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Benefits of Cardiac Rehabilitation and Exercise Training in Secondary Coronary Prevention in the Elderly

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Objectives. The aim of this study was to determine the effects of cardiac rehabilitation and exercise training on plasma lipids, indexes of obesity and exercise capacity in the elderly and to compare the benefits in elderly patients with coronary heart disease with benefits in a younger cohort.

Background. Despite the well proved benefits of cardiac rehabilitation and exercise training, elderly patients with coronary heart disease are frequently not referred or vigorously encouraged to pursue this therapy. In addition, only limited data are available for these elderly patients on the benefits of cardiac rehabilitation on plasma lipids, indexes of obesity and exercise capacity.

Methods. At two large multispecialty teaching institutions, baseline and post-rehabilitation data including plasma lipids, indexes of obesity and exercise capacity were compared in 92 elderly patients (≥65 years, mean age 70.1 ± 4.1 years) and 182 younger patients (<65 years, mean 53.9 ± 7.4 years) enrolled in phase II cardiac rehabilitation and exercise programs after a major cardiac event.

Results. At baseline, body mass index (26.0 ± 3.9 vs. 27.8 ± 4.2 kg/m^2, $p < 0.001$), triglycerides (141 ± 55 vs. 178 ± 105 mg/dl, $p < 0.01$) and estimated metabolic equivalents (METs) (5.6 ± 1.6 vs. 7.7 ± 3.0, $p < 0.0001$) were lower and high density lipoprotein cholesterol was greater (40.4 ± 12.1 vs. 37.5 ± 10.4 mg/dl, $p < 0.05$) in the elderly than in younger patients. After rehabilitation, the elderly demonstrated significant improvements in METs (5.6 ± 1.6 vs. 7.5 ± 2.3, $p < 0.0001$), body mass index (26.0 ± 3.9 vs. 25.6 ± 3.8 kg/m^2, $p < 0.01$), percent body fat (24.4 ± 7.0 vs. 22.9 ± 7.2%, $p < 0.0001$), high density lipoprotein cholesterol (40.4 ± 12.1 vs. 43.0 ± 11.4 mg/dl, $p < 0.001$) and the ratio of low density to high density lipoprotein cholesterol (3.6 ± 1.3 vs. 3.3 ± 1.0, $p < 0.01$) and a decrease in triglycerides that approached statistical significance (141 ± 55 vs. 130 ± 76 mg/dl, $p = 0.14$) but not in total cholesterol or low density lipoprotein cholesterol. Improvements in functional capacity, percent body fat and body mass index, as well as lipids, were statistically similar in the older and younger patients.

Conclusions. Despite baseline differences, improvements in exercise capacity, obesity indexes and lipids were very similar in older and younger patients enrolled in cardiac rehabilitation and exercise training. These data emphasize that elderly patients should not be categorically denied the psychosocial, physical and risk factor benefits of secondary coronary prevention including formal cardiac rehabilitation and supervised exercise training.

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Coronary heart disease is the major cause of death in the elderly, with persons >65 years old accounting for approximately 80% of total coronary deaths and 55% of all acute myocardial infarctions (1–3). Although cardiovascular mortality has experienced a welcome decline during the past 2 decades, the percent reduction in coronary heart disease mortality during this period is nearly 50% less in the elderly (1,4). In fact, with the aging of the population, a recent task force for the American Heart Association indicates that during the next 2 decades the incidence, prevalence, overall mortality and cost of coronary heart disease (adjusted for inflation) will increase markedly in the United States (5). Therefore, primary and secondary prevention of coronary artery disease in the elderly, the fastest growing segment of the U.S. population, is both a public health and a societal concern.

The elderly have a two- to threefold higher incidence of acute myocardial infarction than that of younger persons, experience more complications resulting in prolonged hospital stays with attendant deconditioning, and exhibit substantially higher fatality rates with coronary heart disease events (6,7). Despite this, there seems to be a strong age bias in our approach to treating elderly patients with heart disease in areas including short- and long-term management of myocardial infarction (6), treatment of hypertension and lipid disorders (8) and various other preventive strategies (9–11). Despite the now well proved benefits of cardiac rehabilitation and exercise training, including improvement in exercise capacity, weight, glucose tolerance, lipid levels

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and psychosocial variables, as well as reductions in subsequent hospital costs and in major cardiac events, cardiac deaths and all-cause mortality (3,12–14), it is generally recognized that the elderly are often not referred to formal cardiac rehabilitation and exercise programs and, when referred, are often not strongly encouraged to participate (15–17).

Therefore, we reviewed baseline and post-program data in 274 consecutive patients referred for cardiac rehabilitation and exercise training to determine the efficacy of vigorous nonpharmacologic therapy in a group of elderly patients with coronary heart disease compared with that in a younger cohort.

Methods

Study patients. We reviewed data at baseline and after an outpatient, phase II cardiac rehabilitation and exercise program in 274 consecutive patients (161 from Massachusetts General Hospital and 113 from Ochsner Medical Institutions). A subgroup of 92 elderly patients ≥65 years old were compared with 182 younger patients <65 years old. All patients were referred after a major cardiac event including acute myocardial infarction, coronary artery bypass grafting or percutaneous balloon angioplasty for an acute ischemic syndrome. At Ochsner, the study group consisted of 25% of the patients having these events at our institution; younger patients were 1.5 to 2 times more likely to enter the program ($p < 0.05$). None of these patients were treated with lipid-lowering medications. Other medications known to affect lipids (such as estrogens, beta-adrenergic blocking agents, diuretic drugs, alpha-adrenergic blocking agents, and calcium channel antagonists) were given at stable doses for ≥4 weeks before study entry; doses of the medications were not altered during the program.

Protocol. All patients participated in an outpatient phase II cardiac rehabilitation and exercise program. In general, this program lasted for 12 weeks (36 education and exercise sessions), although the duration of the program was occasionally altered by the patient's ability to progress in altering risk factors and developing independence in performing and monitoring the prescribed exercise program. Each session consisted of 10 min of warm-up calisthenics and stretching, 30 to 40 min of continuous upright dynamic exercise (various combinations of walking, jogging, bicycling, rowing and other activities) together with light isometric exercises such as hand weights and a 10-min cool-down period of calisthenics and stretching. The intensity of exercise was prescribed on an individual basis, so that the exercise heart rate was 70% to 85% of the maximal heart rate or 10 to 15 beats/min below the level of exercise-induced symptomatic or silent ischemia. Patients were encouraged to exercise one to three times a week in addition to the supervised exercise sessions. Exercise prescriptions were adjusted periodically to encourage a gradual increase in exercise performance. In addition, all patients were instructed on the phase I diet of the American Heart Association and the National Cholesterol Education Program and were frequently encouraged by physicians, dietitians, nurses and exercise physiologists to comply with both the dietary and exercise portions of the program.

Data collection. Body weight, body mass index, percent body fat (by the skinfold method), plasma lipids (including fasting total cholesterol, triglycerides, high density lipoprotein cholesterol, low density lipoprotein cholesterol and ratio of low density to high density lipoprotein cholesterol) and estimated metabolic equivalents (METs) were assessed at baseline (4 to 8 weeks after a major cardiac event [average of 6 weeks]) and again within 1 week of completion of the cardiac rehabilitation and exercise program. In addition, the prevalence of patients continuing to smoke or with a personal history of diabetes or hypertension was assessed by questionnaire. The prevalence of obesity was defined by body mass index ≥27.8 kg/m^2 for men and 27.3 kg/m^2 for women, as previously described (18). Baseline psychologic factors, including symptoms of depression and hostility, were assessed in the Massachusetts General Hospital patients according to a protocol previously described by the Beta Blocker Heart Attack Trial (19).

Before entering the rehabilitation program, patients underwent symptom-limited graded exercise testing. The majority of patients at both institutions underwent treadmill testing utilizing a standard Bruce protocol, although about one third of the patients underwent graded exercise testing using either another treadmill protocol or an upright bicycle ergometric study. On completion of the rehabilitation program, similar protocols were repeated in each patient. Functional capacity was estimated in METs from standard formulas based on work load and exercise time (20).

Statistical methods. The results are expressed as mean value ± SD. Baseline characteristics of the elderly and younger patients were compared by nonpaired *t* tests and chi-square analysis. Baseline and post-rehabilitation data were compared in each group by paired *t* tests, and the changes in data between groups were analyzed with a two-factor (pre/post and age) repeated measures analysis of variance with repeated measures in one factor (pre/post).

Results

Baseline characteristics. The baseline characteristics of the study group are shown in Table 1. By study design, the groups differed significantly in age, with the elderly cohort having a mean age of 70.1 ± 4.1 years compared with 53.9 ± 7.4 years in the younger cohort. The majority of patients (83%) in our study cohort were men, with gender similar in both groups. The prevalence of hypertension, smoking and diabetes, as well as the overall clinical classification, were similar in the elderly and younger patients, but the prevalence of obesity was higher in the younger patients. Symptoms of depression were similar in both groups, but younger patients had significantly higher hostility scores, suggesting

Table 1. Baseline Characteristics of Study Group

	Patients	
	Young (n = 182)	Elderly (n = 92)
Age (yr)	53.9 ± 7.4	70.1 ± 4.1*
Male (%)	85	79
Hypertensive (%)	45	45
Smoking (%)	12	8
Diabetic (%)	18	24
Obese (%)	37	25
NYHA class		
I	70	65
II	20	28
III	8	7
IV	2	0
Hostility score (MGH patients only) (U)	3.0 ± 2.4	2.3 ± 2.0†
Depressive symptoms (MGH patients only) (%)	29	26

*Different by study design. †p < 0.05. Values are expressed as mean value ± SD or percent of patient group. MGH = Massachusetts General Hospital; NYHA class = New York Heart Association functional class.

increased type A behavior. At baseline, body mass index (26.0 ± 3.9 vs. 27.8 ± 4.2 kg/m^2, $p < 0.001$), triglycerides (141 ± 55 vs. 178 ± 105 mg/dl, $p < 0.01$) and estimated METs (5.6 ± 1.6 vs. 7.7 ± 3.0, $p < 0.0001$) were lower and high density lipoprotein cholesterol was greater (40.4 ± 12.1 vs. 37.5 ± 10.4 mg/dl, $p < 0.05$) in the elderly than in younger patients (Tables 2 and 3). The two groups had statistically similar levels of total cholesterol, low density lipoprotein cholesterol and ratio of low density to high density lipoprotein cholesterol.

After rehabilitation. With cardiac rehabilitation and exercise training, both groups had a significant lessening of cardiac risk factors (Tables 2 and 3). After rehabilitation, the elderly showed significant improvement in body mass index (−1.5%, $p < 0.01$), percent body fat (−6%, $p < 0.0001$), exercise capacity (+ 34%, $p < 0.0001$), high density lipoprotein cholesterol (+ 6%, $p < 0.001$) and ratio of low density to high density lipoprotein cholesterol (−8%, $p < 0.01$), but improvement in total cholesterol, triglycerides and low density lipoprotein cholesterol did not reach statistical significance (Table 2). The percent improvement in body mass index, percent body fat, plasma lipids and estimated METs in younger patients (Table 3) was nearly identical to that in the older patients, and improvement in each of these variables was statistically similar in the two patient groups. Although minor baseline differences were noted between the Massachusetts General Hospital and Ochsner patients, patient age, body mass index, plasma lipids and exercise capacity at baseline, as well as improvements, occurring after cardiac rehabilitation and exercise training, were very similar in these two groups. Musculoskeletal complications and serious cardiac morbidity were extremely rare in both younger and elderly cardiac patients during the rehabilitation program.

Table 2. Improvement in Coronary Risk Factors After Cardiac Rehabilitation and Exercise Training in Elderly Patients With Coronary Heart Disease (n = 92)

	Baseline	After Rehabilitation	%Δ	p Value
Body mass index (kg/m^2)	26.0 ± 3.9	25.6 ± 3.8	−1.5	< 0.01
Percent body fat (%)	24.4 ± 7.0	22.9 ± 7.2	−6	< 0.0001
Exercise capacity, estimated METs	5.6 ± 1.6	7.5 ± 2.3	+34	< 0.0001
Total cholesterol (mg/dl)	204 ± 44	204 ± 41	0	0.93
Triglycerides (mg/dl)	141 ± 55	130 ± 76	−8	0.14
HDL-C (mg/dl)	40.4 ± 12.1	43.0 ± 11.4	+6	< 0.001
LDL-C (mg/dl)	136 ± 40	133 ± 35	−2	0.74
LDL-C/HDL-C	3.6 ± 1.3	3.3 ± 1.0	−8	< 0.01

Values are expressed as mean value ± SD or percent change (%Δ). HDL-C = high density lipoprotein cholesterol; LDL-C = low density lipoprotein cholesterol; METs = metabolic equivalents; 0 = no change.

Table 3. Improvement in Coronary Risk Factors After Cardiac Rehabilitation and Exercise Training in Younger Patients With Coronary Heart Disease (n = 182)

	Baseline	After Rehabilitation	%Δ	p Value
Body mass index (kg/m^2)	27.8 ± 4.2	27.4 ± 4.0	−1.5	< 0.001
Percent body fat (%)	24.2 ± 6.1	22.8 ± 5.9	−6	< 0.0001
Exercise capacity (estimated METs)	7.7 ± 3.0	9.9 ± 3.5	+29	< 0.0001
Total cholesterol (mg/dl)	209 ± 38	205 ± 34	−2	0.08
Triglycerides (mg/dl)	178 ± 105	154 ± 78	−13	< 0.05
HDL-C (mg/dl)	37.5 ± 10.4	39.8 ± 10.6	+6	< 0.001
LDL-C (mg/dl)	138 ± 36	134 ± 30	−3	0.27
LDL-C/HDL-C	3.9 ± 1.3	3.6 ± 1.2	−8	< 0.01

Values are expressed as mean value ± SD or percent change (%Δ). Abbreviations as in Table 2.

Exercise data. The exercise hemodynamic data are demonstrated in Table 4. As previously discussed, both the younger and the elderly patients had marked improvements in exercise capacity after cardiac rehabilitation and exercise training ($p < 0.0001$), although the younger patients had considerably greater exercise capacity both before and after the rehabilitation program ($p < 0.0001$). At baseline, the elderly had a lower peak heart rate ($p = 0.05$) but higher values for systolic blood pressure at rest ($p < 0.05$) and at peak exercise ($p = 0.08$) compared with values in younger patients, whereas the heart rate at rest and peak rate-pressure product were statistically similar in both older and younger patients. After cardiac rehabilitation and exercise training, there were no statistically significant changes in any of these variables in either younger or older patients, and peak heart rate remained lower in the older patients ($p < 0.05$).

Discussion

It is generally recognized that cardiac rehabilitation, exercise training and secondary coronary prevention are not as vigorously pursued in the elderly as in younger patients

Table 4. Comparison of Exercise Hemodynamics Before and After Cardiac Rehabilitation and Exercise Training In Younger and Elderly Patients With Coronary Heart Disease

	Patients		
	Young (n = 182)	Elderly (n = 92)	p Value
Rest heart rate (beats/min)			
Pre	72 ± 16	75 ± 18	NS
Post	74 ± 18	70 ± 14	NS
Peak heart rate (beats/min)			
Pre	137 ± 25	128 ± 23	0.05
Post	140 ± 25	125 ± 21	< 0.05
Rest systolic blood pressure (mm Hg)			
Pre	129 ± 21	140 ± 19	< 0.05
Post	129 ± 17	132 ± 19	NS
Peak systolic blood pressure (mm Hg)			
Pre	168 ± 32	175 ± 32	0.08
Post	171 ± 25	167 ± 34	NS
Peak rate-pressure product (U)			
Pre	23,133 ± 7,638	23,876 ± 10,933	NS
Post	23,788 ± 6,601	21,079 ± 6,575	NS
Exercise capacity (estimated METs)			
Pre	7.7 ± 3.0	5.6 ± 1.6	< 0.0001
Post	9.9 ± 3.5*	7.5 ± 2.3*	< 0.0001

*p < 0.0001 compared with baseline value. Values are expressed as mean value ± SD. Post and Pre = after and before, respectively, phase II cardiac rehabilitation and exercise training; METs = metabolic equivalents.

(15–17). However, the present data from two large clinical programs clearly demonstrate that these preventive strategies are effective in an elderly cohort, producing significant improvements in body mass index, percent body fat, plasma lipids and exercise capacity after formal outpatient phase II programs of cardiac rehabilitation and supervised exercise training. Cardiac rehabilitation has now been shown to have significant effects in improving psychosocial and physical function, cardiac risk factors and reducing hospital costs and overall morbid and fatal cardiac events (3,12–14), including significant reductions in fatal myocardial infarction, coronary mortality and total mortality by 25%, 22% and 20%, respectively, in patients randomized to cardiac rehabilitation (14). Because the elderly seem to exhibit improvement similar to that of younger persons in many variables, we believe that the present data support the concept that the elderly should not be categorically denied the psychosocial, physical and risk factor benefits of this therapy and should be routinely referred and vigorously encouraged to participate in these programs.

Age bias. Several recent reports have focused on an apparent age bias in the approach to treating elderly patients with cardiovascular diseases (8), including patients with acute coronary syndromes, as well as primary and secondary coronary prevention (6,8,9–11,21–23). In addition, older patients with coronary disease are less likely to be referred for cardiac rehabilitation and exercise training than are younger patients and, when they are referred, the strength of this recommendation is often weaker in the elderly (15–17). The infrequent use of antihypertensive and lipid therapy, provision of recommendations for endocarditis prophylaxis and cardiac rehabilitation are consistent with the finding that other preventive strategies, such as screening for breast and cervical cancer, are also frequently not applied to elderly patients (24,25).

However, numerous studies have suggested that the well recognized coronary risk factors including dyslipidemia, hypertension, obesity, smoking and glucose intolerance continue to be strongly related to coronary risk in the elderly (26–37). Although many of these studies indicate that, with age, the relative risk attributed to coronary risk factors does not change greatly, but deaths from coronary heart disease increase markedly. Therefore, the excess deaths attributable to these risk factors increases markedly with increasing age (28). In addition, recent studies (31,32,36,38,39) suggest that effective treatment of these risk factors in the elderly may markedly reduce the cardiovascular risk of these patients.

Numerous studies have indicated that primary protection from coronary heart disease occurs with increasing amounts of regular physical activity and exercise, and some studies have suggested that the greatest reduction in mortality with increasing exercise occurs in the elderly (40–42). The marked improvement in functional capacity obtained in the elderly in our study agrees with other reports (16,43). Although the elderly were less fit than the younger patients when they entered the cardiac rehabilitation program, they attained a slightly greater relative training response to conditioning. However, the overall relative clinical benefit may be even greater in the more deconditioned elderly patients compared with younger patients who already have an excellent exercise capacity, thus leading to greater improvement in overall functional capacity and quality of life in the elderly.

Several possible explanations exist for the age bias in the management of cardiovascular diseases in the elderly: 1) Some clinicians may feel that an older person represents a relatively low risk subgroup, having already undergone a process of natural selection. However, cardiovascular diseases, including coronary heart disease, markedly increase with age, and 83% of all deaths due to cardiovascular disease occur in persons >65 years old (1).

2) Many clinicians fear adverse reactions to various forms of therapy because such responses seem to be increased in the elderly (8). However, few or no significant side effects occurred with exercise training and dietary modifications in our study.

3) There may be a relative paucity of data regarding benefits obtained with various therapies in the elderly.

4) Many physicians believe that life-style intervention (such as primary and secondary coronary prevention) is of less benefit in persons >65 years old because life expectancy

in this group is limited. However, the average 65-year old can expect to live another 15 to 17 years and remain functionally independent for two thirds of this time; persons aged 75 and 85 years have a life expectancy of 10 to 11 years and 6 years, respectively, and will function independently for half of these years (8,44–46). Therefore, it seems likely that the majority of elderly are functionally active and will probably benefit from cardiovascular screening, health promotion and primary and secondary coronary heart disease prevention.

5) Data suggest that physicians often greatly underestimate the elderly patient's perceived quality of life (3,47) including specific indexes of psychosocial function, physical comfort, morbidity, depression, anxiety and family relations.

6) Older patients often have more numerous medical problems, many of which are more urgent and acute than those present in younger patients; this so-called "thick chart syndrome" may lessen the relative importance given to long-term preventive measures in elderly patients.

Limitations of the study. There are several potential limitations to the present study: 1) There may be some selection bias because the study group may not be representative of all elderly patients who have cardiac events but rather of those selected for referral and those deciding to participate in a formal cardiac rehabilitation and exercise program. The fact that the younger patients were more likely to attend the cardiac rehabilitation program suggests that this referral bias may differ in the comparison group of younger patients.

2) There may be additional selection bias because these patients were all treated at large, academic medical practices, although the exact trends were present in vastly different groups from New Orleans and Boston.

3) Control groups were not available for either the older or the younger patients, and long-term follow-up studies were not included.

4) The majority of our patients studied were men, and benefits of cardiac rehabilitation and exercise training have not yet been as fully defined in female patients (16,48,49).

5) This study did not assess the effects of cardiac rehabilitation and exercise training on psychosocial functioning or quality of life, and formal programs of stress monitoring and intervention, which have been shown to improve prognosis after acute ischemic events (50), were not included. However, cardiac rehabilitation and exercise training are known to increase exercise capacity in the elderly (12,42,43), and preliminary data (51) from a small number of elderly Ochsner patients suggest that they also improve measures of quality of life.

6) Finally, cardiac rehabilitation has not yet been shown to reduce subsequent major cardiac events in a subgroup of elderly patients. Despite these limitations, however, our data indicate that improvement in exercise capacity, percent body fat, body mass index and lipids is very similar in older and younger patients enrolled in outpatient cardiac rehabilitation and supervised exercise training.

Implications. Although two thirds of the U. S. health care budget is spent annually on persons >65 years old, about 20% of these costs are incurred in the last 6 months of an elderly person's life (8,52). Therefore, it has been suggested that a significant proportion of the health care dollars are spent on "prolonging the process of dying rather than facilitating the process of an active and productive life" (8). We believe that our data emphasize that elderly patients should not be denied the psychosocial, physical and risk factor benefits of secondary coronary prevention, including cardiac rehabilitation and exercise training, and that elderly patients should be routinely referred to and vigorously encouraged to participate in these programs.

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