittent claudication, stroke, type 1 diabetes, and a self-reported history of non-adherence to treatment. Volunteers were randomized to either Educoeur, specialized clinic or usual care. 185 patients were randomized in the protocol of which 32 were lost to follow-up at 2 years. This represents a loss to follow-up of 17% (Educoeur $n = 14$, specialized clinic $n = 6$, usual care $n = 12$). Medications or their dosing for their various conditions were prescribed by their physicians as they determined. Analyses were undertaken in 153 participants who completed the 2-year protocol: Educoeur $n = 48$, specialized clinic $n = 55$ and usual care $n = 50$. The study was approved by the Clinical Research Ethics Committee of the IRCM, and written informed consent was obtained from all participants before study enrollment.

Study protocol

Patients in Educoeur were assessed on biological and psychosocial parameters prior to and immediately following the 12-week group treatment program to determine if the treatment was effective in reducing cardiovascular risk and improving health behaviors. Patients in all groups (Educoeur, specialized clinic and usual care) were followed for 2 years and results were then compared. The primary endpoint was cardiovascular risk reduction, using Framingham risk calculation (D'Agostino et al., 2008) and the PROCAM algorithm (Assmann et al., 2002). Secondary endpoints were improvement in weight, BMI, waist circumference, systolic blood pressure, diastolic blood pressure, biochemical parameters (glucose, HbA1c, cholesterol, LDL-C, HDL-C, total cholesterol/HDL-C, triglycerides,

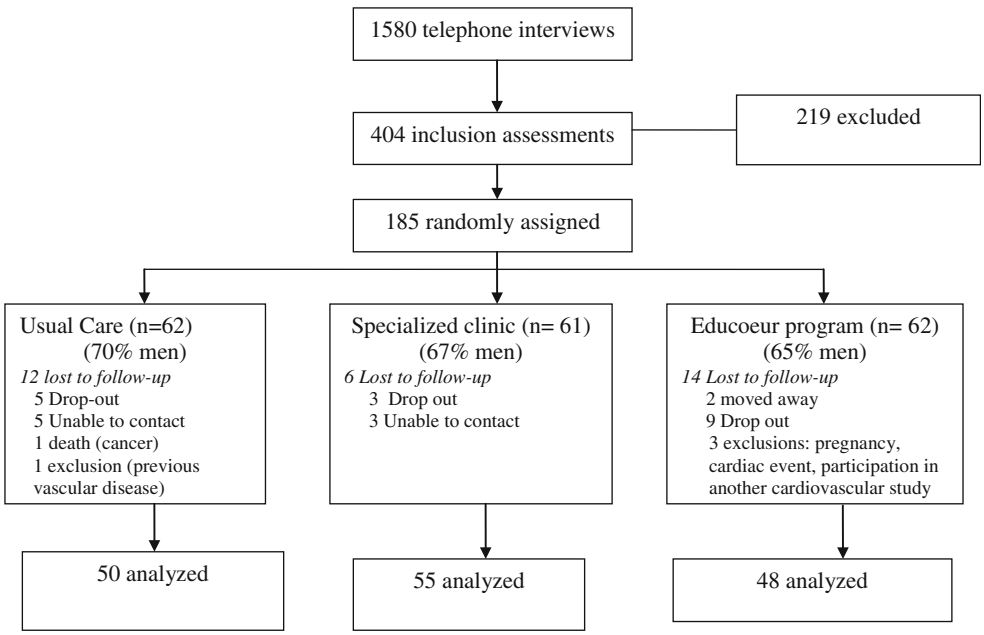

Fig. 1 Trial profile

ApoBlipoprotein), nutritional parameters (kilocalories, lipids, saturated fatty acids, sodium), physical activity (VO_2 max ml/kg/min, physical activity practice in METS-h/week), and psychological parameters (mental health and depression).

Randomization and masking

The 1–1 random allocation sequence of patients was developed by an independent organization (Montreal Heart Institute Coordinating Center). When patients met the inclusion criteria, they signed a second consent form, were given a sealed envelope containing their group assignment by a nurse blinded to the envelope content, and then learned of the group to which they were randomized. All participants received a complete interdisciplinary evaluation at baseline and at 2 years. Patients randomized to Educoeur were also evaluated immediately in post-intensive group sessions at 6 months and 1-year follow-up. Patients allocated to specialized clinic and usual care groups were referred to physicians not involved in the Educoeur program and vice versa.

Interdisciplinary Educoeur program

The Educoeur program of lifestyle modification was conducted by nutritionists, psychologists and kinesiologists with follow-up by nurses and physicians. Patients received 12 weekly group sessions of 3 h between months 3 and 6 of the study. Every 3-h group meeting was divided in 3 educational and experimental sessions focusing equally on nutrition, physical activity and stress management/motivation. Patients were therefore exposed to 12 h in nutrition, in physical activity and in stress management.

Nutrition

The purpose of the nutritional intervention aimed to develop patient awareness about healthier food choices that favorably influence major cardiovascular risk factors, to provide learning tools and a classroom environment where integration/practice of these learning tools was central to help them develop and maintain healthy behaviors. Dietary guidelines consisted of reducing saturated and trans fatty acids to 7% or less of total energy per day, increasing poly- and mono-unsaturated fats, targeting more specifically the consumption of two fish meals per week, lowering sodium content of the diet to 2,300 mg or less per day and increasing soluble dietary fiber intake to 5–10 g daily. It also consisted of educational visits to food stores, and providing information on labeling and cooking habits.

Stress management training

This section aimed at increasing patient awareness of how behaviors and thoughts affect our health, providing motivational and psychosocial tools to help them develop and maintain healthier lifestyles as well as developing stress management coping skills for increased psychological well-being. The content of the sessions were inspired by Prochaska's stages of change (Prochaska et al., 1994), the Health belief model (Fishbein & Ajzen, 1975) and Motivational interviewing (Rollnick et al., 2008). Educational tools developed for each session were inspired from the psychosocial factors identified in the literature to be effective with cardiovascular patients. Since depression, hostility, social support and stress have been shown to have an impact on cardiovascular disease, an effort was made to provide educational tools helpful in those respects. Tools provided were always developed in consideration of the behavioral changes required in physical activity, nutrition, smoking cessation and in their personal lives.

Exercise

The kinesiologist aimed to educate participants about the safety and benefits of exercise despite cardiovascular risk factors and to increase physical activity practice to meet the recommendation of energy expenditure of at least 1,000 kcal $week^{-1}$ (American College of Medicine Position Stand, 1998). The physical activity session started with a 10 min educational information on various subjects such as heart rate measurement, use of pedometer, benefits of exercise on blood pressure, glucose measurements followed by a warm up session and 35 min of core training with a cardiovascular exercise at 60–80% of maximal heart rate and an endurance strength training. Exercises consisted of circuit training, aerobic DVD exposition or a brisk supervised walk outside.

Follow-up group sessions were provided every 3 months until the end of the 2-year protocol. Patients also had access to individualized interventions with each professional on the team every 3 months for the remaining 18 months of the study.

Specialized care intervention

Participants were referred to a physician specialized in cardiovascular prevention at the IRCM. The frequency of their medical follow-ups was not fixed by the study protocol but instead determined by their health status. When judged necessary, the specialist could refer to the staff nutritionist for assessment and follow-up. In general, the duration and frequency of interaction could vary from 15 to 60 min every 6 months. Participants also received a phone

call at 1 year for address verification and to remind them of the 2-year follow-up.

Usual care intervention

Participants were referred to their family physician, providing the results of their blood work along with medical recommendations and informing them they would be called at 2 years for a final assessment. Decision regarding the duration and frequency of interaction between the participant and his family physician was left to the latter and was not monitored to minimize the risk of influencing "usual care". The usual care patients were only contacted at 1 year for address verification and to remind them of the 2-year follow-up.

Measurements

Cardiovascular risk

Cardiovascular risk assessment was undertaken in Educoeur immediately after the 12-week group treatment program and at the 1-year mark. Cardiovascular risk was assessed at baseline and at 2 years in all three groups, using Framingham risk calculation and the PROCAM algorithm.

Anthropometrics

Body weight was measured with a Cardinal Detecto electronic scale, and height was quantified with a Seca stadiometer. Body Mass Index was then calculated by dividing weight (kg) by squared height (m^2). Waist circumference was appraised by the kinesiologist with a measuring tape to the nearest 0.1 cm, mid-way between the iliac crest and the last rib. Blood pressure was estimated manually 3 times at each visit with a mercury sphygmomanometer according to a standardized method. Body fat percentage was calculated in the morning by bipodal bioelectrical impedance (TANITA TBF-310) at baseline and at 2 years (Kyle et al., 2004).

Plasma analyses

Biochemical parameters were measured with an Advia 1800 Chemistry System Analyser from Siemens.

Exercise capacity

Physical activity practice was assessed at baseline, after the 6-month group treatment program in Educoeur and at 2 years for all groups by 2 validated questionnaires: the Modifiable Activity Questionnaire (Kriska et al., 1990) and the Healthy Physical Activity Participation Questionnaire (Shephard & Bouchard, 1994). Cardiorespiratory fitness was appraised by a maximal graded exercise treadmill test according to the Bruce protocol (Bruce et al., 1973).

Psychosocial variables

Mental health was gauged with the SF-12V2 (Ware et al., 2002) QoL questionnaire. Depressive symptom severity was evaluated with the validated, self-reported Beck Depression Inventory-II (BDI-II) (Beck et al., 1996).

Nutritional assessments

Nutrition was appraised by 24-h recall of food intake. To assess daily caloric intake and absolute values for lipids, carbohydrates, proteins, alcohol, sodium as well as the percentage of total calories from these macronutrients, a food frequency questionnaire was administered with the Canadian nutrient file from Health Canada (2007).

Sample size

To determine sample size, we calculated the risk profile of 200 patients referred to the IRCM and a 20% improvement in these results. A recruitment period of 3 years was planned and sample size was calculated with a statistical power of 80%, an alpha error of 0.05 and less than 10% of subjects lost to follow-up. Considering that the 88% rate of ineligibility significantly delayed recruitment, and that pre- and post-analyses of the 12-week Educoeur treatment program demonstrated the predicted cardiovascular risk reduction as well as improvement in nutrition, physical activity and well-being, a sample size of 60 patients in each group was calculated to be sufficient to detect significant differences.

Statistical analysis

185 randomized subjects underwent baseline analyses. ANOVA and Chi-square tests were conducted to verify homogeneity of the 3 treatment groups at baseline for all variables (Table 1). Pre-post analyses were undertaken in 153 participants who completed the 2-year protocol. Repeated-measures ANOVA tested the effects of time (baseline, 3, 6, 12 and 24 months) and their interaction on coronary risk, health behaviors (diet and exercise) as well as psychological well-being for Educoeur (Table 2). Repeated-measures ANOVA compared the impact of Educoeur, specialized clinic and usual care on cardiovascular risk, biological markers, nutrition, exercise and psychological parameters from baseline to 2 years (Table 3). Analyses of changes between baseline and 2 years were

Table 1 Baseline values

	All patients ($n = 185$)	Educoeur ($n = 62$)	Specialized clinic ($n = 61$)	Usual care ($n = 62$)	p Value
CV risk score Framingham	14.1 ± 4.1	13.3 ± 4.1	14.5 ± 4.0	14.3 ± 4.2	0.230
CV risk % Framingham	17.5 ± 8.8	16.0 ± 9.1	18.3 ± 8.5	18.1 ± 8.7	–
CV risk score Procam	41.0 ± 9.4	39.4 ± 8.4	41.1 ± 8.8	42.3 ± 10.7	0.256
CV risk % Procam	8.9 ± 6.9	7.6 ± 5.7	8.7 ± 6.1	10.1 ± 8.3	–
Age (years)	54.4 ± 8.6	53.1 ± 8.3	54.4 ± 9.3	55.7 ± 8.3	0.235
Male (no. %)	124 (67.0)	40 (64.5)	40 (65.6)	44 (71.0)	0.715
Employment (yes. %)	125 (67.6)	43 (69.4)	42 (68.9)	40 (64.5)	0.819
College degree (%)	152 (82.6)	48 (78.7)	49 (80.3)	55 (88.7)	0.289
White (%)	179 (96.8)	58 (93.5)	61 (100)	60 (96.8)	0.130
Weight (kg)	92.7 ± 20.5	94.4 ± 21.9	92.4 ± 20.9	91.4 ± 18.7	0.713
Waist circumference (cm)	105.1 ± 16.0	105.8 ± 17.8	106.0 ± 14.4	103.5 ± 15.4	0.597
BMI (kg/m^2)	32.0 ± 6.5	32.5 ± 7.2	32.3 ± 6.5	31.3 ± 5.8	0.556
Smoking (%)	46	14	19	13	0.701
SBP (mm Hg)	137.4 ± 17.5	135.8 ± 16.5	137.1 ± 19.7	139.1 ± 16.4	0.448
DBP (mm Hg)	85.8 ± 10.3	86.3 ± 10.5	84.6 ± 9.4	86.5 ± 11.0	0.340
Cholesterol (mmol/l)	5.4 ± 1.2	5.4 ± 1.2	5.4 ± 1.2	5.5 ± 1.2	0.583
HDL-C (mmol/l)	1.3 ± 0.4	1.3 ± 0.4	1.3 ± 0.4	1.4 ± 0.4	0.271
LDL-C (mmol/l)	3.1 ± 1.0	3.2 ± 1.0	3.1 ± 1.0	3.2 ± 1.0	0.562
Triglycerides	2.2 ± 1.3	2.0 ± 1.2	2.5 ± 1.6	2.1 ± 1.2	0.088
C/HDL	4.3 ± 1.2	4.3 ± 0.9	4.3 ± 1.0	4.3 ± 1.6	0.940
Apo B (mmol/l)	1.0 ± 0.2	1.0 ± 0.2	1.0 ± 0.2	1.1 ± 0.3	0.665
Glucose (mmol/l)	6.6 ± 2.5	6.5 ± 2.1	6.5 ± 2.4	6.8 ± 3.1	0.897
HbA_1c (%)	6.1 ± 1.3	6.1 ± 1.2	6.1 ± 1.3	6.2 ± 1.6	0.836
Ur Sodium (mmol/l)	108 ± 43	111 ± 43	106 ± 43	106 ± 43	0.753
Physical activity					
VO_2 max (ml/kg/min)	28.0 ± 7.6	27.8 ± 7.8	28.0 ± 7.7	28.3 ± 7.4	0.933
Physical activity practice (Mets*h/week)	16.0 ± 19.6	14.2 ± 16.0	15.5 ± 20.3	18.4 ± 22.0	0.489
Nutrition/day					
Energy (Kcal)	2,786 ± 875	2,744 ± 837	2,847 ± 931	2,768 ± 867	0.795
Lipids (g)	109.1 ± 42.6	107.1 ± 44.8	111.3 ± 42.5	108.7 ± 41.1	0.860
Saturated fatty acids (g)	35.2 ± 16.7	35.5 ± 17.1	35.4 ± 15.4	34.6 ± 17.6	0.947
Sodium (mg)	3,332 ± 1,304	3,334 ± 1,193	3,307 ± 1,285	3,355 ± 1,442	0.980
Psychosocial variables					
Mental health (SF-12/MCS)	44.9 ± 9.65	45.7 ± 9.7	44.2 ± 10.5	44.9 ± 8.7	0.669
Depression (BDI-II)	10.2 ± 8.2	9.0 ± 7.5	10.9 ± 9.1	10.6± 8.0	0.401

p Value—homogeneity between groups

limited to patients with complete outcome data at 2-year follow-up. Significance was set at $p \leq 0.05$.

Results

Baseline characteristics

185 participants were randomized to 3 treatment groups: 62 in Educoeur, 61 in specialized clinic and 62 in usual care. The baseline data on demographic and clinical characteristics are summarized in Table 1. No differences were found between the 3 groups and there was homogeneity in all baseline values. Residual analyses were done to verify the normality of distribution and were robust. There were 32 patients who did not complete the trial in the three groups (Educoeur = 14, specialized clinic = 6, usual care = 12). The proportion of lost to follow up was not different between groups which is coherent with a pattern of missing completely at random data. Reasons for discontinuation are

Table 2 Educoeur group

	Educoeur baseline ($n = 62$)	Post-group ($n = 54$)	12 months ($n = 50$)	24 months ($n = 48$)
CV risk % Framinghan	16.0 ± 9.1	13.3 ± 8.8 ≤ 0.001	13.7 ± 9.3 ≤ 0.003	14.6 ± 9.4 ≤ 0.005
CV risk % Procam	7.6 ± 5.6	6.0 ± 5.5 ≤ 0.002	6.4 ± 5.4	7.1 ± 6.1
Weight (kg)	94.4 ± 21.9	91.8 ± 20.5 ≤ 0.001	92.1 ± 20.6 ≤ 0.001	92.7 ± 21.3 ≤ 0.001
Waist circumference (cm)	105.8 ± 17.8	102.4 ± 16.4 ≤ 0.001	102.4 ± 16.1 ≤ 0.001	102.9 ± 16.4 ≤ 0.002
BMI (kg/m^2)	32.5 ± 7.2	31.5 ± 6.9 ≤ 0.001	31.5 ± ± 6.6 ≤ 0.001	31.5 ± 6.6 ≤ 0.001
SBP (mmHg)	135.8 ± 16.5	124.8 ± 14.1 ≤ 0.001	123.8 ± 10.4 ≤ 0.001	122.3 ± 11.6 ≤ 0.001
DBP (mmHg)	86.3 ± 10.5	79.5 ± 7.9 ≤ 0.001	78.5 ± 8.1 ≤ 0.001	77.5 ± 8.1 ≤ 0.001
Cholesterol (mmol/l)	5.4 ± 1.2	4.7 ± 1.3 ≤ 0.001	4.9 ± 1.2 ≤ 0.003	4.7 ± 1.3 ≤ 0.001
HDL-C (mmol/l)	1.3 ± 0.4	1.3 ± 0.4	1.3 ± 0.4	1.3 ± 0.4
LDL-C (mmol/l)	3.2 ± 1.0	2.7 ± 0.9 = 0.02	2.8 ± 1.0	2.7 ± 1.0 = 0.046
Triglycerides (mmol/l)	2.0 ± 1.2	1.6 ± 0.8 = 0.013	1.5 ± 0.7 = 0.007	1.6 ± 0.9 = 0.047
C/HDL	4.3 ± 0.9	3.8 ± 0.9 ≤ 0.001	3.9 ± 0.9 = 0.002	3.8 ± 1.0 ≤ 0.005
Apo B (mmol/l)	1.0 ± 0.3	0.9 ± 0.2 ≤ 0.001	1.0 ± 0.3 ≤ 0.001	0.9 ± 0.2 ≤ 0.001
Glucose (mmol/l)	6.5 ± 2.1	5.7 ± 1.1 ≤ 0.008	5.9 ± 1.4 = 0.007	5.9 ± 1.3
HbA_1c (%)	6.1 ± 1.2	5.7 ± 0.6 ≤ 0.002	5.7 ± 0.8 = 0.03	5.9 ± 0.7
Ur Sodium (mmol/l)	111 ± 43	98 ± 41	100 ± 43	90 ± 40
Physical activity				
VO_2 max (ml/kg/min)	27.8 ± 7.8	29.9 ± 8.2 ≤ 0.001	30.1 ± 9.0 ≤ 0.001	30.3 ± 7.7 ≤ 0.01
Physical activity practice (Mets*h/week)	14.2 ± 15.9	26.0 ± 20.2 ≤ 0.001	25.5 ± 2.5 ≤ 0.001	24.8 ± 22 ≤ 0.001
Nutrition/day				
Energy (Kcal)	2,744 ± 837	2,381 ± 694 ≤ 0.001	2,409 ± 763 ≤ 0.001	2,473 ± 770 ≤ 0.001
Lipids (g)	107.1 ± 44.8	81.5 ± 32.4 ≤ 0.001	86.8 ± 40.8 ≤ 0.001	89.9 ± 35.1 ≤ 0.001
Saturated fatty acids (g)	35.5 ± 17.1	23.9 ± 11.6 ≤ 0.001	25.8 ± 15.6 ≤ 0.001	27.2 ± 12.7 ≤ 0.001
Sodium (mg)	3,334 ± 1,193	2,581 ± 962 ≤ 0.001	2,767 ± 1,273 ≤ 0.001	2,861 ± 1,342 ≤ 0.001
Psychosocial variables				
Mental health (SF-12/MCS)	45.9 ± 8.9	48.8 ± 8.4	49.7 ± 8.3 ≤ 0.012	51.7 ± 8.2 ≤ 0.001
Depression (BDI-II)	9.0 ± 7.5	4.7 ± 4.7 ≤ 0.001	4.1 ± 4.4 ≤ 0.001	4.4 ± 5.0 = 0.004

p Value between measurements versus baseline

indicated in Fig. 1. In Educoeur, nine of the 14 patients dropped out of the study because they were either unavailable to attend the group sessions between the 2nd and 6th visit or due to conflicting schedules. In the group of usual care, five patients were unreachable despite having information on relatives in their file and could not be contacted. In the specialized clinic group, three patients could not be reached and three patients dropped out because they lost interest in the study. No predictors of drop ut such as age, gender, educational level or occupation were identified.

Interventions

Patients in Educoeur were seen every 3 months at the clinic, had complete biopsychosocial assessment at inclusion, 6, 12 and 24 months in addition to their 12 weekly sessions with the interdisciplinary team between months 3 and 6 of the study protocol. Patients in the specialized clinic were seen at inclusion and at 24 months for complete biopsychosocial assessment and were then seen by their medical specialist for an average of 3.2 ± 2.0 visits and by the staff nutritionist for an average of 3.0 ± 1.7 visits for the 2-year duration of the trial. In the usual care group, visits to the family physician were not documented.

Changes in cardiovascular risk and life habits with Educoeur

Table 2 reports the results at the end of the Educoeur program, at 12 and 24 months. In 12 weeks, patients at moderate risk of cardiovascular disease reduced their Framingham cardiovascular risk from 16.0 to 13.3% ($p \leq 0.001$) along with an improvement in most biological markers, nutritional, physical activity and psychological parameters which remained significant at the 2-year final assessment.

Table 3 Results at two years for the groups under comparison

	Educoeur ($n = 48$) 2 years	Specialized clinic ($n = 55$) 2 years	Usual care ($n = 50$) 2 years
CV risk Framingham %	14.6 ± 9.4 = 0.047(CS)	17.7 ± 9.1	19.1 ± 8.7
CV risk Procam %	7.1 ± 6.1	8.4 ± 6.5	8.6 ± 7.2
Weight (kg)	92.7 ± 21.3 = 0.022	90.9 ± 22.7	92.3 ± 19.8
Waist circumference (cm)	102.9 ± 16.4	103.8 ± 15.5	104.2 ± 15.4
BMI (kg/m^2)	31.5 ± 6.6 = 0.018	31.7 ± 7.0	31.5 ± 6.5
SBP (mmHg)	122.3 ± 11.6 ≤ 0.001(UC)	128.8 ± 11.5	134.6 ± 13.8
DBP (mmHg)	77.5 ± 8.0	79.1 ± 8.2	82.2 ± 8.0
Cholesterol (mmol/l)	4.7 ± 1.3	5.0 ± 1.1	4.9 ± 1.0
HDL-C (mmol/l)	1.3 ± 0.4	1.3 ± 0.3	1.3 ± 0.4
LDL-C (mmol/l)	2.7 ± 1.0	2.8 ± 0.9	2.8 ± 0.9
Triglycerides (mmol/l)	1.6 ± 0.9	2.1 ± 1.7	1.8 ± 1.0
C/HDL	3.8 ± 1.0	4.0 ± 0.8	3.9 ± 1.0
Apo B	0.9 ± 0.2	0.9 ± 0.2	0.9 ± 0.2
Glucose (mmol/l)	5.9 ± 1.3	6.2 ± 2.1	6.4 ± 1.8
HbA_1c (%)	6.0 ± 1.3	6.1 ± 1.0	6.3 ± 1.3
Ur Sodium (mmol/l)	90 ± 40 = 0.058	101.1 ± 47	111 ± 44
Physical activity			
VO_2 max (ml/kg/min)	30.3 ± 7.7 ≤ 0.001	27.9 ± 8.7	27.7 ± 7.7
Physical activity practice (Mets*h/week)	24.8 ± 22.4	19.4 ± 24.6	21.1 ± 24.6
Nutrition/day			
Energy (Kcal)	2,473 ± 770	2,616 ± 815	2,456 ± 834
Lipids (g)	89.9 ± 35.1	101.7 ± 44.2	100.5 ± 51.3
Saturated fatty acids (g)	27.2 ± 12.7 ≤ 0.004	31.9 ± 17.0	32.2 ± 17.8
Sodium (mg)	2,861 ± 1,342	3,047 ± 1,157	2,930 ± 1,353
Psychosocial variables			
Mental health (SF-12 MCS)	51.7 ± 8.2 = 0.012(CS)	45.4 ± 12.5	48.0 ± 10.7
Depression (BDI-II)	4.4 ± 5.0 < 0.001(CS)	10.6 ± 10.6	7.7 ± 6.6

p Value between changes in Educoeur and changes in other groups

Comparison of interventions at 2 years

Biological markers

Table 3 reports the effects of interventions in the 3 groups. The Framingham cardiovascular risk calculations declined from 16 to 14.6% in the Educoeur group ($p \leq 0.005$) in spite of the fact that participants gained 2 years of age during that period. The text describes the results as a difference in improvement in the Framingham cardiovascular risk between the three groups ($p = 0.04$) and a greater reduction than in the usual care group ($p = 0.047$). There was also a greater reduction in the systolic blood pressure ($p \leq 0.001$) in the Educoeur group than in the usual care group. Physical fitness measured by VO_2 max (ml/kg/min) showed greater improvement in Educoeur ($p \leq 0.001$) than in the other two groups. There were no differences in smoking cessation.

Anthropometric measures

On average, the patients in Educoeur lost 2.9 kg ($p \leq 0.001$) and lowered their body mass index by 1.0 kg/m^2 ($p \leq 0.001$) whereas patients in the specialized clinic and usual care did not lose weight and their body mass index remained unchanged at 2 years. The reduction of waist circumference and adiposity was similar in the 3 groups.

Exercise and nutrition

Patients in Educoeur increased their VO_2 max from baseline to 2 years with improvement from 27.8 ± 7.8 to 30.3 ± 7.7 ($p \leq 0.001$) when estimated in ml/kg/min by the Bruce formula and from 2.60 ± 0.71 to 2.71 ± 0.76 ($p \leq 0.01$) when translated in l/min to control for weight. The specialized clinic group ($p = 0.575$) and usual care group ($p = 0.09$) showed a non-significant trend to

decrease their VO_2peak from baseline to 2 years. Educoeur and specialized clinic interventions ($p = 0.022$) were both effective in reducing saturated fatty acids in patients during the 2-year trial in comparison to patients in usual care ($p = 0.179$) who remained stable over time.

Psychological well-being

Educoeur patients showed minimum symptoms of depression on the Beck Depression Inventory (BDI-II index) with a score of 9.0 ± 7.5 at study onset. These patients were close to being categorized as mild depression since a score of 0–9 indicates minimal depression and a score of 10–18 would indicate mild depression. They improved in 6 months ($p \leq 0.001$) and over the course of the two-year program, as they obtained a score of 4.4 ± 5.0 on the inventory.

The mental health and depression inventory remained stable in patients referred to specialized clinic and usual care over time whereas patients in Educoeur manifested improvement at 2 years ($p \leq 0.001$) and significantly better than the patients in the specialized clinic group ($p \leq 0.001$). Psychological well-being measured by the SF-12 ($p = 0.022$) improved more in the Educoeur group compared to the specialized clinic group ($p = 0.014$) but not different than in the usual care group ($p = 0.270$). Depression index measured by the BDI-II questionnaires improved in the Educoeur group ($p \leq 0.001$) and more than in the specialized clinic group ($p \leq 0.001$).

Medication

Patients in specialized clinic used more medications (antihypertensive, hypolipidemics, antidiabetics, antithrombotics, anti anxiety and sedative agents) at the end of the study ($p \leq 0.001$) and more than the patients in Educoeur ($p = 0.012$). No significant differences were found in the use of individual classes of medications except for patients on antihypertensive treatment. Patients in specialized clinic used also more antihypertensive medication at the end of the trial ($p = 0.001$) and there was a trend for a greater use in the patients in the usual care group ($p = 0.063$). Patients in specialized clinic used more antihypertensive medications than patients in Educoeur ($p = 0.038$) at 2 years (Table 4). More patients reduced their antihypertensive medications in Educoeur than in the other 2 groups (Table 4) despite having a lower systolic BP.

Discussion

This randomized, controlled trial in subjects with multiple risk factors but without prior clinical evidence of vascular disease, demonstrates that a comprehensive interdisciplinary program with specific core components similar to those proposed (Balady et al., 2007) in secondary prevention is effective in reducing cardiovascular risk and improving health behaviors in 6 months, and more effective than interventions in a specialized clinic or in usual care practice at lowering cardiovascular risk and improving health habits over a 2-year period.

Educoeur patients reduced their 10-year Framingham cardiovascular risk from 16.0% at baseline to 13.3% in 12 weeks and improved their health habits for up to 2 years. These lifestyle modifications over 2 years translated into significant improvements of systolic blood pressure and plasma total cholesterol, two major components of the Framingham risk score. These beneficial effects of the program have more than counteracted the important negative impact of increasing age on cardiovascular risk estimation, affecting all participants. Cardiorespiratory fitness was significantly enhanced by 0.54 Metabolic Equivalent (MET) which corresponds to an 8% decrease in cardiovascular risk according to studies demonstrating that improvement in cardiorespiratory fitness of 1 MET leads to a reduction of 15% in cardiovascular mortality independently of other risk factors (Myers et al., 2002). Educoeur patients improved their diet with a reduction in kilocalories, saturated fats, total lipids and sodium for the 2-year study duration. This corroborates the findings of a meta-analysis suggesting that, at an average follow-up time of 3 years, lifestyle interventions significantly reduce body weight and cardiovascular risk factors in overweight people (Galani & Schneider, 2007). Patients in Educoeur also used fewer medications than those in the other groups, used fewer antihypertensive medications than patients in specialized clinic and had a significantly lower systolic BP.

Although Educoeur patients were relatively well psychologically at study onset, they improved further throughout the 2-year protocol. The mean value of the depression inventory improved throughout the study in the Educoeur program, moving from the mild to the minimum symptoms category of depression while it did not change in the specialized clinic and in the usual care groups. These results point to the importance of addressing depression during treatment since it is an established risk factor in cardiovascular disease. As noted previously, failure to incorporate psychosocial interventions may identify a subgroup of patients who are particularly susceptible to adverse clinical events (Carney et al., 2004).

Evaluation of interventions in our patients appears to indicate that it is the multi-faceted supportive approach that creates synergy, resulting in multiple behavior changes and cardiovascular risk reduction. This has been reported previously by others (Daubenmier et al., 2007). Educoeur patients improved on psychological variables (mental

Table 4 Medication changes

	Medication ($n = 185$)		
	Educoeur ($n = 62$)	Specialized clinic ($n = 61$)	Usual care ($n = 62$)
(*A*)[a]			
0	1.85 ± 0.26	2.38 ± 0.26	1.96 ± 0.27
24 months	2.01 ± 0.30	3.27 ± 0.30	2.33 ± 0.31
	Antihypertensive medication ($n = 118$)		
	Educoeur ($n = 35$)	Specialized clinic ($n = 44$)	Usual care ($n = 39$)
(*B*)[b]			
Reduction	12	4	6
No change	10	17	18
Increase	13	23	15

[a] Number of medications (mean ± SD) taken by patient at time 0 and 24 months; $p = 0.032$ between Educoeur-specialized clinic-usual care at 24 months; $p \leq 0.001$/specialized clinic at 0 and 24 months; $p = 0.012$/between Educoeur and specialized clinic

[b] Number of patients on antihypertensive medication with a reduction or an increase in the number of medications at 2 years; $p < 0.038$ between specialized clinic and Educoeur

health and depression questionnaires), while patients in specialized clinic remained stable, although slightly elevated, and those in usual care improved on the depression inventory. Mini-interventions by the interdisciplinary team at screening and a comprehensive baseline assessment could have motivated patients to take charge of their health habits more than regular controls. Family physicians in usual care also routinely pay attention to mental health whereas specialized clinic physicians focus on their specialty, not on mental health.

The EUROASPIRE Study Group recently published a report on cardiovascular prevention guidelines in daily practice that yielded results on risk factor status of patients in the year after a cardiac event (Kotseva et al., 2009). These authors observed that cardiac risk factors were on the rise in the 2006–2007 survey with a fifth of patients continuing to smoke after 12 years, that 40% were obese (BMI 30 kg/m^2 or higher) and 30% had diabetes mellitus. Multifaceted and interdisciplinary approaches are needed when multiple health behaviors/risk factors have to be improved and psychological issues are involved in the process. Although the Ornish trial (Ornish et al., 1998) was judged to lack external validity, it nonetheless was instrumental in demonstrating that a 5-year intensive lifestyle program in patients with moderate to severe coronary heart disease could reduce coronary atherosclerosis after 1 year and that more regression occurred after 5 years while more than twice as many cardiac events afflicted the control group. Interdisciplinary programs in primary (Blumenthal et al., 2010; Eriksson et al., 2006; Tuomilehto et al., 2001) and secondary prevention (Ornish et al., 1998; Sdringola et al., 2003) have shown their utility and efficacy in the treatment of coronary artery disease to the point where many organizations (Antman et al., 2004; Balady et al., 2007; De Backer et al., 2003; Leon et al., 2005) have been recommending their integration in the comprehensive care of patients with cardiovascular disease (Balady et al., 2007). The innovative character of the Educoeur program is its interdisciplinary approach in primary prevention, where health professionals work together to optimize long-term cardiovascular risk reduction, fostering healthy behaviors in terms of nutrition, physical activity and psychological well-being.

Trial limitations

There was a bias in the patient selection process in this study. People who responded to newspaper advertisements were mainly white, educated and motivated to change their lifestyle. Dropout rate and lost to follow up represented 17% of the patients. There were no statistical differences in the baseline characteristics of the patients who did not complete the trial but patients in the Educoeur group dropped out mainly because of the time commitment required to participate in the 12-week program. Randomization, however, reduces the selection bias in patients who were selected. Underestimation of the treatment effect was also possible because the control group did not worsen with time, and patients remained stable during the 2-year period, indicating that "mini-interventions" by the interdisciplinary team at screening and comprehensive baseline assessment might have alerted patients and their doctors of the need for change. Our intervention is multifaceted and the relative efficacy of its components cannot be determined. Medications were not discontinued in any of the groups at study onset. There were no significant changes in medi-

cation use between groups although patients in the specialized clinic used more medication as time went on and more so than patients in Educoeur. There was a trend towards fewer antihypertensive medications in the Educoeur group which proves to be clinically significant. Our results can be extrapolated to real life practice to some degree and reflect the clear benefits of a multifaceted, interdisciplinary approach to cardiovascular risk reduction in nutrition, physical activity and psychosocial management. Educoeur's clinical effectiveness was demonstrated, but cost-effectiveness needs to be proven.

In conclusion, these results highlight the importance of providing multifaceted and comprehensive interdisciplinary programs in clinical practice that optimize cardiovascular risk reduction, foster healthy behaviors and compliance, and promote active lifestyles in patients at risk of cardiovascular disease by providing nutritional, physical activity and psychosocial educational tools. The importance of providing such programs as central to the care of cardiovascular disease has been recognized in secondary prevention and should also be integrated in the comprehensive care of patients at moderate to high risk of cardiovascular disease.

Acknowledgments We thank the study participants of Educoeur. We also thank the research nurses Martine Gauthier, Suzanne Dubreuil, Denise Dubreuil, the statistician Miguel Chagnon from the University of Montreal, the kinesiologist Étienne Dumais-Roy, the nutritionist Julie St-Jean, and Lise Lussier for her secretarial work. This study was supported by an unconditional grant from Pfizer Canada Inc.

Conflict of interest We declare that we have no conflict of interest.

References

American College of Medicine Position Stand. (1998). The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. *Medicine and Science in Sports and Exercise, 30*, 975–991.

Antman, E. M., Anbe, D. T., Armstrong, P. W., Bates, E. R., Green, L. A., Hand, M., et al. (2004). ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction-executive summary. A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to revise the 1999 guidelines for the management of patients with acute myocardial infarction). *Journal of the American College of Cardiology, 44*, 671–719.

Assmann, G., Cullen, P., & Schulte, H. (2002). Simple scoring scheme for calculating the risk of acute coronary events based on the 10-year follow-up of the prospective cardiovascular Munster (PROCAM) study. *Circulation, 105*, 310–315.

Balady, G. J., Ades, P. A., Comoss, P., Limacher, M., Pina, I. L., Southard, D., et al. (2000). Core components of cardiac rehabilitation/secondary prevention programs: A statement for healthcare professionals from the American Heart Association and the American Association of Cardiovascular and Pulmonary Rehabilitation Writing Group. *Circulation, 102*, 1069–1073.

Balady, G. J., Williams, M. A., Ades, P. A., Bittner, V., Comoss, P., Foody, J. M., et al. (2007). Core components of cardiac rehabilitation/secondary prevention programs: 2007 update: A scientific statement from the American Heart Association Exercise, Cardiac Rehabilitation, and Prevention Committee, the Council on Clinical Cardiology; the Councils on Cardiovascular Nursing, Epidemiology and Prevention, and Nutrition, Physical Activity, and Metabolism; and the American Association of Cardiovascular and Pulmonary Rehabilitation. *Circulation, 115*, 2675–2682.

Beck, A. T., Steer, R. A., & Brown, G. K. (1996). *Manual for the Beck Depression Inventory-II*. San Antonio: Psychological Corporation.

Berkman, L. F., Blumenthal, J., Burg, M., Carney, R. M., Catellier, D., Cowan, M. J., et al. (2003). Effects of treating depression and low perceived social support on clinical events after myocardial infarction: The Enhancing Recovery in Coronary Heart Disease Patients (ENRICHD) randomized trial. *JAMA : the Journal of the American Medical Association, 289*, 3106–3116.

Blumenthal, J. A., Babyak, M. A., Hinderliter, A., Watkins, L. L., Craighead, L., Lin, P. H., et al. (2010). Effects of the DASH diet alone and in combination with exercise and weight loss on blood pressure and cardiovascular biomarkers in men and women with high blood pressure: The ENCORE study. *Archives of Internal Medicine, 170*, 126–135.

Blumenthal, J. A., Sherwood, A., Babyak, M. A., Watkins, L. L., Waugh, R., Georgiades, A., et al. (2005). Effects of exercise and stress management training on markers of cardiovascular risk in patients with ischemic heart disease: A randomized controlled trial. *JAMA : the Journal of the American Medical Association, 293*, 1626–1634.

Bruce, R. A., Kusumi, F., & Hosmer, D. (1973). Maximal oxygen intake and nomographic assessment of functional aerobic impairment in cardiovascular disease. *American Heart Journal, 85*, 546–562.

Carney, R. M., Blumenthal, J. A., Freedland, K. E., Youngblood, M., Veith, R. C., Burg, M. M., et al. (2004). Depression and late mortality after myocardial infarction in the Enhancing Recovery in Coronary Heart Disease (ENRICHD) study. *Psychosomatic Medicine, 66*, 466–474.

D'Agostino, R. B., Sr., Vasan, R. S., Pencina, M. J., Wolf, P. A., Cobain, M., Massaro, J. M., et al. (2008). General cardiovascular risk profile for use in primary care: The Framingham Heart Study. *Circulation, 117*, 743–753.

Daubenmier, J. J., Weidner, G., Sumner, M. D., Mendell, N., Merritt-Worden, T., Studley, J., et al. (2007). 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. *Annals of Behavioral Medicine, 33*, 57–68.

De Backer, G., Ambrosioni, E., Borch-Johnsen, K., Brotons, C., Cifkova, R., Dallongeville, J., et al. (2003). European guidelines on cardiovascular disease prevention in clinical practice: Third joint task force of European and other societies on cardiovascular disease prevention in clinical practice (constituted by representatives of eight societies and by invited experts). *European Journal of Cardiovascular Prevention and Rehabilitation, 10*, S1–S10.

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

Dusseldorp, E., van Elderen, T., Maes, S., Meulman, J., & Kraaij, V. (1999). A meta-analysis of psychoeducational programs for coronary heart disease patients. *Health Psychology, 18*, 506–519.

Ebrahim, S., & Smith, G. D. (1997). Systematic review of randomised controlled trials of multiple risk factor interventions for preventing coronary heart disease. *BMJ, 314*, 1666–1674.

Ebrahim, S., Taylor, F., Ward, K., Beswick, A., Burke, M., & Davey, S. G. (2011). Multiple risk factor interventions for primary prevention of coronary heart disease. *Cochrane Database of Systematic Reviews*, CD001561.

Eriksson, K. M., Westborg, C. J., & Eliasson, M. C. (2006). A randomized trial of lifestyle intervention in primary healthcare for the modification of cardiovascular risk factors. *Scandinavian Journal of Public Health, 34*, 453–461.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: An introduction to theory and research*. Don Mills, ON: Addison-Wesley.

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

Friedman, M., Thoresen, C. E., Gill, J. J., Ulmer, D., Powell, L. H., Price, V. A., et al. (1986). 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, 112*, 653–665.

Gaede, P., Vedel, P., Larsen, N., Jensen, G. V., Parving, H. H., & Pedersen, O. (2003). Multifactorial intervention and cardiovascular disease in patients with type 2 diabetes. *New England Journal of Medicine, 348*, 383–393.

Galani, C., & Schneider, H. (2007). Prevention and treatment of obesity with lifestyle interventions: Review and meta-analysis. *International Journal of Public Health, 52*, 348–359.

Giannuzzi, P., Mezzani, A., Saner, H., Bjornstad, H., Fioretti, P., Mendes, M., et al. (2003). Physical activity for primary and secondary prevention. Position paper of the working group on cardiac rehabilitation and exercise physiology of the European Society of Cardiology. *European Journal of Cardiovascular Prevention and Rehabilitation, 10*, 319–327.

Gordon, N. F., Scott, C. B., & Levine, B. D. (1997). Comparison of single versus multiple lifestyle interventions: Are the antihypertensive effects of exercise training and diet-induced weight loss additive? *American Journal of Cardiology, 79*, 763–767.

Goyer, L. (2004). Innovation en santé cardiovasculaire : Nouvel angle sur les facteurs psychosociaux et les maladies cardiovasculaires. *Les Actualités du coeur, 9*, 7–10.

Graham, I., Atar, D., Borch-Johnsen, K., Boysen, G., Burell, G., Cifkova, R., et al. (2007). European guidelines on cardiovascular disease prevention in clinical practice: executive summary. *European Heart Journal, 28*, 2375–2414.

Haskell, W. L., Alderman, E. L., Fair, J. M., Maron, D. J., Mackey, S. F., Superko, H. R., et al. (1994). 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, 89*, 975–990.

Health Canada. (2007). *Canadian nutrient file (CNF), 2010: Download files*. Retrieved from http://www.hc-sc.gc.ca/fn-an/nutrition/fiche-nutri-data/cnf_downloads-telechargement_fcen-eng.php.

Koertge, J., Weidner, G., Elliott-Eller, M., Scherwitz, L., Merritt-Worden, T. A., Marlin, R., et al. (2003). 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, 91*, 1316–1322.

Kotseva, K., Wood, D., De Backer, G., De Bacquer, D., Pyorala, K., & Keil, U. (2009). Cardiovascular prevention guidelines in daily practice: A comparison of EUROASPIRE I, II, and III surveys in eight European countries. *Lancet, 373*, 929–940.

Kriska, A. M., Knowler, W. C., LaPorte, R. E., Drash, A. L., Wing, R. R., Blair, S. N., et al. (1990). Development of questionnaire to examine relationship of physical activity and diabetes in Pima Indians. *Diabetes Care, 13*, 401–411.

Kyle, U. G., Bosaeus, I., De Lorenzo, A. D., Deurenberg, P., Elia, M., Manuel, G. J., et al. (2004). Bioelectrical impedance analysis-part II: Utilization in clinical practice. *Clinical Nutrition, 23*, 1430–1453.

Leon, A. S., Franklin, B. A., Costa, F., Balady, G. J., Berra, K. A., Stewart, K. J., et al. (2005). Cardiac rehabilitation and secondary prevention of coronary heart disease: An American Heart Association scientific statement from the Council on Clinical Cardiology (Subcommittee on Exercise, Cardiac Rehabilitation, and Prevention) and the Council on Nutrition, Physical Activity, and Metabolism (Subcommittee on Physical Activity), in collaboration with the American association of Cardiovascular and Pulmonary Rehabilitation. *Circulation, 111*, 369–376.

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

Lisspers, J., Sundin, O., Ohman, A., Hofman-Bang, C., Ryden, L., & Nygren, A. (2005). Long-term effects of lifestyle behavior change in coronary artery disease: Effects on recurrent coronary events after percutaneous coronary intervention. *Health Psychology, 24*, 41–48.

Lloyd-Jones, D., Adams, R. J., Brown, T. M., Carnethon, M., Dai, S., De Simone, G., et al. (2010). Heart disease and stroke statistics—2010 update: A report from the American Heart Association. *Circulation, 121*, e46–e215.

Myers, J., Prakash, M., Froelicher, V., Do, D., Partington, S., & Atwood, J. E. (2002). Exercise capacity and mortality among men referred for exercise testing. *New England Journal of Medicine, 346*, 793–801.

Nordmann, A., Heilmbauer, I., Walker, T., Martina, B., & Battegay, E. (2001). A case-management program of medium intensity does not improve cardiovascular risk factor control in coronary artery disease patients: the Heartcare I trial. *American Journal of Medicine, 110*, 543–550.

Ornish, D., Brown, S. E., Scherwitz, L. W., Billings, J. H., Armstrong, W. T., Ports, T. A., et al. (1990). Can lifestyle changes reverse coronary heart disease? The Lifestyle Heart Trial. *Lancet, 336*, 129–133.

Ornish, D., Scherwitz, L. W., Billings, J. H., Brown, S. E., Gould, K. L., Merritt, T. A., et al. (1998). Intensive lifestyle changes for reversal of coronary heart disease. *JAMA : the Journal of the American Medical Association, 280*, 2001–2007.

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

Prochaska, J. O., Norcross, J. C., & DiClemente, C. C. (1994). *Changing for good: The revolutionary program that explains the six stages of change and teaches you how to free yourself from bad habits*. New York: W. Morrow.

Rollnick, S., Miller, W. R., & Butler, C. (2008). *Motivational interviewing in health care: Helping patients change behavior*. New York: Guilford.

Rozanski, A., Blumenthal, J. A., Davidson, K. W., Saab, P. G., & Kubzansky, L. (2005). 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, 45*, 637–651.

Sdringola, S., Nakagawa, K., Nakagawa, Y., Yusuf, S. W., Boccalandro, F., Mullani, N., et al. (2003). Combined intense lifestyle and pharmacologic lipid treatment further reduce coronary events and myocardial perfusion abnormalities compared with usual-care cholesterol-lowering drugs in coronary artery disease. *Journal of the American College of Cardiology, 41*, 263–272.

Shephard, R. J., & Bouchard, C. (1994). Population evaluations of health related fitness from perceptions of physical activity and fitness. *Canadian Journal of Applied Physiology, 19*, 151–173.

Stone, J. A., Cyr, C., Friesen, M., Kennedy-Symonds, H., Stene, R., & Smilovitch, M. (2001). Canadian guidelines for cardiac rehabilitation and atherosclerotic heart disease prevention: A summary. *Canadian Journal of Cardiology, 17*, 3B–30B.

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

Tuomilehto, J., Lindstrom, J., Eriksson, J. G., Valle, T. T., Hamalainen, H., Ilanne-Parikka, P., et al. (2001). Prevention of type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. *New England Journal of Medicine, 344*, 1343–1350.

Ware, J. E., Kosinski, M., Turner-Bowker, D. M., & Gandek, B. (2002). *Version 2 of the SF-12 health survey*. Boston: Quality Metric Inc.

World Health Organization. (2003, October). *The World Health Report 2003—Shaping the Future, Geneva.*

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