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Use and effects of cardiac rehabilitation in patients with coronary heart disease: results from the EUROASPIRE III survey

Kornelia Kotseva[1], David Wood[1], Guy De Backer[2] and Dirk De Bacquer[2] (on behalf of the EUROASPIRE III Study Group)

Abstract

Aim: To describe lifestyle and risk-factor management in patients attending cardiac rehabilitation programmes (CRPs) compared to those who do not.

Design: A cross-sectional survey.

Methods: The EUROASPIRE III survey was conducted in 76 centres in 22 European countries. Consecutive patients having had a coronary event or revascularization before the age of 80 were identified and interviewed at least 6 months after hospital admission.

Results: 13,935 medical records were reviewed and 8845 patients interviewed (participation rate 73%); 44.8% of patients reported being advised to attend a CRP and of these 81.4% did so (36.5% of all patients). There were wide variations between countries and diagnostic categories, ranging from 15.9% in the Ischaemia group to 68.1% in the CABG group. Characteristics associated with participation in a CRP included younger age, male sex, higher educational level and CABG as a recruiting index event, while smokers were less likely to attend a CRP. Patients who attended a CRP had a significantly lower prevalence of smoking, better control of total and LDL-cholesterol and higher use of beta-blockers, ACE inhibitors/ARBs and lipid-lowering drugs.

Conclusions: CRPs in Europe are underused, with poor referral and low participation rate and wide variations between countries. Despite this heterogeneity, the control of smoking and cholesterol and the use of cardioprotective medication is better in those who attend a CPR. There is an urgent need for comprehensive, multidisciplinary rehabilitation programmes to integrate professional lifestyle interventions with effective risk-factor management, appropriately adapted to the medical, cultural and economic settings of a country.

Keywords

EUROASPIRE III, cardiac rehabilitation, attendance, coronary patients, risk factor management, cardiovascular prevention

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Introduction

The overall objective of cardiac rehabilitation and secondary prevention is to reduce the risk of major coronary events and deaths in patients with clinically established CHD and thereby reduce premature disability and mortality, prolong survival, and improve quality of life.[1] Since 1969, the focus of cardiac rehabilitation has evolved from supervised exercise sessions and return to work in patients recovering from

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acute myocardial infarction or cardiac surgery into more comprehensive programmes including health education regarding smoking, diet and physical activity, risk-factor management in terms of controlling elevated blood pressure, dyslipidaemia and diabetes, and the use of prophylactic drug therapies. According to the most recent WHO definition: 'The rehabilitation of cardiac patients is the sum of activities required to influence favourably the underlying cause of the disease, as well as the best possible physical, mental and social conditions, so that they may, by their own efforts preserve or resume when lost, as normal a place as possible in the community. Rehabilitation cannot be regarded as an isolated form of therapy but must be integrated with the whole treatment of which it forms only one facet'.[2]

Cardiac rehabilitation is recommended by the European Society of Cardiology, the American Heart Association and the American College of Cardiology in the treatment of patients with coronary heart disease (CHD).[3–8] Moreover, it is a cost-effective intervention following an acute coronary event and it improves prognosis by reducing recurrent hospitalization and health care costs, while prolonging life.[8–12] It compares favourably in terms of cost per life year saved with other well-established interventions in the treatment of CHD such as percutaneous coronary interventions or coronary artery bypass surgery.

The implementation of secondary prevention of CHD is still far from optimal in Europe. The comparison of the EUROASPIRE I, II and III surveys over the last 12 years showed adverse lifestyle trends with increasing prevalence rates of smoking among younger patients, especially women, increasing prevalence of obesity, central obesity and diabetes and no change in blood pressure control. Only the management of elevated LDL-cholesterol has improved, due to an increased use of statins.[11]

The EUROASPIRE III survey was carried out in 2006/2007 in selected geographical areas in 22 European countries under the auspices of the Euro Heart Survey programme of the European Society of Cardiology.[12] The results showed that large proportions of coronary patients did not achieve the lifestyle, risk factors and therapeutic targets for cardiovascular disease prevention and there were wide variations in risk-factor prevalence and the use of cardioprotective drug therapies between countries.

The aim of this paper is to describe the use of cardiac rehabilitation programmes in a representative sample of coronary heart disease patients all over Europe as well as the risk-factor management and the use of prophylactic drug therapies in patients participating in a cardiac rehabilitation programme (CRP) compared to those who did not.

Study population and methods

Sample size and data collection

The design and principal results of the EUROASPIRE III survey are described in detail elsewhere.[12] In summary, 76 hospital centres in 22 European countries were included in the study: Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Poland, Romania, the Russian Federation, Slovenia, Spain, The Netherlands, Turkey and the UK. Within each hospital, consecutive patients – men and women aged 80 years or less at the time of index event – were identified through hospitalization due to one of the following conditions: (1) elective or emergency coronary artery by-pass graft (CABG) surgery; (2) elective or emergency percutaneous coronary intervention (PCI); (3) acute myocardial infarction (ST elevation and non-ST elevation MI); or (4) acute myocardial ischaemia but no evidence of infarction (troponin negative).

Data collection was conducted by trained research staff and was based on a retrospective review of hospital medical records and an interview and examination of patients at the hospital or at home using standardized methods and instruments at least 6 months after the hospitalization for the event that included them in the study.

Methods

The information obtained at interview included: personal and demographic details, personal and family history of CHD, reported lifestyle and risk-factor history in relation to smoking, diet, physical activity, hypertension, hyperlipidaemia, diabetes and cardioprotective medication. Patients were specifically asked whether they were advised to follow a CRP within 3 months of discharge following the index event or procedure and, if yes, whether they actually attended it and what they received as part of this programme.

All equipment was calibrated at the start of the survey to ensure comparability of results between centres. The following measurements were performed: height and weight (SECA scales model number 701 and measuring stick model 220), waist (tape measure), blood pressure (Omron M5-I automatic digital sphygmomanometer) and breath carbon monoxide (Smokerlyser, Bedfont Scientific, Model Micro 4). Blood samples were taken for serum total cholesterol, HDL-cholesterol, triglycerides, calculated LDL-cholesterol and plasma glucose.

The central laboratory of the study was the Laboratory of Analytical Biochemistry, National Public Health Institute, Helsinki, Finland. The

laboratory has been accredited by the Finnish Accreditation Service and it fulfils the requirements of the standard SFS-EN ISO/IEC 17025:2005. All measurements were performed on a clinical chemistry analyser; Architect c8000, Abbott Laboratories, Abbott Park, Illinois, USA. The following methods were used: enzymatic method for measuring the serum total cholesterol, homogenous method for direct measurement of serum HDL-cholesterol, enzymatic glycerol phosphate oxidase method for measuring serum triglycerides and enzymatic hexokinase method for plasma glucose. For standardizing measurements the laboratory has taken part in Lipid Standardization Program organised by CDC, Atlanta, USA and External Quality Assessment Schemes organised by Labquality, Helsinki, Finland.

Data management

All data were collected electronically using a unique identification number for country, centre and individual. The data was submitted via the internet to the data management centre where checks for completeness, internal consistency and accuracy were run. All data were stored under the provisions of the National Data Protection Regulations. Data management was undertaken at the ESC Euro Heart Survey department, European Heart House, Nice, France.

Statistical analyses

All statistical analyses were undertaken using SAS statistical software (release 9.1) in the Department of Public Health, Ghent University, Belgium.[13] Descriptive statistics were used to estimate the prevalence of risk factors and medication by centre, diagnosis category, age and gender. Statistical comparisons between groups according to the advice and use of cardiac rehabilitation care were done according to multilevel modelling.[14] These hierarchical models accounted for the clustering of patients within centres. Potential confounding due to differences in distributions of diagnostic category and age was adjusted for in the statistical models. A level of $\alpha = 0.05$ was a priori chosen to indicate statistical significance.

Results

A total of 13,935 medical records were reviewed and 8966 patients interviewed of whom 8845 (74.7% men and 25.3% women) had valid information about their participation in CRPs and were included in the present analysis. The median time between index event and interview was 1.24 years (inter-quartile range 0.95–1.77 years) and the overall interview participation rate, defined as those who were contacted and found alive, was 73%.

There was a wide variation in the size of study population between countries, from 121 patients in Greece to 536 patients in Bulgaria. Proportions by diagnostic category were: 19.5% (1729) CABG; 41.5% (3671) PCI; 19.4% (1715) AMI; and 19.6% (1730) with Ischaemia. The median age at the time of interview was 63.7 years and 63.5% (5613) of patients were $\geq$60 years.

The proportions of patients who were advised to partake and attended a CRP by country are presented in Table 1. Overall, 44.8% of the whole study population was advised by physicians or other health professionals to attend CRP and 36.5% (81.4% of those advised) participated in some form of CRP. By diagnostic category, both the proportion advised and the proportion attending when advised was lowest in the Ischaemia group and highest in the CABG group.

Less than 10% of patients in Greece, Cyprus, the Russian Federation, Spain and Turkey were advised to attend a CRP. Between all the other countries the participation rate among those who were advised varied from 31.7% in Bulgaria to 95.6% in Lithuania. There were no clear differences between proportions advised and proportions attending with regard to age and gender.

Table 2 shows the characteristics associated with the advice given by a doctor or other health professional to attend a CRP. The advice to participate in a CRP was given more often to slightly younger patients, to those who had CABG as index event, to those with a history of previous MI and to higher educated patients. Patients with PCI and acute Ischaemia, those who had previous history of angina pectoris and those with lower total cholesterol level at discharge were less likely to be advised to attend a CRP.

The characteristics associated with participation in a CRP, if advised, are presented in Table 3. There were significant differences by age, diagnostic category, history of previous PCI and angina pectoris, smoking prior to index event and blood pressure at discharge. Patients who participated in a CRP had a significantly higher use of lipid-lowering drugs and ACE inhibitors or angiotensin II receptor blockers ARBs at discharge.

The comparison between patients' characteristics and risk-factor prevalence and control at interview according to the advice and participation in a CRP is presented in Table 4. After adjustment for age at index event, country and diagnostic category, there were significant differences with regard to smoking, regular physical exercise, blood pressure and total cholesterol control, as well as in the use of cardioprotective medication. Table 5 shows the components of the CRP by country, index event, age and gender.

Table 1. Proportion of patients advised to follow a cardiac rehabilitation programme and among those advised, proportion attended, by country, age, gender and diagnostic category

	Cardiac rehabilitation programme	
	%Advised (n/total)	%Attended[a] (among those advised) (n/total)
Country		
Belgium	77.8 (252/324)	83.7 (211/252)
Bulgaria	71.3 (382/536)	31.7 (121/382)
Croatia	41.9 (190/454)	89.5 (170/190)
Cyprus	4.9 (21/426)	38.1 (8/21)
Czech Republic	50.0 (239/478)	83.7 (200/239)
Finland	40.2 (94/234)	81.9 (77/94)
France	32.4 (110/340)	90.0 (99/110)
Germany	56.6 (303/535)	91.1 (276/303)
Greece	0.8 (1/121)	0.0 (0/1)
Hungary	56.6 (256/452)	91.4 (234/256)
Ireland	88.0 (338/384)	86.1 (291/338)
Italy	51.5 (194/377)	88.7 (172/194)
Latvia	37.5 (191/510)	92.1 (176/191)
Lithuania	90.3 (458/507)	95.6 (438/458)
Poland	53.1 (262/493)	92.0 (241/262)
Romania	26.4 (136/516)	51.5 (70/136)
Russian Federation	8.2 (33/402)	42.4 (14/33)
Slovenia	60.3 (178/295)	94.9 (169/178)
Spain	0.6 (3/509)	33.3 (1/3)
The Netherlands	54.4 (130/239)	86.9 (113/130)
Turkey	7.3 (24/329)	45.8 (11/24)
United Kingdom	43.0 (165/384)	80.6 (133/165)
Index event		
CABG	74.8 (1293/1729)	91.1 (1178/1293)
PCI	39.4 (1448/3671)	83.8 (1213/1448)
AMI	41.2 (707/1715)	79.1 (559/707)
Ischaemia	29.6 (512/1730)	53.7 (275/512)
Age at interview		
<60 years	45.9 (485/3232)	82.1 (1219/1485)
≥60 years	44.1 (475/5613)	81.0 (2006/2475)
Gender		
Men	45.7 (3020/6605)	81.7 (2468/3020)
Women	42.0 (940/2240)	80.5 (757/940)
Total	44.8 (3960/8845)	81.4 (3225/3960)

[a]At least one of the sessions. CABG, coronary artery bypass graft; PCI, percutaneous coronary intervention; AMI, acute myocardial infarction; Ischaemia, acute myocardial ischaemia.

Discussion

There is compelling scientific evidence that cardiac rehabilitation is an effective treatment for patients with CHD. The meta-analysis of 8940 patients from 48 trials of cardiac rehabilitation showed that a structured service, compared to usual care, was associated with a reduction in all-cause mortality: odds ratio 0.80 (95% CI 0.68–0.93), and cardiac mortality 0.74 (0.61–0.96).[15] Another meta-analysis of the effectiveness of secondary prevention programmes of 63 randomized controlled trials including 21,295 patients showed a summary risk ratio for all-cause mortality 0.85 (0.77–0.94) and for recurrent myocardial infarction 0.83 (0.74–0.94).[16] In the systematic review of trials of secondary prevention, multidisciplinary disease management programmes led to a reduction in hospital admissions and recurrent myocardial infarction.[17] So the distinction between 'cardiac rehabilitation' and 'secondary prevention' is artificial and these meta-analyses demonstrate the overall benefits of an integrated multidisciplinary and comprehensive multifactorial approach to reducing cardiovascular risk, cardiovascular events and all-cause mortality.

However, despite the strength of this evidence, cardiac rehabilitation in Europe continues to be considerably underused with poor referral and a low participation rate. The results of the EUROASPIRE III survey showed inadequate lifestyle and risk-factor control and underuse of cardiac rehabilitation in Europe. Less than half of patients with CHD were advised to follow a CRP and just over one-third actually participated in some form of cardiac rehabilitation. Yet, of those who were advised to attend a CRP, four-fifths did so. These results are similar to those of the EUROASPIRE II survey, which demonstrated that two in five coronary patients reported receiving advice to follow a CRP and only one-third actually attended some form of cardiac rehabilitation.[18] The comparison between those 13 countries that participated in both EUROASPIRE II and III surveys demonstrated that the proportion of patients advised to follow a CRP increased from 44.5% to 55.7% ($p < 0.0001$) and the participation rate also increased from 38.0% to 46.1% ($p < 0.0001$). In EUROASPIRE III, there was considerable variation with regard to participation in a CRP between European countries, with the highest attendance reported in Lithuania and Ireland, the lowest in Turkey, Cyprus and the Russian Federation, and virtually no attendance in Greece and Spain. These differences are most likely to reflect the heterogeneity of healthcare systems and the availability of cardiac rehabilitation services in some regions of Europe.

In EUROASPIRE III, the patients' age, diagnosis and educational level were associated with the reported advice to attend a CRP. Those who had had CABG were nearly twice as likely to be advised to follow a CRP than those with PCI and AMI. Importantly, the potential gain from cardiac rehabilitation for angina patients, who have not yet had a MI, may be greater

Table 2. Reported advice to participate in a CRP programme according to patients' characteristics at discharge

	CRP advised		
	%No (n/total)	%Yes (n/total)	p^b
Age at index event[a] (years), N	61.8 (9.7), 4885	61.5 (9.4), 3690	<0.0001
Female gender	26.6 (1300/4885)	23.7 (940/3960)	0.35
Index event – CABG	8.9 (436/4885)	32.6 (1293/3960)	<0.0001
Index event – PCI	45.5 (2223/4885)	36.6 (1448/3960)	<0.0001
Index event – AMI	20.6 (1008/4885)	17.8 (707/3960)	0.03
Index event – Ischaemia	24.9 (1218/4885)	12.9 (512/3960)	<0.0001
Previous CABG	8.3 (403/4862)	7.1 (280/3941)	0.03
Previous PCI	17.7 (861/4856)	18.6 (732/3932)	0.58
Previous AMI	27.8 (1338/4818)	33.6 (1316/3916)	0.009
Previous Ischaemia	8.6 (409/4778)	9.5 (369/3867)	0.48
Previous angina pectoris	32.2 (1541/4781)	29.7 (1143/3845)	<0.0001
Previous stroke	3.4 (166/4851)	4.3 (170/3934)	0.43
Previous TIA	2.4 (116/4838)	3.0 (116/3924)	0.16
Previous PAD	5.4 (257/4750)	5.2 (204/3914)	0.03
Diabetes at discharge	28.4 (1085/3814)	29.3 (865/2954)	0.43
Smoking in month prior to IE	31.6 (1540/4873)	29.0 (1147/3950)	0.74
Discharge BMI $\geq$25 kg/m^2	78.9 (1711/2169)	77.8 (1223/1573)	0.54
Discharge BMI $\geq$30 kg/m^2	31.6 (685/2169)	29.4 (462/1573)	0.76
Systolic BP at discharge[a] (mmHg), N	129.7 (19.2), 3355	130.0 (18.0), 2443	0.52
Diastolic BP at discharge[a] (mmHg), N	78.0 (10.2), 3347	78.5 (10.2), 2437	0.62
Total cholesterol at discharge[a] (mmol/l), N	5.20 (1.25), 2930	5.11 (1.27), 1972	0.004
BMI at discharge[a] (kg/m^2), N	28.4 (4.40), 2169	28.3 (4.44), 1573	0.77
Low educational level	30.0 (1454/4850)	19.6 (772/3940)	0.001
Medication at discharge:			
Antiplatelets	95.8 (4559/4760)	94.2 (3652/3877)	0.26
Beta-blockers	80.6 (3829/4749)	84.9 (3290/3874)	0.11
ACE inhibitors/angiotensin II RA	70.7 (3362/4754)	66.4 (2574/3876)	0.68
Calcium antagonists	22.5 (1067/4751)	22.4 (868/3879)	0.16
Diuretics	27.1 (1288/4753)	32.1 (1244/3879)	0.55
Lipid-lowering	83.0 (3937/4746)	77.8 (3007/3864)	0.64
Anticoagulants	5.4 (259/4752)	10.6 (412/3877)	0.08

[a]Mean (SD); [b]adjusted for diagnostic category, age at index event and centre. CRP, cardiac rehabilitation programme; CABG, coronary artery bypass graft; PCI, percutaneous coronary intervention; AMI, acute myocardial infarction; Ischaemia, acute myocardial ischaemia; TIA, transient ischaemic attack; PAD, peripheral artery disease; BMI, body mass index; BP, blood pressure.

than for any other diagnostic group. They need lifestyle intervention and control of risk factors as much as those revascularized by CABG or PCI or presenting with AMI. In our study, patients with low educational level were less likely to be recommended for a CRP than those with higher education. A systematic review of ten published observational studies including 30,333 coronary patients on determinants of referral to CRP showed that they can be grouped as sociodemographic, medical, psychological and healthcare system factors. The major predictors were English speaking, prior MI, being admitted to hospital providing CR and having insurance cover.[19]

Patients who attended a CRP (if advised) were men, slightly younger, had CABG or PCI as recruiting index event more often, were more likely to have a history of previous PCI or angina pectoris and had higher systolic blood pressure and lipid-lowering and ACE inhibitors/ARBs use at discharge. Patients who were smokers in the month prior to their recruiting coronary event were less likely to attend a CRP. So, ironically, smokers, women and older patients were less likely to participate

Table 3. Reported participation in a CRP according to patients' characteristics at discharge

	CRP attended if advised[a]		
	%No (n/total)	%Yes (n/total)	p^b
Age at index event[c] (years), N	62.0 (9.6), 735	61.4 (9.3), 3225	0.01
Female gender	24.9 (183/735)	23.5 (757/3225)	0.54
Index event – CABG	15.6 (115/735)	36.5 (1178/3225)	<0.0001
Index event – PCI	32.0 (235/735)	37.6 (1213/3225)	0.04
Index event – AMI	20.1 (148/735)	17.3 (559/3225)	0.57
Index event – Ischaemia	32.2 (237/735)	8.5 (275/3225)	<0.0001
Previous CABG	7.5 (55/735)	7.0 (225/3206)	0.43
Previous PCI	15.5 (114/734)	19.3 (618/3198)	0.002
Previous AMI	35.2 (257/731)	33.2 (1059/3185)	0.54
Previous Ischaemia	11.8 (85/721)	9.0 (284/3146)	0.46
Previous angina pectoris	24.6 (177/721)	30.9 (966/3124)	0.008
Previous stroke	5.3 (39/731)	4.1 (131/3203)	0.93
Previous TIA	3.0 (22/728)	2.9 (94/3196)	0.87
Previous PAD	5.8 (42/728)	5.1 (162/3186)	0.11
Diabetes at discharge	25.7 (152/591)	30.2 (713/2363)	0.13
Smoking in month prior to IE	33.3 (244/733)	28.1 (903/3217)	0.0003
Discharge BMI $\geq$25 kg/m^2	78.3 (242/309)	77.6 (981/1264)	0.77
Discharge BMI $\geq$30 kg/m^2	28.5 (88/309)	29.6 (374/1264)	0.58
Systolic BP at discharge[c] (mmHg), N	129.4 (16.7), 546	130.2 (18.4), 1897	0.03
Diastolic BP at discharge[c] (mmHg), N	78.1 (8.9), 545	78.6 (10.5), 1892	0.40
Total cholesterol at discharge[c] (mmol/l), N	5.19 (1.24), 346	5.09 (1.28), 1626	0.42
BMI at discharge[c] (kg/m^2), N	28.2 (4.20), 309	28.3 (4.50), 1264	0.32
Low educational level	14.3 (105/733)	20.8 (667/3207)	0.96
Medication at discharge:			
Antiplatelets	92.4 (670/725)	94.6 (2982/3152)	0.99
Beta-blockers	83.3 (605/726)	85.3 (2685/3148)	0.49
ACE inhibitors/angiotensin II RA	65.2 (473/726)	66.7 (2101/3150)	0.02
Calcium antagonists	21.8 (158/726)	22.5 (710/3153)	0.62
Diuretics	29.3 (213/726)	32.7 (1031/3153)	0.13
Lipid-lowering	73.8 (536/726)	78.7 (2471/3138)	0.008
Anticoagulants	8.3 (60/725)	11.2 (352/3152)	0.99

[a]At least one session; [b]adjusted for diagnostic category, age at index event and centre; [c]mean (SD). CRP, cardiac rehabilitation programme; CABG, coronary artery by-pass graft; PCI, percutaneous coronary intervention; AMI, acute myocardial infarction; Ischaemia, acute myocardial ischaemia; TIA, transient ischaemic attack; PAD, peripheral artery disease; BMI, body mass index; BP, blood pressure.

in a CRP. Our study showed a considerable selection bias in the profile of patients who were advised to attend a CRP, as well as in those who actually did attend a CRP. This may influence the results not only in this study, but in most other studies that assess the effectiveness of CRPs. Our results are in accordance with previous reviews summarizing the main predictors of patients' non-adherence as being older, female, spending fewer years in formal education, having angina and being less physically active.[20] A systematic review of fifteen studies published between 1978 and 2001 showed that the main factors associated with low attendance were older age, lower income/greater deprivation and not understanding the severity of their illness.[21] Patients who smoked, were unmarried, unemployed, of lower socioeconomic status, socially deprived or living some distance from the programme venue were also commonly less likely to attend a CRP. Another study of barriers to participation in a CRP after MI showed that the main characteristics associated with CRP attendance included younger age, male sex, ST-elevation MI, reperfusion therapy, in-hospital cardiologist provider, no prior MI, no prior CRP attendance, and referral to rehabilitation in hospital.[22]

Table 4. Patients' characteristics, risk-factor prevalence and control at interview according to advice and participation in a CRP programme

	CRP advice and attendance				
	%Not advised N = 4885 (n/total)	%Advised but not attended N = 735 (n/total)	%Partially attended[a] N = 463 (n/total)	%Fully attended[b] N = 2762 (n/total)	p^c
Age at interview[d] (years)	63.3 (9.7)	63.6 (9.6)	62.5 (9.9)	62.9 (9.2)	<0.0001
Female gender	26.6 (1300/4885)	24.9 (183/735)	24.6 (114/463)	23.3 (643/2762)	0.54
Index event – CABG	8.9 (436/4885)	15.6 (115/735)	27.0 (125/463)	38.1 (1053/2762)	<0.0001
Index event – PCI	45.5 (2223/4885)	32.0 (235/735)	41.0 (190/463)	37.0 (1023/2762)	<0.0001
Index event – AMI	20.6 (1008/4885)	20.1 (148/735)	19.2 (89/463)	17.0 (470/2762)	0.10
Index event – Ischaemia	24.9 (1218/4885)	32.2 (237/735)	12.7 (59/463)	7.8 (216/2762)	<0.0001
Diabetes	25.5 (1235/4835)	23.6 (172/730)	25.3 (117/463)	23.0 (631/2743)	0.06
Smoking	18.6 (908/4871)	17.8 (131/735)	20.6 (95/462)	13.9 (383/2758)	<0.0001
Smoking cessation	45.7 (703/1539)	48.0 (117/244)	41.8 (61/146)	54.7 (414/757)	<0.0001
BMI ≥25 kg/m^2	81.9 (3980/4860)	78.1 (573/734)	81.1 (374/461)	83.0 (2282/2749)	0.11
BMI ≥30 kg/m^2	36.0 (1748/4860)	30.4 (223/734)	36.4 (168/461)	35.2 (969/2749)	0.11
Regular physical exercise[e]	29.2 (1316/4508)	24.3 (167/686)	38.8 (167/431)	43.4 (1130/2604)	<0.0001
Blood pressure ≥140/90 mmHg (≥130/80 mmHg for diabetics)	56.0 (2729/4877)	54.6 (401/734)	54.9 (254/463)	56.8 (1563/2752)	0.03
Total cholesterol ≥4.5 mmol/l	52.9 (2445/4622)	50.1 (353/705)	45.5 (198/435)	49.3 (1277/2592)	<0.0001
Controlled blood pressure[f]	43.8 (1997/4562)	45.1 (315/698)	45.1 (198/439)	43.3 (1153/2664)	0.03
Controlled total cholesterol[g]	53.2 (1932/3628)	54.7 (275/503)	58.6 (214/365)	57.0 (1217/2136)	0.004
Controlled glycaemia among diabetics	9.1 (82/902)	12.4 (12/97)	10.7 (8/75)	11.8 (53/448)	0.81
Low educational level	30.0 (1454/4850)	14.3 (105/733)	22.8 (105/461)	20.5 (562/2746)	0.009
Medication use:					
Antiplatelets	90.5 (4399/4862)	91.8 (671/731)	92.0 (425/462)	89.8 (2470/2751)	0.01
Beta-blockers	76.2 (3700/4857)	82.6 (604/731)	82.6 (381/461)	85.1 (2340/2751)	<0.0001
ACE inhibitors/ARBs	69.8 (3392/4857)	66.4 (485/730)	71.6 (331/462)	73.6 (2024/2748)	0.004
Calcium antagonists	24.6 (1195/4858)	25.2 (184/730)	22.8 (105/461)	24.4 (671/2750)	0.19
Diuretics	29.6 (1440/4858)	34.9 (255/731)	28.2 (130/461)	29.8 (820/2747)	0.66
Lipid-lowering	79.1 (3845/4859)	72.6 (531/731)	84.2 (388/461)	82.3 (2262/2747)	<0.0001
Anticoagulants	4.6 (221/4861)	6.0 (44/731)	5.4 (25/462)	7.5 (207/2751)	0.39

[a]Attended at least one session; [b]attended all sessions; [c]adjusted for diagnostic category, age at index event and centre; [d]mean (SD); [e]any planned physical activity (e.g. brisk walking, aerobics, jogging, bicycling, swimming, rowing, etc.) performed to increase physical fitness (performed 3 to 5 times per week for 20–60 minutes per session); [f]BP <140/90 mmHg (<130/80 mmHg for diabetics) in patients on blood pressure lowering medication; [g]total cholesterol <4.5 mmol/l in patients on lipid-lowering medication. CRP, cardiac rehabilitation programme; CABG, coronary artery bypass graft; PCI, percutaneous coronary intervention; AMI, acute myocardial infarction; Ischaemia, acute myocardial ischaemia; TIA, transient ischaemic attack; PAD, peripheral artery disease; BMI, body mass index.

In the EUROASPIRE III survey, those patients who reported attending a CRP had a significantly lower prevalence of smoking and reported higher smoking cessation rates. A significantly higher proportion of patients in the CRP group reported performing regular physical exercise. Patients who attended a CRP had significantly better total cholesterol control and higher use of beta-blockers, ACE inhibitors/ARBs and lipid-lowering drugs at interview. However, there were no significant differences in the prevalence of being overweight and obesity and blood pressure and glucose control according to participation in a CRP. The differences in risk-factor management at interview should be interpreted in the context of selection bias with regard to advice and participation in a CRP, as it is unclear how far they are related to the effectiveness of the CRP or to the selected patients in the respective groups.

Although these results are encouraging there is still considerable potential for CRPs to further reduce the risk of fatal and non-fatal cardiovascular events. Among patients who participated in a CRP, more

Table 5. Components of the CRP programmes by country, age, gender and diagnostic category, reported at interview

	%Only written educational material (n/total)	%Teaching sessions/ health promotion workshops (n/total)	%Smoking cessation[a] (n/total)	%Dietary modification/ weight management (n/total)	%Supervised exercise programme (n/total)	%Stress modification and relaxation (n/total)	%Other (n/total)
Country							
Belgium	4.3 (9/211)	6.2 (13/211)	12.3 (9/73)	33.2 (70/211)	97.2 (205/211)	17.1 (36/211)	2.8 (6/211)
Bulgaria	29.8 (36/121)	35.5 (43/121)	43.3 (13/30)	47.9 (58/121)	65.3 (79/121)	34.7 (42/121)	1.7 (2/121)
Croatia	5.9 (10/170)	64.1 (109/170)	62.3 (38/61)	64.7 (110/170)	89.4 (152/170)	45.9 (78/170)	0.6 (1/170)
Cyprus	62.5 (5/8)	0.0 (0/8)	0.0 (0/4)	12.5 (1/8)	25.0 (2/8)	0.0 (0/8)	0.0 (0/8)
Czech Republic	3.5 (7/200)	53.5 (107/200)	34.0 (18/53)	53.0 (106/200)	74.0 (148/200)	4.5 (9/200)	0.5 (1/200)
Finland	28.6 (22/77)	55.8 (43/77)	71.4 (10/14)	68.8 (53/77)	55.8 (43/77)	39.0 (30/77)	0.0 (0/77)
France	47.5 (47/99)	19.2 (19/99)	38.5 (10/26)	68.7 (68/99)	100.0 (99/99)	63.6 (63/99)	0.0 (0/97)
Germany	3.3 (9/276)	89.1 (246/276)	51.2 (42/82)	86.6 (239/276)	92.4 (255/276)	71.7 (198/276)	1.4 (4/276)
Hungary	6.8 (16/234)	79.5 (186/234)	20.7 (12/58)	77.8 (182/234)	96.6 (226/234)	15.8 (37/234)	0.0 (0/234)
Ireland	10.3 (30/291)	89.3 (260/291)	79.5 (70/88)	94.5 (275/291)	95.5 (278/291)	88.0 (256/291)	47.2 (137/290)
Italy	28.5 (49/172)	27.9 (48/172)	27.6 (16/58)	58.7 (101/172)	83.1 (143/172)	29.7 (51/172)	9.3 (16/172)
Latvia	9.7 (17/176)	76.7 (135/176)	68.6 (24/35)	79.5 (140/176)	84.7 (149/176)	71.6 (126/176)	9.8 (17/174)
Lithuania	31.1 (136/438)	48.9 (214/438)	44.3 (51/115)	67.6 (296/438)	94.3 (413/438)	60.5 (265/438)	0.7 (3/434)
Poland	3.3 (8/241)	22.8 (55/241)	18.0 (11/61)	20.3 (49/241)	76.3 (184/241)	17.0 (41/241)	0.4 (1/241)
Romania	12.9 (9/70)	32.9 (23/70)	50.0 (6/12)	92.9 (65/70)	78.6 (55/70)	58.6 (41/70)	0.0 (0/70)
Russian Federation	0.0 (0/14)	71.4 (10/14)	0.0 (0/7)	42.9 (6/14)	85.7 (12/14)	0.0 (0/14)	0.0 (0/14)
Slovenia	10.1 (17/169)	27.8 (47/169)	2.7 (1/37)	14.8 (25/169)	81.7 (138/169)	18.3 (31/169)	14.8 (25/169)
Spain	0.0 (0/1)	0.0 (0/1)	0.0 (0/1)	0.0 (0/1)	100.0 (1/1)	0.0 (1/1)	0.0 (0/1)
The Netherlands	13.4 (15/112)	70.5 (79/112)	23.3 (7/30)	31.3 (35/112)	91.1 (102/112)	63.4 (71/112)	0.0 (0/111)
Turkey	27.3 (3/11)	54.5 (6/11)	33.3 (1/3)	36.4 (4/11)	54.5 (6/11)	0.0 (0/11)	0.0 (0/11)
United Kingdom	20.6 (27/131)	70.2 (92/131)	67.3 (37/55)	81.1 (107/132)	86.4 (114/132)	74.8 (98/131)	1.5 (2/131)
Index event							
CABG	14.2 (167/1177)	54.9 (646/1177)	32.7 (74/226)	61.5 (724/1177)	87.8 (1033/1177)	41.0 (482/1177)	3.7 (43/1175)
PCI	16.3 (197/1212)	56.0 (679/1212)	45.8 (182/397)	68.0 (825/1213)	88.1 (1069/1213)	51.0 (618/1212)	8.8 (106/1206)
AMI	13.1 (73/558)	48.2 (269/558)	38.7 (82/212)	51.4 (287/558)	85.5 (477/558)	44.1 (246/558)	9.1 (51/558)
Ischaemia	12.7 (35/275)	51.3 (141/275)	55.9 (38/68)	56.0 (154/275)	81.8 (225/275)	46.5 (128/275)	5.5 (15/273)
Age at interview							
<60 years	13.6 (166/1218)	56.3 (686/1218)	42.1 (240/570)	62.5 (762/1219)	89.3 (1088/1219)	48.0 (585/1218)	7.5 (91/1212)
≥60 years	15.3 (306/2004)	52.3 (1049/2004)	40.8 (136/333)	61.3 (1228/2004)	85.6 (1716/2004)	44.4 (889/2004)	6.2 (124/2000)
Gender							
Men	15.2 (375/2465)	54.1 (1334/2465)	42.4 (315/743)	62.1 (1532/2466)	87.1 (2149/2466)	46.5 (1145/2465)	7.0 (173/2456)
Women	12.8 (97/757)	53.0 (401/757)	38.1 (61/160)	60.5 (458/757)	86.5 (655/757)	43.5 (329/757)	5.6 (42/756)
Total	14.6 (472/3222)	53.8 (1735/3222)	41.6 (376/903)	61.7 (1990/3223)	87.0 (2804/3223)	45.7 (1474/3222)	6.7 (215/3212)

[a]For patients smoking in the month prior to the index event. CRP, cardiac rehabilitation programme; CABG, coronary artery bypass graft; PCI, percutaneous coronary intervention; AMI, acute myocardial infarction; Ischaemia, acute myocardial ischaemia.

than one in six were still smoking cigarettes, over one-third were obese, more than half had not reached the blood pressure target and over one-third had not achieved the total cholesterol target. Core components of a modern CRP include a comprehensive lifestyle intervention in relation to stopping smoking, making healthy food choices and becoming physically active as well as weight, blood pressure, lipids and glucose management and psychosocial support.[1,6–8] In this survey, nine out of ten patients reported participation in a supervised exercise programme and two-fifths had dietary modification/weight management. However, just over half attended teaching sessions or health promotion workshops, less than half participated in stress modification and relaxation. Only two out of five smokers attended smoking cessation clinic.

The findings of this EUROASPIRE III survey must be considered within the context of study limitations. First, patient populations from participating countries were identified from selected geographical areas, and largely academic hospitals, and are not representative

of all coronary patients in each country. However, this bias is likely to overestimate the extent to which risk factors are being controlled, and therefore results for the generality of coronary patients seen in everyday clinical practice are likely to be worse. Second, the information about the advice, participation and components of the CRP was obtained from self-reports. There is no data on the progression, levels of intensity and duration of the programmes and this may also affect the outcome of secondary prevention/CRPs. However, an important strength of the EUROASPIRE surveys is that they are not just based on abstracted medical record data but face-to-face interviews and examinations using the same protocol and standardized methods and instruments, including central laboratory analyses of lipids and glucose. Therefore, this survey provides contemporary information on lifestyle, risk-factor and therapeutic management for cardiovascular disease prevention.

Cardiac rehabilitation programmes are based on long-established models involving hospital, ambulatory, community or home-based programmes, according to the local and national traditions. However, most of the CRPs rely mainly on short-term interventions and are not adequately implemented in the long term. Short-term interventions are unlikely to bring in long-term benefits with regard to lifestyle and risk-factor management, improve quality of life, or decrease morbidity and mortality. Recent studies, such as EUROACTION and GlObal Secondary Prevention strategiEs to Limit (GOSPEL) studies, provided scientific evidence for the beneficial long-term effect and improved prognosis in patients with CHD.[23,24] So, there is considerable potential to further reduce the risk of CVD in existing CRPs. All coronary patients should be advised and have the opportunity to access a comprehensive cardiovascular prevention and rehabilitation programme, addressing all aspects of lifestyle – smoking cessation, healthy eating and being physically active – together with more effective management of blood pressure, lipids and glucose.

In conclusion, the results of this study show that the CRPs in Europe are underused, with poor referral and low participation rates. Wide variations exist in the participation in a CRP between countries. Patients who are advised to attend and actually participate in CRPs have different characteristics from those who are not advised and do not attend CRPs. Patients who are younger, recruited post-CABG and with higher educational level are more likely to be advised to attend a CRP. This means that the profile of patients getting or not getting the advice to attend a CRP should be taken into account when interpreting results of most studies on the effectiveness of CRPs. There are wide variations in the characteristics of CRPs in terms of components and number of sessions, reflecting the heterogeneity of healthcare systems in Europe. Despite this heterogeneity some positive results, especially in terms of control of smoking and cholesterol and the use of cardioprotective medication, are evident. However, participation in a CRP had no effect on the management of weight, blood pressure and glycaemia in patients with diabetes. There is an urgent need to raise the standard of secondary prevention as many patients referred to and participating in a CRP do not achieve the lifestyle and risk-factor target.

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Conflict of interest

David Wood serves on advisory boards, and has received research grants and honoraria for speaking at some of the pharmaceutical companies sponsored meetings. Guy De Backer has research contracts with some of the companies that contributed to the ESC for funding the study. Kornelia Kotseva and Dirk De Bacquer: none declared.

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