Clinical and Demographic Trends in Cardiac Rehabilitation: 1996-2015

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STRUCTURED ABSTRACT

Purpose: Clinical interventions in programs such as cardiac rehabilitation (CR) are guided by clinical characteristics of participating patients. This study describes changes in CR participant characteristics over 20 yr.

Methods: To examine changes in patient characteristics over time, we analyzed data from 1996 to 2015 (n = 5396) garnered from a systematically and prospectively gathered database. Linear, logistic, multinomial logistic or negative binomial regression were used, as appropriate. Effects of sex and index diagnosis were considered both as interactions and as additive effects.

Results: Analyses revealed that mean age increased (60.7 to 64.2 yr), enrollment of women increased (26.8% to 29.6%), and index diagnosis has shifted; coronary artery bypass surgery decreased (37.2% to 21.6%) while heart valve (HV) repair/replace increased (0 to 11.4%). Risk factors also shifted with increases in body mass index (28.7 vs 29.6 kg/m^2), obesity (33.2% to 39.6%), hypertension (51% to 62.5%), type 2 diabetes mellitus (17.3% to 21.7%), and those reporting current smoking (6.6% to 8.4%). Directly measured peak aerobic capacity remained relatively stable throughout. The proportion of patients on statin therapy increased from 63.6% to 98.9% coinciding with significant improvements in lipid levels.

Conclusions: Compared to 1996, participants entering CR in 2015 were older, more overweight, and had a higher prevalence of coronary risk factors. Lipid values improved substantially concurrent with increased statin use. While the percentage of female participants increased, they continue to be underrepresented. HV patients now constitute 11.4% of the patients enrolled. Clinical programs need to recognize changing characteristics of attendees to best tailor interventions.

CONDENSED ABSTRACT

Cardiac rehabilitation programming is guided by clinical characteristics. Compared to 1996, participants in 2015 were older, more overweight, and had a higher prevalence of risk factors. Lipid values improved with increased statin use. While female participation increased, women continue to be underrepresented. Heart valve patients now constitute 11.4% of enrollees.

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Appropriate clinical care should reflect the characteristics of the patients who will receive it. As the population ages,[1] and proportions of risk factors change (eg, significant decrease in smoking),[2] clinical care must change as well. Only by being cognizant of the changing demographic and clinical profile of patients can clinical programs deliver appropriate care and interventions. In this research, we used cardiac rehabilitation (CR) as an illustration of how clinical populations are changing over time and how those changes may affect the care that is offered.

Contemporary outpatient CR began in the early 1970s, when exercise programs were extended beyond hospital discharge to highly structured, physician supervised, and electrocardiographically monitored exercise programs.[3] The focus was almost entirely on exercise training to reverse physical decline resulting from extended bed rest and participation was mostly limited to middle-class men <65 yr of age with uncomplicated myocardial infarction (MI) or coronary bypass surgery (CABG). Since that time CR has proven highly effective in broader populations, decreasing cardiac mortality by 26% over 3 yr and hospitalizations by 31% in the year after an acute coronary event.[4] These positive health outcomes have been shown for a variety of diagnoses and CR programs grew to include chronic stable angina pectoris and heart transplant.[5] More recently, in 2006, heart valve replacement/repair and percutaneous coronary intervention (without MI) were added as eligible diagnoses, followed by chronic systolic heart failure (HF) in 2014 and peripheral artery disease (PAD) in 2017.[6–9] Thus, presently, referral to CR is a class 1-A recommendation of the American Heart Association.[10]

Contemporary CR has evolved into a multidisciplinary disease management program guided by case-managers[11–13] and treatment is individualized based upon patient characteristics. Exercise programming and counseling varies substantially from an 83-year-old frail woman participant vs a 55-year-old but overweight male participant. Similarly, programming is significantly different for an individual with early onset coronary heart disease (CHD) and multiple coronary risk factors vs an older individual with isolated aortic valvular disease in the absence of CHD or left ventricular dysfunction.

There has also been increased effort to include a greater proportion of eligible patients.[6] Historically women, the elderly, minorities and patients of low-socioeconomic status have been underrepresented.[14] This is despite studies demonstrating that these patients similarly benefit from participation in CR.[15–19] As more patients are enrolled (eg more women), clinical characteristics may also shift.

Over time CR programs have needed to adapt as patient demographics shifted and diagnoses of participants have expanded.[20] To provide the requisite care and programming, understanding the characteristics of patients entering CR is critical. To this end, we examined the demographic and clinical characteristics of patients entering a CR program over a 20-yr period from 1996 to 2015.

METHODS

We analyzed prospectively gathered data on 5396 consecutive individuals entering the University of Vermont Medical Center phase 2 CR program between January 1996 and December 2015. For patients with multiple admissions to CR, only data from the initial enrollment was included. During the initial visit, we collected data on age, sex, anthropometric variables (stadiometer obtained height in meters, digital scale measured weight kilograms, and tape measured waist circumference in centimeters (measured at the level of the umbilicus), conventional risk factors (type 2 diabetes mellitus [DM], diagnosed by medical history and use of hypoglycemic medication; hypertension (HTN), diagnosed by medical history), current smoking, and fasting lipid levels (total cholesterol [TC], low-density lipoprotein cholesterol [LDL-C], high-density lipoprotein cholesterol [HDL-C], and triglycerides [TG]). Measures of total cholesterol, TG, HDL-C, and glucose were obtained in the morning following a 12-hr fast prior to starting CR. LDL-C was calculated by using the formula of Friedewald et al.[21] Index diagnosis at entry into CR was recorded in a hierarchal fashion (ie, all patients with CABG for any indication were coded as CABG, then those with MI without CABG were coded as MI, then those without CABG/MI who received percutaneous coronary intervention were coded as PCI; followed by those who has angina treated medically and other diagnosis, such as congestive heart failure or valvular heart disease). Information on treatment with evidence-based cardiovascular drugs (antiplatelet agents, β-adrenergic blockers, statins, and angiotensin-converting enzyme inhibitors or angiotensin receptor blockers) was recorded. All patients underwent a symptom-limited treadmill test with collection and analysis of expired gas for determination of peak aerobic capacity (peak $\dot{V}O_2$) in mL/kg/min (relative) or in L/min (absolute).

Comorbidity scores were calculated with a scale used in prior studies, but which has been not formally validated.[22] A comorbidities score was calculated as a combination of the presence and severity of conditions that could limit activities within the CR program including chronic obstructive pulmonary disease, peripheral vascular disease, orthopedic problems, and cerebrovascular accident/stroke. Presence of a comorbid condition was obtained via electronic health record while severity was determined by direct observation during the baseline exercise test. Absence of a comorbid condition was given a score of 0. For each diagnosis a score of 1–3 signified; (1) not symptomatic during exercise, (2) symptomatic during exercise or (3) exercise-limiting.[22]

Statistical Analysis

Frequencies and means are presented visually by four 5-yr time periods (1996–2000, 2001–2005, 2006–2010, 2011–2015) based on date of entry into CR. In the statistical analyses; however, time was modeled as a linear trend with year as a continuous variable. The type of regression analysis used depended on outcome type: linear regression analysis for continuous outcomes, logistic or multinomial logistic regression for categorical outcomes, and negative binomial regression for count data (number of comorbidities). The impact of patients' sex and index diagnosis (valve replacement vs other) on time trends were considered both as interactions and as additive effects; in other words, whether trends differed significantly in slope/trajectory over time and whether there was a group difference

that was consistent over time. All analyses were conducted using SAS 9.4 (SAS Institute). Across all tests, statistical significance was defined as $P < .05$ (2-tailed).

RESULTS

Changes Over Time in Characteristics of the Overall Sample at Entry into CR

Over the twenty years, there were significant changes in clinical characteristics of our total population (Table 1). Age increased significantly from 60.8 to 64.2 yr with a yearly increase of 0.23 yr (t = 8.5, $P < .0001$). Accordingly, the percent of the population 65 yr of age or greater significantly increased from 40.2% to 49.2% with a yearly increase of 0.6% ($\chi^2 = $ 21.6, $P < .0001$) and the percent 75 yr of age or greater increased from 11.2% to 19.9% with a yearly increase of 0.4% ($\chi^2 = 18.6$, $P < .0001$). The percentage of women increased as well from 26.8% to 29.6% with a yearly increase of 0.3% ($\chi^2 = 7.7$, $P < .05$). BMI and the percent of patients considered obese (BMI > 30) increased significantly (28.7 to 29.6, yearly increase 0.07, t = 5.1, $P < .0001$; and 33.9% to 38.8%, yearly increase 0.5%, $\chi^2 = 15.4$, $P < .$ 0001, respectively). Mean weight and waist circumference did not change significantly over time. However, this is due to an increasing proportion of women over time. When controlling for sex, both weight and waist circumference increase significantly over time (all P values < .01).

There were also significant increases in the prevalence of cardiac risk factors (Table 1). Prevalence of diabetes increased significantly from 17.3% to 21.7% with a yearly increase of 0.3%, ($\chi^2 = 9.4$, $P < .05$). Those with a diagnosis of hypertension have increased from 51% to 62.5% with a yearly increase of 0.8%, ($\chi^2 = 48.1$, $P < .0001$). Those reporting current smoking have increased from 6.6% to 8.4% with a yearly increase of 0.2%, ($\chi^2 = 7.1$, $P < .$ 05). Comorbidity scores also significantly increased from 0.3 to 0.6/4 with a yearly increase of 0.02 ($\chi^2 = 25.8$, $P < .0001$). Baseline aerobic capacity did not change over time. This lack of change persisted even when controlling for sex, age, and diagnosis.

There have also been significant changes in the index diagnosis (χ^2(df=6) = 371.71, $P < .$ 0001; Table 2). The percentage of CABG patients decreased substantially when comparing time periods 1 and 4, 37.2% to 21.6% with a yearly decrease of 1.1%. Those entering the program due to medically treated angina also decreased from 5.4 to 1.5% with a yearly decrease of 0.29%. These changes mirrored significant increases in MI (29.7% to 39.6%), PCI for angina (18.6% to 22.4%), and HV surgery which went from zero to 11.4% of the population.

Substantial changes have occurred in the percentage of patients taking cardiovascular medications at entry to CR (Table 3). Use of all 4 medications tracked increased. Antiplatelet agent use increased from 91.7% to 98.3% with a yearly increase of 0.5%, ($\chi^2 = $ 71.8, $P < .0001$), β-adrenergic blockers increased from 68.7% to 82.7% with a yearly increase of 1%, ($\chi^2 = 95.71$, $P < .0001$), and angiotensin-converting enzyme inhibitors or angiotensin receptor blockers increased from 29.8% to 52.9% with a yearly increase of 1.6%, ($\chi^2 = 180.5$, $P < .0001$). The most striking change was seen in statin use which increased from 63.6% to 98.9% with a yearly increase of 2.7%, ($\chi^2 = 627.83$, $P < .0001$). The effect of this increase in statin use is reflected in the lipid levels seen in the Figure. At

entry into CR, the mean ± standard deviation values for total cholesterol (189 + 40 vs 161 + 44 mg/dL), triglycerides (198 + 128 vs 145 + 112 mg/dL), LDL-C (113 + 34 vs 89 + 37 mg/dL) all decreased while HDL-C increased (39 + 10 vs 43 + 13 mg/dL) (all P values < .0001) from time period 1 to time period 4.

Sex Differences

A significant main effect of sex was seen for several characteristics (Table 1). Overall, mean age was 3 yr older in the female patients (t = 8.63, P < .0001). Weight and waist circumference were significantly lower in females (14.5 kg lower, t = −29.46, P < .0001 and 8.5 cm lower, t = −18.91, P < .0001, respectively). However, BMI and percent considered obese did not differ significantly by sex.

DM and current smoking also did not differ significantly by sex. However, HTN was more common in females (11% higher, χ^2 = 11.87, P < .001) and they had higher comorbidity scores (χ^2 = 5.47, P = .02). Fitness level was significantly lower in females. Women had a peak $\dot{V}O_2$ that was on average 3.8 mLO$_2$/kg/min lower than men (t = −23.09, P < .0001).

Index diagnosis differed by sex (Table 2). Patients with a diagnosis of CABG were more likely to be male (11% higher, χ^2 = 48.93, P < .001) and MI and HV patients were more likely to be female (5% higher, χ^2 = 25.32, P < .001 and 4% higher, χ^2 = 109.57, P < .001, respectively).

Medication use differed in some respects by sex (Table 3). Women were less likely to be taking antiplatelet agents or statins (10% fewer, χ^2 = 15.12, P < .001 and 8% fewer, χ^2 = 14.22, P < .001, respectively). However, the significant interaction (sex and time) in antiplatelet use as well as the nonsignificant differences in use of angiotensin-converting enzyme inhibitors/angiotensin receptor blockers and β-adrenergic blockers, as well as visual examination of the data demonstrate that over time prescription of all 4 medications have increased and differences by sex are dissipating.

Effects of Inclusion of Valve Patients

Given that the percent of valve patients has changed dramatically over the 20-yr period, the inclusion of these patients has shifted the characteristics of the population. Accordingly, data were examined for main effects of inclusion of HV patients as well as potential interactions between time and inclusion of these patients. Table 4 demonstrates how characteristics differ if HV patients were separated out.

A significant main effect of diagnoses was seen on several characteristics (Table 4). Mean age was 2.3 yr higher in the HV patients as compared to other diagnoses (t = 2.9, P < .05). The percentage of women was higher as well (11% higher, χ^2 = 15.02, P < .001). Weight, waist circumference, BMI, and percent considered obese all were lower in the HV population (8 kg lower, t = −6.61, P < .0001; 7.2 cm lower, t = −6.6, P < .0001; 2.1 lower, t = −5.93, P < .0001; and 12% lower, x^2 = 16.77, P < .0001, respectively).

Risk factors and clinical characteristics differed by HV status. Heart valve patients are less likely to have traditional CAD risk factors. Current smoking and diabetes were significantly

lower in HV patients (3% lower, $\chi^2 = 7.83$, $P < .05$; 11% lower, $\chi^2 = 22.48$, $P < .0001$). Peak aerobic capacity, at entry, differed by diagnosis. Peak $\dot{V}O_2$ for HV patients was, on average, 1.4 mLO2/kg/min lower than nonHV patients (t = −3.74, $P < .001$). HTN is the only characteristic that had a significant interaction between time and diagnosis with it increasing over time in other diagnoses but decreasing in HV patients ($\chi^2 = 16.77$, $P < .0001$). However, this is likely an artifact of HV patients only being included in the last 2 time periods.

Given these differences in risk factors, medication usage also differed between HV patients and the other diagnoses. The use of antiplatelet agents and angiotensin-converting enzyme inhibitors or angiotensin receptor blockers were significantly lower in HV patients (21% lower, $\chi^2 = 20.72$, $P < .0001$, and 14% lower $\chi^2 = 38.54$, $P < .0001$, respectively). However, neither β-adrenergic blockers nor statin use differed significantly in the HV patients compared to other diagnoses.

DISCUSSION

In the present study of over 5000 individuals entering CR between the years of 1996 to 2015, we found that patients have become older, more overweight, and more likely to have risk factors such as DM and current smoking. Patients also have more comorbidities and a greater percentage were women. Yet, fitness measures were essentially unchanged. The type of patients entering CR has shifted the overall clinical profile. While still underrepresented, more women are entering CR. The women are significantly older, and less fit, with more comorbidities than men, which shifts the overall clinical sample accordingly. Additionally, coinciding with the introduction of drug-eluting stents in 2003, there has been an increase in the percentage of patients undergoing PCI and a resulting decrease in the numbers undergoing CABG.[23] Other clinical changes have likely affected clinical characteristics. For example, American Heart Association Get with the Guidelines Initiative may have increased statin prescription and use.[24] Finally, the inclusion of other patients (eg, HV) also shifts the characteristics of the sample. HV diagnoses increased from 0% to 11.4% of the entrants to CR. HV patients do not necessarily have clinical CHD, and differed compared to the traditional population, being less obese, less likely to have DM, less likely to smoke, and older. As a result, HV patients alter the clinical and demographic characteristics of CR (Tables 1 and 4). For example, if valve patients were excluded, the percent of patients categorized as obese would have increased from 33.2% to 41.1% (instead of to 39.5%).

This dataset demonstrates how a change in entry diagnoses, such as the inclusion of HV patients, can significantly change the characteristics of a clinical population. Changes such as this one is likely to continue with inclusion of other populations, such as patients with a diagnosis of HF (added 2014), and patients with symptomatic PAD (added 2017). These changes will likely further increase the heterogeneity of the CR population. In addition, CR continues to be underutilized, only 35.5% of people who survived an MI attended CR.[25] If efforts to increase CR participation are successful, programs will likely see patients with different sets of characteristics than are seen currently. Currently underrepresented in CR are patients with some of the highest risk profiles, such as lower-SES patients and nonEnglish speaking individuals.[26]

Cardiac rehabilitation programming depends upon the characteristics of patients and goals of therapy, related both to physical functioning and prevention of future cardiac events. Historically, most CR patients have had CHD and a large body of literature has demonstrated that improving fitness and cardiac risk factors yields improved clinical outcomes.[4] As other diagnoses are included, patients will have different needs. As demonstrated, HV patients differ from other CHD patients, being older and less aerobically fit. Consequently, training programs for HV patients might have increased focus on improving aerobic fitness and strength rather than on lowering cholesterol or losing weight. Those who have CHF will work on improving fitness but will also need education specific to managing their unique clinical characteristics.[27,28] PAD patients are more likely to smoke and have DM and, thus, will need specific interventions around those risk factors. In addition, the focus of their exercise training differs as specific training protocols have been shown to increase time until onset of claudication and overall walking time.[29] It will continue to be important to adjust CR programming based upon the diverse needs of an increasingly heterogenous patient population. Staffing requirements will need to be considered as well. Given the increase in patient heterogeneity, programs could benefit from having staff with diverse skill sets, able to handle the unique needs of patients with different medical needs. The ability to individualize treatment plans will need to increase. Patient complexity will also differ, suggesting a potential need for increasing staffing ratios. The greater prevalence of obesity, diabetes, smoking and comorbidities will require behavioral programs for weight loss, close monitoring of diabetes, and increasing expertise at smoking cessation interventions. Programs need to assure that patient needs are addressed, and care is delivered in a safe and appropriate fashion with a focus on individualizing treatment plans to optimize patient outcomes.

Limitations of this study include that it was performed at a single community-based university affiliated center with a relatively homogeneous population. Medical history was used to define some variables (eg, DM and HTN) possibly underestimating the true prevalence of these conditions. Additionally, diagnostic criteria for these conditions have changed over time. Detailed information on glycosylated hemoglobin levels and blood pressure were not available although there were no clinically meaningful changes in blood pressure in the sample during the 20-year time period. Diagnostic categories were not comprehensive because, for example, in the MI category, the proportions of non-ST segment elevation MI or ST segment elevation MI were not known, and the proportion of PCI or other treatment following MI were not presented. Furthermore, we decided to classify CABG and MI as mutually exclusive categories due to the profound impact of CABG upon patient recovery. Additionally, given how diagnoses were categorized we were unable to detail how characteristics changed within a single diagnosis or within combinations of diagnoses. Detailed psychosocial characteristics were not available for the whole time-period but depression scores were stable throughout. Finally, determination of smoking status was by patient history and self-report.

Conclusions

Over a 20-yr period, cardiac patients entering CR have become older, more obese, and have a higher prevalence of coronary risk factors. Lipid values have improved remarkably

associated with increasing use of statin medications. The diagnoses of patients enrolled has changed with the percentage of patients enrolling in CR after CABG decreasing (37.2% to 21.6%), HV patients now constituting over 10% of patients, and other diagnoses, such as PCI patients, having increased as well. Given the diversity of and changing demographics throughout the United States, a consistent monitoring of age, sex and diagnosis within individual programs will need to take place to tailor interventions to specific patient needs.

Acknowledgements

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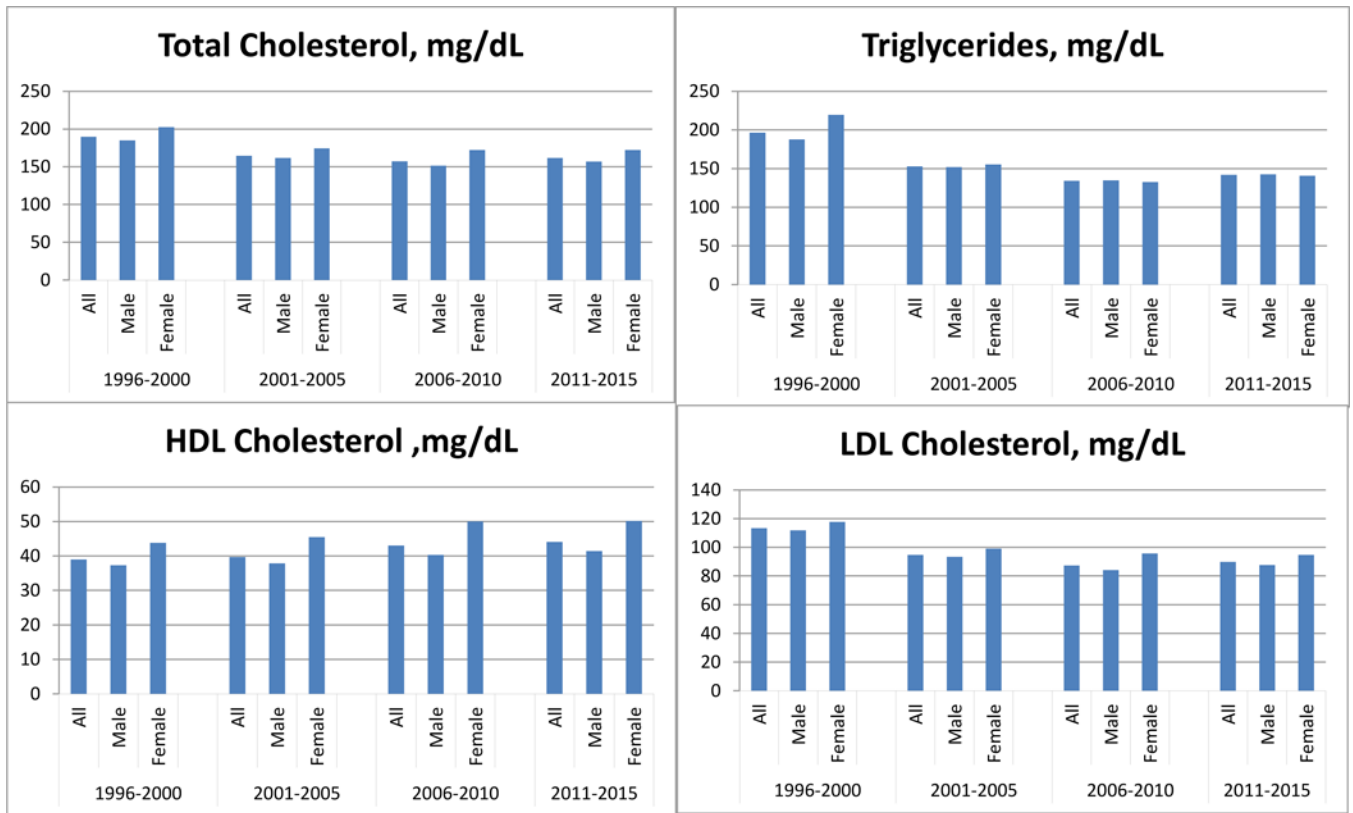
Figure.
Lipid levels in patients entering cardiac rehabilitation over a 20-yr period.

Table 1.

Demographic and Clinical Characteristics at Entry into Cardiac Rehabilitation[a]

	Period 1: 1996 – 2000 (n = 1174)	Period 2: 2001 – 2005 (n = 1371)	Period 3: 2006 – 2010 (n = 1407)	Period 4: 2011 – 2015 (n = 1444)	Average Yearly Change	Effect of Time
					Sex Difference	**Effect of Sex**
Age, yr						
All	60.7 ± 11.5	62.3 ± 11.8	63.5 ± 11.1	64.2 ± 11.6	0.23	8.46[c]
Men	59.9 ± 11.4	61.7 ± 11.2	62.4 ± 10.7	63.4 ± 11.3	3	8.63[d]
Women	63.1 ± 11.4	64.3 ± 13.4	66.1 ± 11.5	66.1 ± 12.1		
Women, %						
All	26.8	24.1	28	29.6	0.30%	7.72[b]
Older, % aged 65 yr						
All	40.2	44.8	44.8	49.2	0.56%	21.56[d]
Men	37.4	42.2	40.2	45.4	13%	90.41[d]
Women	47.9	52.9	56.6	58.4		
Elderly, % aged 75 yr						
All	11.2	17.2	17.6	19.9	0.44%	18.58[d]
Men	10.4	14.3	15	17.1	8.5%	40.12[d]
Women	13.7	26.3	24.4	26.6		
Weight, kg						
All	84.8 ± 18.1	86.9 ± 18.5	86.8 ± 19.6	86.7 ± 19.1	1.93	ns
Men	88.4 ± 17.2	90.7 ± 17.2	91.0 ± 18.4	90.5 ± 17.9	14.5	-29.46[d]
Women	75.0 ± 17.0	74.6 ± 17.4	76.2 ± 18.3	77.5 ± 18.7		
Waist, cm						
All	100.9 ± 13.7	101.8 ± 14.4	102.8 ± 14.5	101.8 ± 14.1	ns	ns
Men	103.0 ± 12.7	104.4 ± 13.4	104.7 ± 13.6	103.7 ± 13.1	8.5	-18.91[d]
Women	95.2 ± 14.7	93.0 ± 14.0	97.7 ± 15.5	97.1 ± 15.4		
Body mass index, kg/m²						
All	28.7 ± 5.4	29.0 ± 5.5	30.1 ± 6.0	29.6 ± 5.9	0.07	5.05[d]
Men	28.5 ± 5.0	29.1 ± 5.2	30.1 ± 5.5	29.4 ± 5.3	ns	ns
Women	29.1 ± 6.3	28.5 ± 6.4	30.0 ± 7.1	30.0 ± 7.1		
Obesity						

	Period 1: 1996 – 2000 (n = 1174)	Period 2: 2001 – 2005 (n = 1371)	Period 3: 2006 – 2010 (n = 1407)	Period 4: 2011 – 2015 (n = 1444)	Average Yearly Change	Effect of Time
					Sex Difference	**Effect of Sex**
All	33.2	36.6	42.9	39.6	0.46%	15.41[d]
Men	31.1	37.1	43.7	38.1	ns	ns
Women	39.1	35.1	40.7	43		
Diabetes mellitus						
All	17.3	21.5	24.7	21.7	0.31%	9.38[b]
Men	16.1	21.6	25.4	21.2	ns	ns
Women	20.6	21.1	23.1	23.1		
Hypertension						
All	51	59.4	70.6	62.5	0.80%	48.06[d]
Men	48.7	58	69.9	63.3	11%	11.87[c]
Women	57.5	63.7	72.3	60.7		
Current smoking						
All	6.6	5.3	7.2	8.4	0.16%	7.06[b]
Men	7.3	5.3	6.8	8.6	ns	ns
Women	4.8	5.4	8.1	7.9		
Comorbidity score						
All	0.3 ± 0.9	0.4 ± 1.0	0.5 ± 1.2	0.6 ± 1.2	0.016	25.8[d]
Men	0.3 ± 0.9	0.3 ± 1.0	0.5 ± 1.2	0.5 ± 1.2	0.12	5.47[b]
Women	0.4 ± 0.9	0.4 ± 1.1	0.6 ± 1.2	0.7 ± 1.3		
Relative peak $\dot{V}O_2$, mL/kg/min						
All	18.2 ± 5.9	18.0 ± 6.2	18.3 ± 6.5	18.2 ± 6.0	ns	0.29
Men	19.4 ± 6.1	19.0 ± 6.4	19.5 ± 6.7	19.2 ± 6.2	3.8	-23.09[d]
Women	14.9 ± 3.9	14.8 ± 4.3	15.0 ± 4.5	15.5 ± 4.2		
Absolute peak $\dot{V}O_2$, L/min						
All	1.5 ± 0.6	1.6 ± 0.6	1.6 ± 0.7	1.6 ± 0.6	ns	1.4
Men	1.7 ± 0.6	1.7 ± 0.6	1.8 ± 0.7	1.7 ± 0.6	0.6	-35.53[d]
Women	1.1 ± 0.4	1.1 ± 0.4	1.1 ± 0.4	1.2 ± 0.4		

Abbreviations: ns, nonsignificant; $\dot{V}O_2$, oxygen uptake.

Data analyzed for statistical significance using ANOVA with 3 degrees of freedom or by χ^2.

[a]Data reported as mean ± standard deviation or percent.

[b]$P < .05.$

[c]$P < .001.$

[d]$P < .0001.$

Table 2.

Index Diagnosis at Entry into Cardiac Rehabilitation

	Period 1: 1996 – 2000 (n = 1174)	Period 2: 2001 – 2005 (n = 1371)	Period 3: 2006 – 2010 (n = 1407)	Period 4: 2011 – 2015 (n = 1444)	Average Yearly Change	Effect of Time
					Sex Difference	**Effect of Sex**
CABG, n = 1675 (31%)						
All	37.2	38.0	29.2	21.6	−1.07%	98.59[a]
Men	39.2	40.2	33.2	23	11.2	48.93[a]
Women	31.8	30.9	16	12.2		
MI, n = 1705 (32%)						
All	29.7	29.1	27.8	39.6	0.60%	32.05[a]
Men	27.8	28.3	25.7	38.4	5.3	25.32[a]
Women	34.9	31.8	33.3	41.4		
Angina (PCI), n = 1209 (22%)						
All	18.6	18.3	29.6	22.7	0.37%	14.91[a]
Men	19.8	19	29.1	21.8		ns
Women	15.2	15.9	31	24.3		
Angina (Medical Treatment), n = 159 (3%)						
All	5.4	3.7	1.8	1.5	−0.29%	43.59[a]
Men	4.8	3.1	1.8	1.2	1.4	28.46[a]
Women	7.0	5.5	1.8	2.1		
Valve Replacement, n = 218 (4%)						
All			4.7	10.6	0.82%	176.03[a]
Men			3.6	10	4.2	109.57[a]
Women			7.6	14.5		
CHF, n = 190 (4%)						
All	2.4	4.6	3.6	3.4		ns
Men	2.9	4.1	3.5	3.2		ns
Women	1.0	6.1	3.8	4.0		

Abbreviations: CABG, coronary artery bypass graft; CHF, congestive heart failure; MI myocardial infarction; ns, nonsignificant; PCI, percutaneous coronary intervention.

Notes:

• 4% of patients were categorized as "other" and are not represented in this table.

• Overall effect of time was significant using multinomial logistic regression.

- Average yearly change calculated by pairwise logistic regression (target diagnosis vs all others).

- Statistical significance analyzed using χ^2 or t-tests, as appropriate.

[a]$P < .0001$.

Table 3.

Cardiovascular Medications at Entry into Cardiac Rehabilitation[a]

	Period 1: 1996 – 2000 (n = 1174)	Period 2: 2001 – 2005 (n = 1371)	Period 3: 2006 – 2010 (n = 1407)	Period 4: 2011 – 2015 (n = 1444)	Average Yearly Change	Effect of Time
					Sex Difference	**Effect of Sex**
Antiplatelet Agents						
All	91.7	92.9	95.7	98.3	0.50%	71.8[b]
Men	93.2	94.1	95.8	98.2	2.8%	15.12[c]
Women	87.3	88.8	95.7	98.4		
β-adrenergic Blocker						
All	68.7	71.6	79.5	82.7	1%	95.71[b]
Men	69.3	73.1	80.6	82.4	ns	ns
Women	67.3	67.1	76.9	83.4		
ACE inhibitor or ARB						
All	29.8	35.6	48.4	52.9	1.60%	180.5[b]
Men	29.1	36	49	53.2	ns	ns
Women	31.7	34.4	47	52.1		
Statin						
All	63.6	69.1	94.6	98.9	2.70%	627.83[b]
Men	65.5	71.1	95	99.2	8%	14.22[c]
Women	58.6	62.8	93.4	98.1		

Abbreviations: ACE, angiotensin-converting enzyme; ARB, angiotensin receptor blocker; ns, nonsignificant.

Note: Statistical significance analyzed using χ^2 or t-tests, as appropriate.

[a]All data reported as percent.

[b]$P < .0001$.

[c]$P < .001$.

Table 4.

Sample Characteristics of CR Population with and without Valve Patients[a]

	Period 3: 2006 – 2010 (n = 1407)	Period 4: 2011 – 2015 (n = 1444)	Main Effect of Valve Procedure	Average Difference Between Valve and All Others
Valve Replacement/Repair				
All	4.69	10.53		
Age				
All	63.5 ± 11.1	64.2 ± 11.6		
Valve	65.8 ± 12.8	66.4 ± 12.9	2.9[b]	2.30
All others	63.4 ± 11.0	63.8 ± 11.3		
Women				
All	28.0	29.6	15.02[c]	11.00%
Valve	45.5	38.2		
All others	27.1	28.6		
Weight, kg				
All	86.8 ± 19.6	86.7 ± 19.1	−6.61[d]	−8.0
Valve	80.0 ± 18.1	78.9 ± 16.5		
All others	87.2 ± 19.6	87.6 ± 19.1		
Waist, cm				
All	102.8 ± 14.5	101.8 ± 14.1	−6.6[d]	−7.2
Valve	97.3 ± 14.4	94.6 ± 12.0		
All others	103.1 ± 14.4	102.6 ± 14.2		
Body Mass Index, kg/m²				
All	30.1 ± 6.0	29.6 ± 5.9	−5.93[d]	−2.1
Valve	28.3 ± 5.4	27.4 ± 5.0		
All others	30.1 ± 6.1	29.9 ± 5.9		
Obesity				
All	42.9	39.6		
Valve	33.8	25.0	16.77[d]	−12%
All others	43.3	41.2		
Diabetes Mellitus				
All	24.7	21.7		
Valve	12.1	8.5	22.48[d]	−11.00%

	Period 3: 2006 – 2010 (n = 1407)	Period 4: 2011 – 2015 (n = 1444)	Main Effect of Valve Procedure	Average Difference Between Valve and All Others
All others	25.4	23.2		
Hypertension				
All	70.6	62.5	4.30[b]	
Valve	62.1	58.6		−1.80%
All others	70.9	63.0		0.89%
Current Smoking				
All	7.2	8.4		
Valve	0	3.9	7.83[b]	−3%
All others	7.5	9.0		
Comorbidity Score				
All	0.5 ± 1.2	0.6 ± 1.2		
Valve	0.5 ± 1.0	0.4 ± 1.0	ns	ns
All others	0.6 ± 1.2	0.6 ± 1.3		
Antiplatelet Agents				
All	95.7	98.3		
Valve	84.8	95.4	20.72[d]	−21%
All others	96.3	98.6		
β-adrenergic Blocker				
All	79.5	82.7		
Valve	81.8	77.0	ns	ns
All others	79.5	83.5		
ACE Inhibitor or ARB				
All	48.4	52.9		
Valve	28.8	32.2	38.54[d]	−14%
All others	49.4	55.4		
Statin, %				
All	94.6	98.9		
Valve	90.0	96.0	ns	ns
All others	94.8	99.1		
Relative Peak $\dot{V}O_2$, mL/kg/min				
All	18.3 ± 6.5	18.2 ± 6.0		

	Period 3: 2006 – 2010 (n = 1407)	Period 4: 2011 – 2015 (n = 1444)	Main Effect of Valve Procedure	Average Difference Between Valve and All Others
Valve	16.3 ± 5.0	16.8 ± 5.3	−3.74^c	−1.4
All Others	18.4 ± 6.6	18.4 ± 6.0		
Absolute peak V̇O$_2$, L/min				
All	1.6 ± 0.7	1.6 ± 0.6		
Valve	1.3 ± 0.5	1.3 ± 0.5	−6.45^d	−0.25
All others	1.6 ± 0.7	1.6 ± 0.6		

Abbreviations: ACE, angiotensin-converting enzyme; ARB, angiotensin receptor blocker; ns, nonsignificant; VO$_2$, oxygen uptake.

[a] Data reported as percent or mean ± standard deviation.

Notes:

• Statistical significance analyzed using χ^2 or *t*-tests, as appropriate.

• For hypertension, a significant interaction was found so the differences listed are the yearly changes that differ for valve patients and all other patients.

[b] $P < .05$.

[c] $P < .001$.

[d] $P < .0001$.