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Determinants of participation and risk factor control according to attendance in cardiac rehabilitation programmes in coronary patients in Europe: EUROASPIRE IV survey

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Abstract

Aim: The purpose of this study was to describe the proportions of patients referred to and attending cardiac rehabilitation programmes in Europe and to compare lifestyle and risk factor targets achieved according to participation in a cardiac rehabilitation programme.

Methods: The EUROASPIRE IV cross-sectional survey was undertaken in 78 centres from 24 European countries. Consecutive patients aged <80 years with acute coronary syndromes and/or revascularization procedures were interviewed at least six months after their event.

Results: A total of 7998 patients (24% females) were interviewed. Overall, 51% were advised to participate in a cardiac rehabilitation programme and 81% of them attended at least half of the sessions; being 41% of the study population. Older patients, women, those at low socio-economic status or enrolled with percutaneous coronary intervention and unstable angina, as well as those with a previous history of coronary disease, heart failure, hypertension or dysglycaemia were less likely to be advised to follow a cardiac rehabilitation programme. People smoking prior to the recruiting event were less likely to participate. The proportions of patients achieving lifestyle targets were higher in the cardiac rehabilitation programme group as compared to the non-cardiac rehabilitation programme group: stopping smoking (57% vs 47%, $p < 0.0001$), recommended physical activity levels (47% vs 38%, $p < 0.0001$) and body mass index<30 kg/m^2 (65% vs 61%, $p=0.0007$). However, there were no differences in the blood pressure, lipids and glucose control. Patients who attended a cardiac rehabilitation programme had significantly lower anxiety and depression scores and better medication adherence.

Conclusions: Only half of all coronary patients were referred and a minority attended a cardiac rehabilitation programme. Those attending were more likely to achieve lifestyle targets, had lower depression and anxiety, and better medication adherence. There is still considerable potential to further reduce cardiovascular risk by increasing uptake and fully integrating secondary prevention and cardiac rehabilitation to provide a modern preventive cardiology programme.

Keywords
EUROASPIRE, cardiac rehabilitation, secondary prevention

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Introduction

The main objectives of cardiac rehabilitation and secondary cardiovascular disease (CVD) prevention are to reduce recurrent events and premature disability in patients with coronary heart disease (CHD) and increase the chances of longer life expectancy.[1]

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Cardiac rehabilitation is defined by the World Health Organisation (WHO, p. 122) as:

> 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 (people) 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 or stage of therapy but must be integrated within secondary prevention services of which it forms only one facet.[2]

Initially, cardiac rehabilitation was recommended in patients with acute myocardial infarction or cardiac surgery and was focused on supervised exercise programmes. Subsequently, they gradually evolved into a more comprehensive intervention and current practice guidelines consistently recommend 'comprehensive rehabilitation' programmes that should include psychological counselling, lifestyle interventions in terms of smoking cessation, healthy eating, weight management, increased physical activity, as well as blood pressure, lipids and glucose management to optimise cardiovascular risk reduction and reduce disability. International guidelines strongly (Class I) recommend cardiac rehabilitation for all patients following acute coronary syndrome, revascularisation procedures, chronic stable angina and heart failure.[1,3–5] There is evidence that secondary prevention and cardiac rehabilitation have a beneficial and cost-effective impact on all-cause and cardiovascular mortality and the risk of hospital readmissions.[6]

However, participation in cardiac rehabilitation and secondary prevention of CHD in everyday clinical practice is far from optimal. Implementation of CVD prevention guidelines in Europe was evaluated by four cross-sectional surveys, called EUROASPIRE, carried out in patients following first or recurrent clinical diagnosis or treatments for CHD starting in 1995. The comparison of the most recent three studies over the last 14 years showed adverse lifestyle trends, a substantial increase in obesity, central obesity and diabetes, and high prevalence of persistent smoking, especially in younger patients and especially women. Blood pressure and low-density lipoprotein (LDL)-cholesterol targets were reached by only half and just over one fifth of patients, respectively.[7,8] The results of the EUROASPIRE III survey demonstrated that less than half of the coronary patients reported receiving advice to follow a cardiac rehabilitation programme (CRP) and only one-third actually attended some form of cardiac rehabilitation.[9]

The main objective of this paper is to describe the determinants of participation and achievement of risk factor targets in coronary patients in Europe attending a CRP.

Study population and methods

Sample size and data collection

A detailed description of the study population and design of EUROASPIRE IV survey has been published elsewhere.[10] In summary, this cross-sectional study was carried out at 78 hospital centres in 24 European countries: Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Finland, France, Germany, Greece, Ireland, Latvia, Lithuania, the Netherlands, Poland, Romania, Russia, Serbia, Slovenia, Spain, Sweden, Turkey, Ukraine and the UK. Patients aged $\geq$18 years and $<$80 years who had been hospitalised for acute myocardial infarction (AMI; ICD-10 I21), unstable angina (UA; ICD-10 I20), or revascularization procedure in the form of elective or emergency coronary artery surgery (coronary artery by-pass graft (CABG)) or balloon angioplasty (percutaneous coronary intervention (PCI)) were interviewed and examined at least six months and at most three years later. Data collectors were trained to use standardised methods and instruments.

Height and weight were measured in light indoor clothes without shoes (Seca scales 701 and measuring stick model 220). Obesity was defined as a body mass index (BMI)$\geq$30 kg/m^2.

Waist circumference was measured using a metal tape applied horizontally at the point midway in the mid-axillary line between the lowest rim of the rib cage and the tip of the hip bone (superior iliac crest) with the patient standing. Central obesity was defined as a waist circumference $\geq$88 cm for women and $\geq$102 cm for men.

Blood pressure was measured twice on the right upper arm in a sitting position using an automatic digital sphygmomanometers (Omron M6) and the mean was used for all analyses. Raised blood pressure was defined as blood pressure $\geq$140/90 mm Hg ($\geq$140/80 mm Hg in patients with diabetes mellitus).

Breath carbon monoxide was measured in ppm using a smokelyser (Bedfont Scientific, Model Micro+). Smoking at the time of interview was defined as self-reported smoking, and/or a breath carbon monoxide exceeding 10 ppm. Persistent smoking was defined as smoking at interview among patients reporting themselves to be smokers in the month prior to the index event.

Medication adherence was assessed by the questions used in the Heart and Soul study.[11]

Depression and anxiety were assessed using the Hospital Anxiety and Depression Scale (HADS). HADS scores $<$8 were considered as normal.[12]

Patients were also asked to complete the validated HeartQoL questionnaire, comprising 14 items. Using this, global (all items), physical (10 items) and emotional (four items) scores, calculated as the mean of the item scores, can be computed with scores ranging between

zero (lowest Heart Related Quality of Life [HRQL]) and three (best HRQL).[13]

Low educational level was defined as completion of education to primary school level or below.

Venous blood samples were taken for total and high-density lipoprotein (HDL) cholesterol, triglycerides, glycated haemoglobin (HbA1c) and LDL cholesterol (LDL-C) was calculated according to Friedewald's formula. Elevated LDL-C concentration was defined as $\geq$1.8 mmol/l. In patients with diabetes, HbA1c was considered at target if lower than 7%.

The central laboratory was the Disease Risk Unit, National Institute for Health and Welfare, Helsinki, Finland, which is accredited by the Finnish Accreditation Service and fulfils the requirements of the standard SFS-EN ISO/IEC 17025:2005. The laboratory takes part in the Lipid Standardization Program organised by CDC, Atlanta, Georgia, USA and external quality assessment schemes organised by Labquality, Helsinki, Finland.

Data management

Data were submitted online to the data management centre (EuroObservational Research Program at the European Heart House, Sophia Antipolis, France) and were checked for completeness, internal consistency, and accuracy. All data were stored under the provisions of the National Data Protection Regulations.

Statistical analyses

Descriptive statistics (means, standard deviation, and proportions) were used to present information on patient characteristics. Values of p for the crude comparison between the groups were obtained by means of the Fisher exact test. Calculation of 95% confidence intervals (CIs) for differences between proportions was according to the Agresti-Caffo method.[14] The impact of having attended a CRP on reaching lifestyle and risk factor targets and the use of prophylactic drugs at the time of the interview (Table 4), expressed as odds ratios with 95% confidence intervals, was adjusted for age, sex and educational level according to mixed logistic modelling, the latter accounting for the clustering of patients within centre. A two-sided $p < 0.05$ was considered as indicating statistical significance. All statistical analyses were undertaken using SAS statistical software release 9.4 (SAS Institute Inc., Cary, North Carolina, USA).

Ethical procedures

The study complied with the Declaration of Helsinki and local Ethics Committee approval in all participating centres. Written, informed consent was obtained from each participant.

Results

A total of 7998 patients were interviewed on average 1.35 years after their index event (interquartile range 0.95–1.93 years) of whom 7907 (24% females) had valid information about their participation in a CRP and were included in the present analysis. The mean age of patients at the time of interview was 64 years with 67.4% exceeding the age of 60 years. There were wide variations in the size of the study population between countries, ranging from 51 patients in Greece to 535 patients in Germany (Supplementary Material Table 1). The distribution of the recruiting diagnosis was as follows: CABG 13% (1018), PCI 54% (4272), AMI 23% (1803) and UA 10% (814).

The proportions of patients who were advised and attended a CRP by age, gender and recruiting diagnosis are presented in Table 1. Overall, 51% of patients were advised to participate in a CRP and 81% of them attended at least half of the sessions, the latter being only 41% of the whole study population. By recruiting diagnosis, the proportion of patients advised to attend a CRP was highest in the CABG group (65%) and lowest in the UA group (25%).

The reported advice to participate in a CRP according to patients characteristics at discharge is presented in Table 2. Patients having received advice to attend a CRP were slightly younger, more often male with a somewhat higher educational level and had experienced a previous coronary event less often. These patients also suffered less from comorbidities such as heart failure, hypertension and dysglycaemia.

Table 3 shows the participation in a CRP, if advised to do so, according to patients characteristics at discharge. Patients with low educational level and those smoking in the month prior to recruiting event were less likely to participate in a CRP if advised. Patient characteristics and risk factor prevalence at interview according to participation in a CRP is presented in Table 4. The proportions of patients achieving lifestyle targets at the time of the interview were higher in the CRP group as compared to the non-CRP group: smoking cessation (57% vs 47%), recommended physical activity levels (47% vs 38%) and BMI $<30\,kg/m^2$ (65% vs 61%). However, there were no differences in the proportions of patients achieving blood pressure, LDL-cholesterol and HBA1c targets despite the higher use of blood pressure and lipid-lowering medication in the CRP group. Furthermore, patients who attended a CRP had better medication adherence and lower anxiety and depression scores. With respect to the HeartQoL instrument, average scores for the global scale ($p < 0.0001$) and both physical ($p < 0.0001$) and emotional ($p = 0.03$) subscales were significantly higher in patients having followed a CRP, after adjustment for age, gender and educational level. Testing

Table 1. Proportion of patients advised and attended a cardiac rehabilitation programme (CRP) by age, gender and recruiting event.

	CRP		
	Advised % (*n*)	Attended[a] (among those advised) % (*n*)	Attended[a] (among all patients) % (*n*)
Age at interview			
<50 years	52.6% (355/675)	78.0% (277/355)	41.0% (277/675)
50–59 years	53.2% (1011/1899)	83.1% (840/1011)	44.2% (840/1899)
60–69 years	50.6% (1493/2951)	82.4% (1230/1493)	41.7% (1230/2951)
≥70 years	48.3% (1150/2382)	79.5% (914/1150)	38.4% (914/2382)
Gender			
Men	52.2% (3123/5978)	81.6% (2548/3123)	42.6% (2548/5978)
Women	45.9% (886/1929)	80.5% (713/886)	37.0% (713/1929)
Recruiting event			
CABG	77.0% (784/1018)	84.4% (662/784)	65.0% (662/1018)
PCI	44.8% (1913/4272)	81.2% (1553/1913)	36.4% (1553/4272)
AMI	58.0% (1045/1803)	80.9% (845/1045)	46.9% (845/1803)
UA	32.8% (267/814)	75.3% (201/267)	24.7% (201/814)
All	50.7% (4009/7907)	81.3% (3261/4009)	41.2% (3261/7907)

AMI: acute myocardial infarction; CABG: coronary artery by-pass graft; PCI: percutaneous coronary intervention; UA: unstable angina.
[a]At least half of the sessions.

CRP-by-sex interaction terms in the models showed that the impact of attending a CRP programme was similar for men and women. There were wide variations in the proportion of patients attending a CRP ranging from 0% in Greece to Cyprus to 91% in Lithuania (Supplementary Material Table 1).

The components of the CRPs are shown in Figure 1 and Supplementary Material Table 2. Four-fifths of patients reported attending supervised exercise programmes, followed by 74% who had dietary modification and weight management and 66% were given written educational materials. In addition, about three-fifths of patients reported teaching sessions and health promotion workshops, and stress modification and relaxation sessions. Strikingly, less than half of patients who were smokers in the month prior to the recruiting event attended some form of smoking cessation sessions.

Discussion

The importance of lifestyle, risk factor and therapeutic interventions following the development of coronary disease is strongly evidence-based. The core components of a modern preventive cardiology programme, which unites secondary prevention and cardiac rehabilitation, should include comprehensive lifestyle management in relation to smoking cessation, healthy diet and physical exercise, psychosocial support as well as weight, blood pressure, lipids and glucose management, and prescription of and adherence to cardioprotective medications.[1,5,15] There is compelling evidence from systematic reviews and meta-analyses that secondary prevention and cardiac rehabilitation can reduce mortality, morbidity and hospital re-admissions, and improve quality of life and psychological well-being in a cost-effective way.[16–22] A 2011 Cochrane systematic review and meta-analysis of 47 studies that randomised 10,794 CHD patients to exercise-based cardiac rehabilitation or usual care, showed that exercise-based cardiac rehabilitation was associated with a reduction in both total (risk ratio (RR) 0.87, 95% CI 0.75–0.99) and cardiovascular mortality (RR 0.74, 95% CI 0.63–0.87) as well as hospital admissions (RR 0.69, 95% CI 0.51–0.93).[17]

The contribution of secondary prevention programs with or without exercise was evaluated in a meta-analysis of 63 randomised controlled trials including 21,295 patients with CHD.[19] Secondary prevention programmes reduced all-cause mortality (RR 0.85, 95% CI 0.77–0.94). The risk ratio for recurrent myocardial infarction was 0.83 (95% CI 0.74–0.94) over a median follow-up of 12 months. In 2012, a systematic review and meta-analysis including 23 trials involving 11,085 randomised patients demonstrated that lifestyle modification programs were associated with reduced

Table 2. Reported advice to participate in a cardiac rehabilitation programme (CRP) according to patient's characteristics at discharge.

	CRP			
	Not advised	Advised	Difference (95% CI)	*p*-Value
Age at recruiting event, mean (SD)	62.9 (9.63)	62.1 (9.53)		<0.0001
Female gender	26.8% (1043/3898)	22.1% (886/4009)	–4.7% (–6.6% to –2.8%)	<0.0001
Low educational level	19.0% (732/3857)	16.2% (649/3994)	–2.7% (–4.4% to –1.0%)	0.0015
Recruiting event = CABG	6.0% (234/3898)	19.6% (784/4009)	+13.6% (+12.1% to +15.0%)	<0.0001
Recruiting event = PCI	60.5% (2359/3898)	47.7% (1913/4009)	–12.8% (–15.0% to –10.6%)	<0.0001
Recruiting event = AMI	19.4% (758/3898)	26.1% (1045/4009)	+6.6% (+4.8% to +8.5%)	<0.0001
Recruiting event = UA	14.0% (547/3898)	6.7% (267/4009)	–7.4% (–8.7% to –6.0%)	<0.0001
Previous CABG	7.0% (270/3860)	5.7% (227/3978)	–1.3% (–2.4% to –0.2%)	0.020
Previous PCI	21.2% (817/3859)	18.8% (747/3973)	–2.4% (–4.1% to –0.6%)	0.0093
Previous AMI	27.9% (1070/3841)	23.7% (936/3957)	–4.2% (–6.1% to –2.3%)	<0.0001
Previous UA	9.2% (350/3815)	6.5% (256/3940)	–2.7% (–3.9% to –1.5%)	<0.0001
Previous angina pectoris	29.7% (1139/3834)	24.6% (969/3942)	–5.1% (–7.1% to –3.2%)	<0.0001
Previous stroke	4.5% (173/3847)	3.8% (152/3973)	–0.7% (–1.6% to +0.2%)	0.14
Previous TIA	2.3% (89/3839)	2.2% (87/3964)	–0.1% (–0.8% to +0.5%)	0.76
Previous PAD	4.5% (173/3835)	4.6% (182/3960)	+0.1% (–0.8% to +1.0%)	0.87
Previous HF	6.9% (264/3818)	4.9% (195/3954)	–2.0% (–3.0% to –0.9%)	0.0002
Smoking in month prior to recruiting event	30.1% (1173/3898)	31.4% (1257/4009)	+1.3% (–0.8% to +3.3%)	0.23
Obesity at discharge	33.7% (942/2792)	33.8% (913/2699)	+0.1% (–2.4% to +2.6%)	0.95
Hypertension at discharge	81.0% (2918/3604)	76.1% (2747/3610)	–4.9% (–6.8% to –3.0%)	<0.0001
Dyslipidaemia at discharge	73.8% (2489/3375)	74.4% (2555/3432)	+0.7% (–1.4% to +2.8%)	0.52
Abnormal glucose metabolism at discharge	30.5% (1032/3384)	25.7% (873/3396)	–4.8% (–6.9% to –2.7%)	<0.0001
Medication at discharge				
Antiplatelets	97.7% (3761/3851)	98.4% (3899/3962)	+0.8% (+0.1% to +1.4%)	0.018
Beta-blockers	85.0% (3263/3840)	87.7% (3456/3940)	+2.7% (+1.2% to +4.3%)	0.0005
ACE inhibitors/ARBs	77.3% (2970/3840)	74.8% (2942/3935)	–2.6% (–4.5% to –0.7%)	0.0079
Calcium channel blockers	23.5% (902/3842)	14.4% (571/3953)	–9.0% (–10.8% to –7.3%)	<0.0001
Diuretics	29.9% (1150/3843)	29.5% (1168/3957)	–0.4% (–2.4% to +1.6%)	0.71
Lipid-lowering	90.7% (3475/3830)	90.8% (3563/3925)	+0.1% (–1.2% to +1.3%)	0.97
Anticoagulants	7.8% (302/3848)	9.4% (370/3957)	+1.5% (+0.3% to +2.7%)	0.019

AMI: acute myocardial infarction; ARBs: Angiotensin receptor blockers; CABG: coronary artery by-pass graft; CI: confidence interval; HF: heart failure; PAD: peripheral artery disease; PCI: percutaneous coronary intervention; SD: standard deviation; TIA: transient ischaemic attack; UA: unstable angina.

all-cause and cardiac mortality, and cardiac readmissions and non-fatal reinfarctions.[20]

By contrast with all previous meta-analyses of cardiac rehabilitation up to 2011, which consistently showed reductions in all-cause mortality and cardiovascular mortality, the most recent Cochrane systematic review on exercise-based cardiac rehabilitation showed no effect on total mortality, myocardial infarction or revascularisations.[21] This meta-analysis involved 63 randomised controlled trials (RCTs) with 14,486 participants with myocardial infarction, angina and coronary revascularisation with a median follow-up of 12 months and demonstrated a significant reduction in cardiovascular mortality by 26% (RR 0.74, 95% CI 0.64–0.86) and hospital readmissions by 18% (RR 0.82, 95% CI 0.70–0.96).[21] The inclusion of patients from the controversial UK randomised controlled trial (Rehabilitation After Myocardial Infarction Trial (RAMIT)) is one reason for there being no reduction in all-cause mortality in this meta-analysis.[23] In a subsequent meta-analysis of contemporary randomised controlled trials published in the period 2010–2015, including trials of both prevention and rehabilitation programmes, and also patients with other forms of atherosclerotic CVD, there was also no reduction in all-cause mortality (RR 1.00, 95% CI 0.88–1.14) but there were reductions in cardiovascular mortality by 58% (95% CI 0.21–0.88), myocardial infarction by 30%

Table 3. Participation in a cardiac rehabilitation programme (CRP), if advised to do so, according to patient's characteristics at discharge.

	CRP			
	Not participated	Participated[a]	Difference (95% CI)	*p*-Value
Age at recruiting event, mean (SD)	62.3 (9.84)	62.0 (9.46)		0.32
Female gender	23.1% (173/748)	21.9% (713/3261)	−1.3% (−4.7% to +2.0%)	0.46
Low educational level	19.0% (142/746)	15.6% (507/3248)	−3.4% (−6.6% to −0.4%)	0.024
Recruiting event = CABG	16.3% (122/748)	20.3% (662/3261)	+4.0% (+0.9% to +6.9%)	0.014
Recruiting event = PCI	48.1% (360/748)	47.6% (1553/3261)	−0.5% (−4.5% to +3.5%)	0.81
Recruiting event = AMI	26.7% (200/748)	25.9% (845/3261)	−0.8% (−4.4% to +2.6%)	0.64
Recruiting event = UA	8.8% (66/748)	6.2% (201/3261)	−2.7% (−5.0% to −0.5%)	0.012
Previous CABG	6.4% (47/732)	5.6% (180/3246)	−0.9% (−2.9% to +1.0%)	0.38
Previous PCI	19.1% (140/733)	18.7% (607/3240)	−0.4% (−3.6% to +2.7%)	0.83
Previous AMI	25.7% (187/728)	23.2% (749/3229)	−2.5% (−6.0% to +1.0%)	0.16
Previous UA	9.0% (65/724)	5.9% (191/3216)	−3.0% (−5.4% to −0.9%)	0.0044
Previous angina pectoris	25.9% (188/726)	24.3% (781/3216)	−1.6% (−5.2% to +1.9%)	0.36
Previous stroke	4.1% (30/731)	3.8% (122/3242)	−0.3% (−2.0% to +1.2%)	0.67
Previous TIA	3.4% (25/731)	1.9% (62/3233)	−1.5% (−3.0% to −0.2%)	0.017
Previous PAD	5.3% (39/730)	4.4% (143/3230)	−0.9% (−2.8% to +0.8%)	0.28
Previous HF	4.6% (33/726)	5.0% (162/3228)	+0.5% (−1.3% to +2.1%)	0.64
Smoking in month prior to recruiting event	37.0% (277/748)	30.0% (980/3261)	−7.0% (−10.8% to −3.2%)	0.0002
Obesity at discharge	35.8% (164/458)	33.4% (749/2241)	−2.4% (−7.2% to +2.4%)	0.33
Hypertension at discharge	79.8% (516/647)	75.3% (2231/2963)	−4.5% (−7.9% to −0.9%)	0.017
Dyslipidaemia at discharge	73.8% (425/576)	74.6% (2130/2856)	+0.8% (−3.1% to +4.8%)	0.71
Abnormal glucose metabolism at discharge	30.0% (180/601)	24.8% (693/2795)	−5.2% (−9.2% to −1.2%)	0.010
Medication at discharge				
Antiplatelets	99.1% (734/741)	98.3% (3165/3221)	−0.8% (−1.6% to +0.2%)	0.14
Beta-blockers	84.2% (619/735)	88.5% (2837/3205)	+4.3% (+1.5% to +7.2%)	0.0018
ACE inhibitors/ARBs	70.1% (515/735)	75.8% (2427/3200)	+5.8% (+2.2% to +9.4%)	0.0014
Calcium channel blockers	17.7% (131/740)	13.7% (440/3213)	−4.0% (−7.1% to −1.1%)	0.0064
Diuretics	26.4% (195/740)	30.2% (973/3217)	+3.9% (+0.3% to +7.4%)	0.040
Lipid-lowering	89.1% (656/736)	91.2% (2907/3189)	+2.0% (−0.4% to +4.6%)	0.09
Anticoagulants	9.7% (72/739)	9.3% (298/3218)	−0.5% (−2.9% to +1.8%)	0.67

ACE: angiotensin-converting enzyme; AMI: acute myocardial infarction; ARBs: Angiotensin receptor blockers; CABG: coronary artery by-pass graft; CI: confidence interval; HF: heart failure; PAD: peripheral artery disease; PCI: percutaneous coronary intervention; TIA: transient ischaemic attack; UA: unstable angina.

[a]At least half of sessions.

(95% CI 0.54–0.91 and, for the first time, stroke by 60% (95% CI 0.22–0.74).[22] Importantly, comprehensive prevention and rehabilitation programmes managing six or more risk factors did significantly reduce all-cause mortality by 37% (RR 0.63, 95% CI 0.43–0.93) as did programmes taking responsibility for prescribing, up-titrating and monitoring adherence to cardioprotective medications (RR 0.35, 95% CI 0.18–0.70.[22] These important findings provide further support for truly comprehensive prevention and rehabilitation programmes.

The most recent meta-analysis of 22 RCTs with 4834 participants recruited after the year 2000 addressed the added value of exercise-based cardiac rehabilitation against a no-exercise control and found no difference in all-cause mortality (19 studies; $n = 4194$; risk difference 0.00, 95% CI − 0.02–0.01, $p = 0.38$) or cardiovascular mortality (nine studies; $n = 1182$; risk difference−0.01, 95% CI − 0.02–0.01, $p = 0.25$).[24] This meta-analysis challenged the effectiveness of exercise-based cardiac rehabilitation vs no exercise, but the authors qualified their conclusion because adherence to, and fidelity of, the exercise interventions was not reported and the actual dose of exercise in these trials could not be quantified. Therefore the added value of exercise-based cardiac rehabilitation versus no exercise

Table 4. Patient's characteristics and risk factors prevalence at interview according to participation in a cardiac rehabilitation programme (CRP).

	No CRP, % (*n*) *n* = 4646	CRP,[a] % (*n*) *n* = 3261	Odds ratio (95% CI)[b]	*p*-Value[b]
Stopped smoking[c]	47.4% (688/1450)	57.4% (563/980)	1.48 (1.25 to 1.74)	<0.0001
Physical activity at target	37.8% (1754/4646)	47.3% (1541/3261)	1.45 (1.32 to 1.59)	<0.0001
BMI<25kg/m^2	17.6% (811/4617)	18.3% (597/3257)	1.05 (0.94 to 1.18)	0.41
BMI<30kg/m^2	60.7% (2803/4617)	64.8% (2111/3257)	1.18 (1.07 to 1.29)	0.0007
Blood pressure on target[d]	53.9% (2497/4630)	54.5% (1774/3256)	1.00 (0.91 to 1.09)	0.94
LDL cholesterol on target[e]	19.6% (819/4168)	19.5% (583/2996)	0.99 (0.88 to 1.12)	0.90
HbA1c on target[f]	51.1% (643/1259)	54.6% (388/711)	1.15 (0.96 to 1.38)	0.13
Antiplatelets	93.8% (4332/4618)	93.8% (3046/3249)	0.94 (0.78 to 1.14)	0.52
BP-lowering medication	94.7% (4375/4618)	95.8% (3112/3249)	1.27 (1.02 to 1.58)	0.03
Lipid-lowering medication	85.3% (3941/4618)	88.2% (2867/3249)	1.28 (1.12 to 1.46)	0.0004
Medication adherence	93.9% (4342/4626)	95.3% (3102/3256)	1.30 (1.06 to 1.60)	0.01
HADS-Anxiety score < 8	71.2% (3125/4388)	77.2% (2412/3123)	1.35 (1.21 to 1.50)	<0.0001
HADS-Depression score < 8	74.4% (3263/4388)	82.3% (2569/3123)	1.56 (1.39 to 1.75)	<0.0001

BMI: body mass index; BP: blood pressure; CI: confidence interval; HADS: Hospital Anxiety and Depression Scale; HbA1c: glycated haemoglobin; LDL: low-density lipoprotein; RA: rheumatoid arthritis.

[a]At least half of the sessions; [b]odds ratio (+ 95% confidence interval) and *p*-value from logistic model adjusting for age, sex and educational level; [c]for patients smoking in the month prior to the recruiting event; [d]blood pressure ≤ 140/90 mm Hg (140/80 mm Hg in patients with diabetes); [e]LDL cholesterol < 1.8 mmol/l; [f]HbA1c < 7% in patients with diabetes.

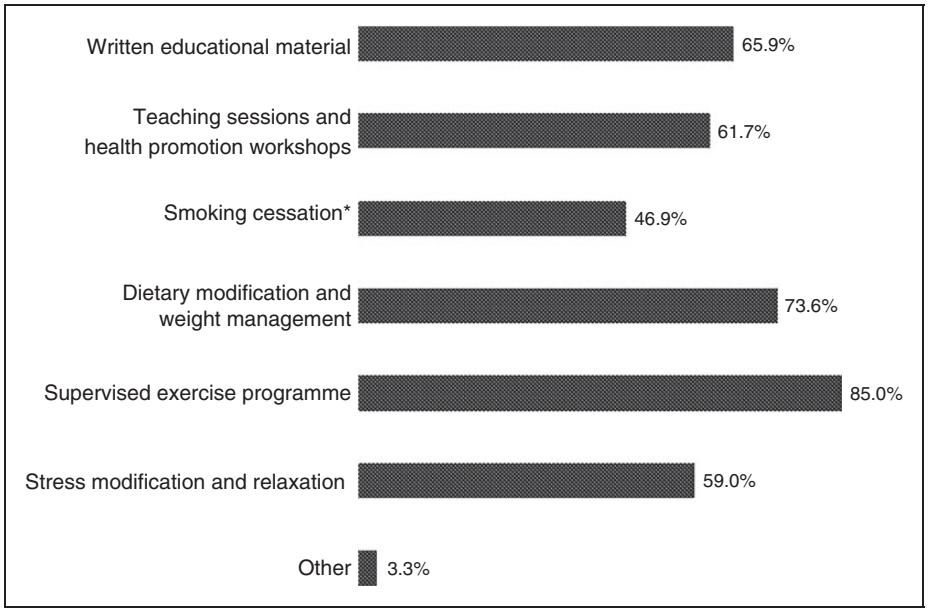

Figure 1. Components of the cardiac rehabilitation programme (CRP) programme.
*For patients smoking in the month prior to the recruiting event.

remains an open question, but the value of comprehensive prevention and rehabilitation programmes using cardioproective medications is not in doubt.[22]

Cardiac rehabilitation continues to be widely underused with completely inadequate referral and low participation rates. Effective implementation of cardiac rehabilitation after acute coronary syndrome, coronary revascularisation, and heart failure has remained suboptimal, with overall participation rates <50% over recent decades despite international recommendations. Only half of EUROASPIRE IV patients (51%) were advised to participate in a CRP after their coronary

event and four-fifths of them (82%) attended at least half of the sessions; just over two-fifths (41%) of the whole study population. Reports from other non-EU countries show that only about 50% of patients referred to CR actually enrol and participate in CR.[25]

Poor participation in a CRP has been attributed to several factors, including physicians' reluctance to refer patients, as well as a lack of cardiac rehabilitation services. In EUROASPIRE IV, some patients' characteristics at hospital discharge (age, gender, diagnosis and educational level) were associated with whether advice was given or not to attend a CRP. Older patients, women, those with lower educational level or following PCI and UA, and those with a previous history of coronary disease, heart failure, hypertension or dysglycaemia were less likely to be advised to attend a CRP. Even if advised, smokers and less educated patients were less likely to participate in a CRP.

Our results are in accordance with previous reviews and meta-analyses summarising the main predictors of CRP non-adherence as older age, female, lower educational and socioeconomic status, lower income/greater deprivation, having angina and being less physically active.[26,27] A meta-analysis including 241,613 participants found that women were less likely to be referred to a CRP compared to men (odds ratio (OR) 0.68, 95% CI 0.62–0.74).[28] A systematic review of 10 published observational studies including 30,333 coronary patients found that the determinants of referral to CRP can be grouped as sociodemographic, medical, psychological and healthcare system factors.[29] Another study of barriers to participation in a CRP showed that inpatient referral is a very strong predictor of attendance in a CRP.[30] The main characteristics associated with participation in a CRP were younger age, male sex, ST elevation myocardial infarction, revascularization therapy and history of prior myocardial infarction.

In EUROASPIRE IV, patients who reported having participated in a CRP had significantly higher smoking cessation rates and a larger proportion achieved the physical activity target. However, even in the CRP group two-fifths of patients who were smoking at the time of their recruiting coronary event were still smokers at the time of interview and less than half of patients were achieving their physical activity target. In addition, a significantly lower proportion of patients who attended a CRP had symptoms of anxiety and depression. Although the proportion of patients with BMI$\geq$30 kg/m^2 was significantly lower in the CRP over a third of patients were still obese. Patients attending a CRP reported significantly better medication adherence and higher use of blood pressure and lipid-lowering medication. However, despite the higher medication use, there were no significant differences in terms of blood pressure, lipid and glucose control between the CRP and non-CRP groups. The differences in lifestyle at interview between the CRP and non-CRP groups should be interpreted with caution as they may be the result of selection bias regarding advice given and participation with healthier patients more likely to participate in such programmes.

In EUROASPIRE IV, of those advised to attend a CRP more than four-fifths of patients reported attending a supervised exercise programme thus demonstrating the fundamental problem that lies with the cardiology profession not giving advice, and with the underprovision of such programmes in most countries across Europe. More worryingly, there was no increase in the proportions of patients being advised, and participating in, a CRP between EUROASPIRE III and IV surveys over a seven-year period. The comparison between those 18 countries and geographical areas that participated in both surveys showed that the proportion of patients advised to attend a CRP remained the same (46% in EUROASPIRE III and 47% in EUROASPIRE IV, $p = 0.44$) as was the overall participation in a CRP programme (37% in EUROASPIRE III and 39% in EUROASPIRE IV, $p = 0.40$). Given the level of evidence for comprehensive prevention and rehabilitation programmes it is unacceptable that service provision should remain stagnant.

EUROASPIRE IV is a unique database based on information from medical records and face-to-face interviews and examinations, using the same protocol and standardised methods and instruments, including central laboratory measurements. However, our findings must be considered within the context of study limitations. First, patient populations from participating countries were identified from selected geographical areas; hence caution is required when generalising the results. Second, patients participating in the study are more likely to be those who are more interested in their own health. However, this bias is likely to overestimate the extent of risk factor control and therefore the results seen in everyday clinical practice are likely to be worse. Third, the information about the advice, participation and components of the CRP was obtained from self-reports. In addition, the heterogeneity of healthcare systems would have a substantial influence on the access to and core components of the cardiac rehabilitation services in each country.

In conclusion, the results of EUROASPIRE IV show that implementation of cardiac rehabilitation after acute coronary syndrome and coronary revascularization in Europe has remained stagnant and suboptimal with overall participation rates of about 40% and with wide variations between countries. The main determinants for non-referral and non-participation in a CRP were older age, female gender, lower educational

level, having PCI or UA as the index event, smoking in the month prior to coronary event and a previous history of CVD. Although the control of smoking, prevalence of obesity and physical activity levels were better, and the level of anxiety and depression was lower, in those attending a CPR, there were no differences in terms of blood pressure, lipids and glucose management. The proportion attending a CRP did not increase since the previous survey and there were wide variations in attendance and content of CRPs in Europe.

Therefore there is still considerable potential to further reduce the risk of CVD by integrating secondary prevention and cardiac rehabilitation to provide modern comprehensive preventive cardiology programmes addressing all aspects of lifestyle, risk factor and therapeutic management for all patients with coronary and also other forms of atherosclerotic disease.

Author contribution

KK contributed to conception and design and drafted the manuscript. KK, DW and DDB contributed to data acquisition, analysis and interpretation, and critically revised the manuscript. All authors gave final approval and agreed to be accountable for all aspects of work ensuring integrity and accuracy.

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