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Inequalities in access to cardiac rehabilitation after an acute coronary syndrome: the EPiHeart cohort

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ABSTRACT

Objectives To estimate cardiac rehabilitation (CR) referral and participation rates among patients with acute coronary syndrome (ACS) and to identify their determinants, in two Portuguese regions.

Design Prospective cohort study.

Setting Patients consecutively admitted to the cardiology department of two hospitals, one in the district of Porto and one in the north-east region (NER) of Portugal, were enrolled in the EPIHeart cohort and then followed up for 6 months.

Participants Between August 2013 and December 2014, 939 patients were included in the cohort, and 853 were re-evaluated at 6-month follow-up.

Outcome measures Referral rate was defined as the proportion of eligible patients who were referred to a CR programme, whereas participation rate was defined as the proportion of eligible patients who completed a CR programme, as was recommended by their physicians.

Results Patients referred were 32.3% and 10.7% of those eligible in Porto and NER, respectively. In both regions, referral to CR decreased with age and with longer travel times to CR centres and increased with education or social class. At follow-up, 128 patients from Porto (26.2% of those eligible and 81.0% of those referred) and 26 from NER (7.1% of those eligible and 66.7% of those referred) reported actually participating in a CR programme. In Porto, the main barriers to participation were the long time until a programme was available and lack of perceived benefit. Patients in NER identified distance to CR and costs as the main barriers.

Conclusions CR remains clearly underused in Portugal, with major inequalities in access between regions. Achieving equitable and greater use of CR requires a multilevel approach addressing barriers related to healthcare system, providers and patients in order to improve provision, referral and participation.

Strengths and limitations of this study

- ► This study assessed the frequency and determinants of referral and participation to cardiac rehabilitation (CR), among urban and rural settings.
- ► Identifying target groups and geographic areas where access is more limited is essential to establish clear strategies to reduce inequalities in the use of healthcare services.
- ► Our results may not be generalised to other settings with different characteristics, although the study was conducted in two hospitals attending patients with contrasting use of CR.

INTRODUCTION

Cardiac rehabilitation (CR) programmes are currently recognised as an integral part of the approach for secondary prevention of coronary heart disease (CHD) and considered a class I recommendation in current clinical guidelines by the American Heart Association, the American College of Cardiology and the European Society of Cardiology for treatment of patients with CHD.[1–4]

A recent Cochrane systematic review showed that CR reduces cardiovascular mortality and hospitalisations while improving quality of life.[5] This evidence was subsequently extended by a multicentre cohort of patients with acute myocardial infarction (AMI) showing that participation in CR was associated with 41% lower hazard of all-cause mortality.[6] Moreover, CR has been described as a cost-effective intervention,[7 8] with cost-effectiveness ratios similar to the use of angiotensin converting enzyme (ACE) inhibitors and statins.[8]

Despite the robust evidence supporting the use of CR, it clearly remains underused worldwide.[9] In Portugal, the proportion of eligible patients enrolled in rehabilitation programmes has increased from 3% in 2007 to 8% in 2013,[10 11] though still far from the 30% target set by the National Health Plan for 2010.[12] The implementation of CR in Portugal is constrained by insufficient supply of CR services and large geographical disparities in their distribution, with CR centres concentrated mainly in large urban areas of the country.[10 11] The aim of the present study was to estimate the proportion of patients with acute coronary syndrome (ACS) who were referred and who actually participated in a CR programme, comparing two regions in the north of Portugal. The work also intended to identify determinants of referral and to describe barriers to participation.

METHODS

Setting

The present study evaluated patients with an ACS enrolled in the EPIHeart cohort, who were admitted to two hospitals (São João Hospital and São Pedro Hospital) in the north of mainland Portugal. São João Hospital is a university hospital located in the Porto municipality, which serves as first-line service part of the population of the Porto district (mainly coastal and urban), whereas São Pedro Hospital is a tertiary-level hospital located in the Vila Real municipality serving, as first-line or referral target, the population of the north-east region (NER) of Portugal (mainly rural and located in the inner land), which covers the districts of Vila Real, Bragança and some municipalities of the Viseu district. Since the EPIHeart cohort was set up to assess inequalities in CHD management and outcomes in urban and rural settings in Portugal, the selection of these regions intended to capture the variation in CHD management and outcomes across populations with different sociodemographic and clinical characteristics.

In the four districts considered in this study, there are eight CR centres available, seven in the Porto district and one in the NER.[11] In the Porto district, there are four public centres, located within the facilities of public hospitals, and three private centres, located in privately owned healthcare organisations. In the Porto district, the first CR programme was implemented in 1992 in a private clinic, and the last one was implemented in 2008 in São João Hospital. In the NER, there is only one private centre available, which was launched in 2012.

The location of the study area is depicted in figure 1A.

Study population

Between August 2013 and December 2014, patients consecutively admitted to the cardiology departments of the two hospitals involved in the study were enrolled in the EPIHeart cohort and then followed up for 6 months. Hospitalised patients were invited to participate in the study by trained staff nurses or physicians in charge, who gave written information, explained the study verbally and obtained written informed consent. The inclusion criteria were to be admitted with a diagnosis of ACS type I, aged ≥18 years, expected to have a length of stay longer than 48 hours and living inside the hospitals' catchments area. Exclusion criteria were non-confirmed diagnosis of ACS, death, discharge or transfer prior to interview invitation and inability to answer the questionnaires, due to clinical instability, no domain of Portuguese language, hearing problems or cognitive impairment, as evaluated by the interviewer. Of the 1297 patients initially considered, 286 were excluded, and 72 refused to participate (7.1% of those invited, 4% in the Porto district and 11%

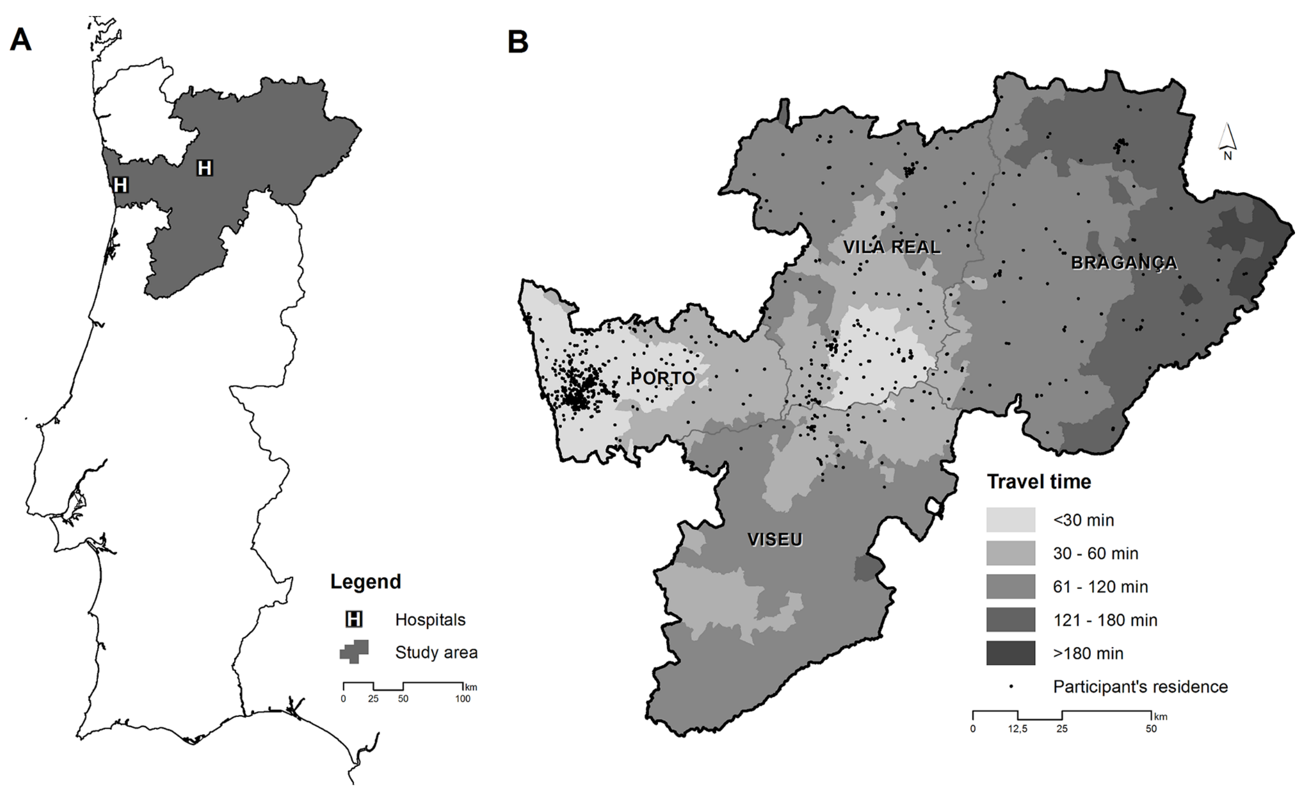

Figure 1 EPIHeart cohort study setting. (A) Study area and location of the hospitals. (B) Travel times from patients' home to the nearest cardiac rehabilitation centre.

in the NER), thus the final sample included 939 patients. Patients who refused to participate in the study were significantly older (72.7 years vs 64.2 years, P<0.001) and had lower education than those who participated (4 years of schooling or less: 59.4% vs 77.6%, P=0.003), whereas there was no significant difference in the ACS types (ST-segment elevation myocardial infarction (STEMI): 37.1% vs 37.4%, P=0.961). At the 6-month follow-up, 51 patients were dead, 18 patients were not evaluated due to invalid contact details and 17 refused to continue in the study, hence 853 patients were included in the current analysis. Non-participants in the follow-up were older (non-participants due to death: 75.3 years vs non-participants due to refusals and losses: 64.1 years vs participants: 63.5 years, P<0.001) and had lower education (≤4 years of schooling) than those who participated (non-participants due to death: 82.6% vs participants due to refusals and losses: 71.9% vs participants: 57.7%, P<0.001).

The study protocol complied with the Declaration of Helsinki and was approved by the Ethics Committee of both hospitals involved.

Data collection

At baseline, a face-to-face interview was conducted by trained researchers to collect data about sociodemographic characteristics, and the patients' medical records were reviewed to collect clinical data.

Sociodemographic data included age, sex, home address, marital status, health insurance coverage, subjective social class, schooling years, main activity, occupation and monthly household income. The marital status was considered partnered for married patients or living in civil union and unpartnered for patients who were single, separated, divorced or widow(er). Health insurance coverage comprised health subsystems and private health insurance. Subjective social class was assessed by asking patients to identify their social class category from a list provided, that included lower class, lower-middle class, upper-middle class and upper class. Occupations were classified into major professional groups, according to the Portuguese National Classification of Occupations 2010 integrated in the International Standard Classification of Occupations 2008[13 14] and grouped into three categories: upper white collar (executive civil servants, industrial directors and executives, professionals and scientists and middle management and technicians), lower white collar (administrative and related workers and service and sales workers) and blue collar (farmers and skilled agricultural, fisheries workers, skilled workers, craftsmen and similar, machine operators and assembly workers and unskilled workers). Armed forces were not considered for this classification. Retired, disabled and housewives were classified considering their previous main occupation, when applicable.

Clinical data included risk factors and comorbidities, clinical characteristics at admission, medical procedures, left ventricular systolic dysfunction (LVSD) and type of ACS. LVSD was considered present when there was a qualitative description consistent with moderate or severe systolic dysfunction in the last completed echocardiography during the hospital stay. The type of ACS was used as clinically defined in discharge notes and classified as STEMI and non-ST-elevation ACS (NSTEACS), with the latter including unstable angina, non-ST-elevation AMI, subacute MI and non-classified ACS.

Six months after the index event, patients were contacted by telephone and asked whether they were referred to CR following the event and whether they attended the CR programme as was recommended by their physician. Patients who attended and completed the CR programme were asked to identify the CR centre and the number of sessions attended. Patients who did not attend or complete the programme were asked about the reasons for non-participation, through the selection of one or more of the following options: (1) cost, (2) distance from home to the CR centre, (3) limited time availability, (4) lack of perceived benefit, (5) delay in enrolment in a CR programme due to lack of vacant places and (6) other reason. Referral rate was defined as the proportion of eligible patients who were referred to a CR programme, whereas participation rate was defined as the proportion of eligible patients who completed a CR programme, as was recommended by their physicians.

In order to compute travel time to the nearest CR centre, descriptive data about the available CR centres in Portugal were collected, based on the results of the national surveys on CR centres.[11] All patients and CR centres were georeferenced according to the address using ArcGIS Online World Geocoding Service and Google Maps. The shortest road distance (in min) from the patients' home to the nearest CR centre was calculated with ArcGIS V.10.4.1 and the Network Analyst extension, using an updated street network dataset provided by the Environmental Systems Research Institute.

Statistical analysis

Continuous variables are described as mean and SD, whereas categorical variables are presented as absolute frequencies and percentages. Categorical and continuous variables were compared using the χ^2 test and the two-tailed Student's t-test, as appropriate. The relation between patients' characteristics and referral to CR was quantified through the calculation of ORs and 95%CIs, using unconditional logistic regression. Analyses were conducted for all patients and also stratified according to referral hospital. Starting from models with all candidate predictors (P value<0.15), based on results from bivariate analysis, independent predictors were identified after stepwise backward elimination (P value >0.05). All tests were two tailed, and a P value<0.05 was considered statistically significant. Data were analysed using STATA V.11 for Windows (StataCorp).

RESULTS

Among the 853 patients included in this study (mean age 63.5±12.9 years, 75.2% men), 489 (57.3%) were from the Porto district, and 364 (42.7%) were from the NER of Portugal. Baseline characteristics are summarised in table 1. Compared with patients from the NER, those from Porto were more often male (79.1% vs 69.8%, P=0.002), younger (61.6 years vs 66.7 years, P<0.001), more frequently employed (34.3% vs 22.5%, P<0.001) and had higher levels of education (>4 schooling years: 50.5% vs 31.4%, P<0.001), social class (higher-middle/high: 9.0% vs 4.4%, P=0.001) and household income (>€1500: 19.0% vs 11.8%, P=0.014). Hypertension (72.5% vs 63.0%, P=0.003), dyslipidaemia (66.8% vs 58.7%, P=0.016), chronic heart failure (9.1% vs 4.7%, P=0.012) and impaired renal function at admission (9.9% vs 5.7%, P=0.022) were more frequent among patients who lived in the NER, whereas current smoking (38.5% vs 19.5%, P<0.001) and peripheral arterial disease (6.3% vs 3.3%, P=0.045) were more frequent among those who lived in Porto. The proportion of patients discharged with a diagnosis of STEMI was lower in the NER than in the Porto district (33.2% vs 42.7%, P=0.005). Patients who lived in the NER were more likely to need a travel time to CR greater than 30 min compared with those who lived in the Porto district (82.1% vs 5.3%, P<0.001). Travel times to the nearest CR centre are illustrated in figure 1B.

From the whole study sample, 158 patients from Porto district were referred by their physicians to attend a CR programme, whereas only 39 from the NER were referred (32.3% vs 10.7%, P<0.001) (figure 2). In both regions, patients who were male, younger, employed, with a white collar occupation, in higher social class, education and income and with health insurance coverage were more likely to be referred to a CR programme. Those who lived nearest to a CR centre, who were smokers and who were diagnosed with STEMI were also more likely to be referred to rehabilitation, whereas patients with comorbidities, anaemia at admission or impaired renal function were less likely to be referred to CR in both regions (table 2).

Predictors independently associated with CR referral are presented in table 3. In both regions, the probability of referral to CR decreased with age (Porto district: OR 0.95, 95% CI 0.93 to 0.97 per year of age; NER: OR 0.95, 95% CI 0.91 to 0.98 per year of age) and with longer travel times to CR centres (Porto district: OR 0.18, 95% CI 0.04 to 0.92; NER: OR 0.18, 95% CI 0.07 to 0.42). Patients living in the NER were less likely to be referred to CR, but the differences were not statistically significant, whereas longer travel times were negatively associated with referral. Among patients who lived in the Porto district, current smokers (OR 1.89, 95% CI 1.12 to 3.20), in higher social class (lower-middle: OR 2.20, 95% CI 1.17 to 4.14; higher-middle: OR 2.30, 95% CI 0.94 to 5.61), with health insurance coverage (OR 2.11, 95% CI 1.23 to 3.62) and those who underwent a percutaneous coronary intervention (PCI) (OR 3.24, 95% CI 1.85 to 5.66) were more likely to be referred to CR, whereas those with comorbidities were less likely to be referred (1 comorbidity: OR 0.40, 95% CI 0.19 to 0.80; ≥2 comorbidities: OR 0.22, 95% CI 0.05 to 1.01). In patients who lived in the NER, higher education (OR 3.10, 95% CI 1.09 to 8.84) and higher household income (OR 4.83, 95% CI 1.84 to 12.71) were independently associated with referral to CR.

Six months after hospital discharge, 128 patients from Porto and 26 from the NER reported participating in a CR programme (26.2% vs 7.1% of those eligible, P<0.001% and 81.0% vs 66.7% of those referred, P<0.052) (figure 2). Among the 43 patients who did not enrol or complete the CR programme, the three major reasons reported for non-participation were the long time until a CR programme was available (33.3%), limited time available to participate (23.3%) and lack of perceived benefit (20.0%), according to patients from the Porto district, whereas most patients from the NER reported first the distance from home to the CR centre (84.6%), then the cost of CR (23.1%) and finally the limited time availability (7.7%).

DISCUSSION

Despite the proven benefits and the international recommendations for CR after an ACS, our results showed that CR remains underused in Portugal, with major inequalities in access between regions. Following an ACS, one-third of the patients from the Porto district were referred to CR, whereas only 1 out of 10 patients from the NER were referred. Yet, of those who were referred, four-fifths from Porto and two-thirds from NER actually completed the CR programme, indicating that low participation was largely explained by low referral. Older patients with comorbidities, with lower socioeconomic status and those living farther from a CR centre were less likely to be referred to CR, whereas patients with health insurance coverage, smokers and those who underwent a PCI were more likely to be referred.

The number of patients enrolled in CR programmes in Portugal in recent years is increasing;[10 11] however, such programmes remain considerably underused, indicating that a large proportion of patients with CHD are missing the opportunity to benefit from CR. Several studies have shown that suboptimal referral patterns represent one of the major causes of poor participation in CR,[15] which is corroborated by our findings. Although in the Porto district the proportion of patients referred met the target set by the Portuguese Minister of Health, in the NER referral was far from reaching 30%.[12] Studies conducted in other countries showed wide international variation,[16 17] however, with much higher overall referral than in Portugal. A meta-analysis that included 241 613 patients with CHD reported overall referrals of 45%,[17] similarly to those observed in the European Action on Secondary and Primary Prevention through Intervention to Reduce Events (EUROASPIRE) survey, which included 13 935 patients with CHD, from 22 European countries.[16] Moreover, in the USA, data from the initiative *Get with Guidelines*, including 72 817 patients hospitalised after an MI, PCI or cardiac artery bypass graft, showed that 56%

Table 1 Baseline characteristics of the study population by region

	Total*	Porto district	NER of Portugal	
	n (%)†	n (%)†	n (%)†	P value
Total	853 (100.0)	489 (57.3)	364 (42.7)	–
Males	641 (75.2)	387 (79.1)	254 (69.8)	0.002
Age (years), mean±SD	63.5±12.9	61.1 (12.6)	66.7 (12.5)	<0.001
Partnered (vs unpartnered)	665 (78.3)	376 (77.5)	289 (79.4)	0.513
Schooling years >4 (vs ≤4)	359 (42.3)	245 (50.5)	114 (31.4)	<0.001
Employed (vs unemployed/retired/disable)	268 (29.2)	180 (34.3)	88 (22.5)	<0.001
Occupation				
Blue collar	460 (58.3)	260 (56.2)	200 (61.4)	0.054
Lower white collar	184 (23.3)	105 (22.7)	79 (24.2)	
Upper white collar	145 (18.4)	98 (21.2)	47 (14.4)	
Social class				
Low	282 (33.1)	138 (28.2)	144 (39.6)	0.001
Lower-middle	285 (33.4)	172 (35.2)	113 (31.0)	
Higher-middle/high	60 (7.0)	44 (9.0)	16 (4.4)	
No response	226 (26.5)	135 (27.6)	91 (25.0)	
Monthly household income (€)				
≤1500	575 (67.4)	321 (65.6)	254 (69.8)	0.014
>1500	136 (15.9)	93 (19.0)	43 (11.8)	
No response	142 (16.7)	75 (15.3)	67 (18.4)	
Health insurance coverage	205 (26.3)	110 (25.9)	95 (26.8)	0.763
Travel time to CR centre (min)				
<30	528 (61.9)	463 (94.7)	65 (17.9)	<0.001
≥30	325 (38.1)	26 (5.3)	299 (82.1)	
CV risk factors				
BMI (kg/m^2), mean±SD	27.1±4.2	26.9±4.4	27.3±3.9	0.143
Current smoker	257 (30.3)	186 (35.56)	7 (19.5)	<0.001
Hypertension	572 (67.1)	308 (63.0)	264 (72.5)	0.003
Dyslipidaemia	530 (62.1)	287 (58.7)	243 (66.8)	0.016
Diabetes	279 (32.7)	151 (30.9)	128 (35.2)	0.187
Comorbidities				
Previous MI	146 (17.1)	89 (18.1)	57 (15.7)	0.330
Previous stroke	73 (8.6)	45 (9.2)	28 (7.7)	0.436
Peripheral arterial disease	43 (5.0)	31 (6.3)	12 (3.3)	0.045
Chronic renal failure	57 (6.7)	27 (5.5)	30 (8.2)	0.116
Chronic heart failure	54 (6.6)	22 (4.7)	32 (9.1)	0.012
Number of comorbidities				
0	562 (68.6)	323 (69.2)	239 (67.9)	0.795
1	175 (21.4)	96 (20.6)	79 (22.4)	
≥2	82 (10.0)	48 (10.3)	34 (9.7)	
Clinical characteristics at admission				
Heart rate (bpm), mean±SD	77.7±19.3	77.9±20.0	77.2±17.9	0.700
Systolic blood pressure (mm Hg), mean±SD	140.3±29.1	141.3±29.0	138.3±29.4	0.283
Anaemia‡	161 (18.9)	83 (17.0)	78 (21.4)	0.100
Impaired renal function§	64 (7.5)	28 (5.7)	36 (9.9)	0.022
Killip class III–IV	38 (4.5)	19 (3.9)	19 (5.2)	0.350

Continued

Table 1 Continued

	Total*	Porto district	NER of Portugal	
	n (%)†	n (%)†	n (%)†	P value
Moderate–severe LVSD	249 (30.0)	146 (29.9)	103 (30.0)	0.973
Medical procedures				
PCI	544 (63.8)	310 (63.4)	234 (64.3)	0.789
CABG	135 (15.8)	85 (17.4)	50 (13.7)	0.149
STEMI (vs NSTEACS)	330 (38.7)	209 (42.7)	121 (33.2)	0.005

*Total may not add to 853 due to missing data.
†Results are presented as n (%), except if otherwise specified.
‡Anaemia was defined as haemoglobin level ≤12 g/dL for women and ≤13 g/dL for men.
§Impaired renal function was defined as serum creatinine level ≥1.5 mg/dL.
BMI, body mass index; CABG, cardiac artery bypass graft; CR, cardiac rehabilitation; CV, cardiovascular; LVSD, left ventricular systolic dysfunction; MI, myocardial infarction; NER, north-east region; NSTEACS, non-ST-elevation acute coronary syndrome; PCI, percutaneous coronary intervention; STEMI, ST-segment elevation myocardial infarction.

of those eligible were referred,[18] whereas recent results of a national survey in England showed 81.5% of patients referred to CR between 2012 and 2015.[19]

Previous research has demonstrated that there are wide inequalities in CR referral against women, elders and deprived socioeconomic populations.[16–18 20 21] In fact, we found that older patients were less likely to be referred to CR, but no association was found regarding sex. In addition to higher income and education being associated with referral in the NER, our results also showed that patients in the lower social class and with multiple comorbidities were less likely to be referred in the Porto district, reiterating the treatment-risk paradox,[22 23] such that patients at high-risk who may benefit the most from CR are less likely to access it. These findings are particularly worrisome in the current context of population ageing, with an increasing number of comorbidities. Although evidence shows that all patients with CHD benefit from participation in CR, regardless of age or medical comorbidity burden,[24] physicians may perceive these disadvantaged groups as less likely to take advantage of CR. Several studies that analysed physician factors associated with CR referral pointed out the perceived benefit of CR as one of the most relevant factors affecting referral.[25 26] Therefore, increasing physicians' awareness about the benefits of CR in higher risk populations is warranted. Besides the importance of physicians' endorsement, implementing systematic referral approaches in which eligible patients are automatically identified and referred to CR have been shown to have a significant impact on increasing referral and enrolment.[27] Grace *et al* demonstrated that using a combined automatic referral with patient discussion can achieve referral of over 85% and enrolment around 74%.[28] Moreover, these strategies have been described as having the potential to mitigate disparities in access to CR, namely among patients with lower socioeconomic status.[29]

Our results also showed that patients who live farther from a CR centre were less likely to be referred, in accordance with previous studies that described geographical accessibility, measured by distance, transportation, travel time or costs, as an important barrier to CR referral and participation.[25 30] The 30 min travel time threshold has often been used to define accessible healthcare services;[31 32] however, a study conducted by Brual *et al* that investigated the travel time threshold affecting specifically CR use found that patients who have a travel time to CR greater than 60 min were less likely to be referred and also to be enrolled in a programme.[30] In our study, almost half of the patients from the NER lived beyond 60 min of the CR centre compared with a residual proportion in the Porto district, indicating that patients from the NER face higher geographical barriers to access CR services than patients living in the Porto district. To overcome geographical barriers in access to CR, alternative delivery models, such as home-based programmes, should be considered, particularly for those patients in rural areas. A recent systematic review of data from 17 randomised trials,[33] which included 2172 patients from 10 countries, compared the effectiveness of home-based to supervised centre-based CR and found similar benefits in terms of mortality, morbidity, quality of life and modifiable risk factors.

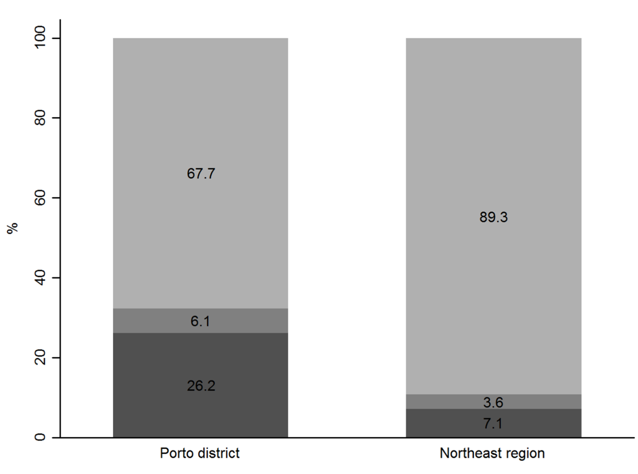

Figure 2 Referral and participation rates to CR according to region. CR, cardiac rehabilitation.

Table 2 Referral to CR after an ACS according to the patients' characteristics by region

	All		Porto district		NER of Portugal	
	n (%)*	P value	n (%)*	P value	n (%)*	P value
Total	197 (23.1)	–	158 (32.3)	–	39 (10.7)	–
Sex						
Female	30 (14.2)	<0.001	25 (24.5)	0.058	5 (4.6)	0.012
Male	167 (26.1)		133 (34.5)		34 (13.4)	
Age (years), mean±SD	54.6±10.5	<0.001	54.4±10.3	<0.001	55.6±11.0	<0.001
Marital status						
Partnered	158 (23.8)	0.466	123 (32.7)	0.906	35 (12.1)	0.063
Unpartnered	39 (21.2)		35 (32.1)		4 (5.3)	
Schooling years						
≤4	57 (11.7)	<0.001	49 (20.4)	<0.001	8 (3.2)	<0.001
>4	140 (39.0)		109 (44.5)		31 (27.2)	
Employment status						
Employed	115 (44.2)	<0.001	94 (52.2)		22 (25.0)	
Unemployed/retired/disable	82 (13.8)		69 (20.0)	<0.001	19 (6.3)	<0.001
Occupation						
Blue collar	90 (19.6)	<0.001	76 (29.2)	0.006	14 (7.0)	0.002
Lower white collar	36 (25.0)		33 (31.4)		13 (16.5)	
Upper white collar	57 (39.3)		46 (46.9)		11 (23.4)	
Social class						
Low	42 (14.9)	<0.001	34 (24.6)	<0.001	8 (5.6)	0.030
Lower-middle	85 (29.8)		73 (42.4)		12 (10.6)	
Higher-middle/high	25 (41.7)		21 (47.7)		4 (25.0)	
No response	45 (19.9)		30 (22.2)		15 (16.5)	
Monthly household income (€)						
≤1500	110 (19.1)	<0.001	90 (28.0)	<0.001	20 (7.9)	<0.001
>1500	67 (49.3)		50 (53.8)		17 (39.5)	
No response	20 (14.1)		18 (24.0)		2 (3.0)	
Health insurance coverage						
No	111 (19.3)	<0.001	90 (28.6)	<0.001	21 (8.1)	0.008
Yes	71 (34.6)		54 (37.4)		17 (17.9)	
Travel time to CR centre (min)						
<30	172 (32.6)	<0.001	155 (33.5)	0.020	17 (26.2)	<0.001
≥30	25 (7.7)		3 (11.5)		22 (7.4)	
Risk factors						
BMI (kg/m^2), mean±SD	26.8±4.1	0.412	26.7±4.2	0.582	27.4±3.5	0.887
Current smoker—no	88 (14.9)	<0.001	68 (22.4)	<0.001	20 (6.8)	<0.001
Yes	108 (42.0)		89 (45.9)		19 (26.8)	
Hypertension—no	97 (34.5)	<0.001	75 (41.4)	0.001	22 (22.0)	<0.001
Yes	100 (17.5)		83 (27.0)		17 (6.4)	
Dyslipidaemia—no	90 (27.9)	0.010	78 (38.6)	0.012	12 (9.9)	0.620
Yes	107 (20.2)		80 (27.9)		27 (11.1)	
Diabetes—no	154 (26.8)	<0.001	124 (36.7)	0.002	30 (76.9)	0.094
Yes	43 (15.4)		34 (22.5)		9 (7.0)	
Comorbidities						
Previous MI—no	180 (25.5)	<0.001	143 (35.8)	0.001	37 (12.1)	0.055

Continued

Table 2 Continued

	All		Porto district		NER of Portugal	
	n (%)*	P value	n (%)*	P value	n (%)*	P value
Yes	17 (11.6)		15 (16.9)		2 (3.5)	
Previous stroke—no	189 (24.2)	0.010	152 (34.2)	0.004	37 (11.0)	0525
Yes	8 (11.0)		6 (13.3)		2 (7.1)	
Peripheral arterial disease—no	193 (23.8)	0.028	156 (34.1)	0.001	37 (10.5)	0498
Yes	4 (9.3)		2 (6.5)		2 (16.7)	
Chronic renal failure— no	195 (24.5)	<0.001	156 (33.8)	0.004	39 (11.7)	0.048
Yes	2 (3.5)		2 (7.4)		0 (0.0)	
Chronic heart failure—no	185 (24.2)	<0.001	150 (33.7)	0.001	35 (10.9)	0.049
Yes	0 (0.0)		0 (0.0)		0 (0.0)	
Number of comorbidities						
0	163 (29.0)	<0.001	131 (40.6)	<0.001	32 (13.4)	0.005
1	17 (9.7)		16 (16.7)		1 (1.3)	
≥2	5 (6.1)		3 (6.3)		2 (5.9)	
Clinical characteristics at admission						
Heart rate (bpm), mean±SD	77.1±17.5	0.786	77.2±17.9	0.700	76.7±15.7	0.898
SBP (mm Hg), mean±SD	139.0±29.0	0.198	138.3±29.4	0.283	141.7±27.5	0.840
Anaemia†—no	180 (26.0)	<0.001	144 (35.5)	0.001	36 (12.6)	0.027
Yes	17 (10.6)		14 (16.9)		3 (3.9)	
Impaired renal function‡—no	194 (25.6)	<0.001	155 (33.6)	0.012	39 (11.9)	0.029
Yes	2 (4.7)		3 (10.7)		0 (0.0)	
Killip class						
I–II	190 (23.3)	0.484	153 (32.6)	0.569	37 (10.7)	0.978
III–IV	7 (18.4)		2 (26.3)		2 (10.5)	
Moderate–severe LVSD—no	146 (25.1)	0.153	115 (33.6)	0.367	31 (12.9)	0.168
Yes	51 (20.5)		43 (29.5)		8 (7.8)	
Medical procedures						
PCI—no	41 (13.3)	<0.001	30 (16.8)	<0.001	11 (8.5)	0.300
Yes	156 (28.7)		128 (41.3)		28 (12.0)	
CABG—no	176 (24.5)	0.023	146 (36.1)	<0.001	30 (9.6)	0.073
Yes	21 (15.6)		12 (14.1)		9 (18.0)	
Type of ACS						
STEMI	104 (31.5)	<0.001	84 (40.2)	0.001	20 (16.5)	0.011
NSTEACS	93 (17.9)		74 (26.4)		19 (7.8)	

*Results are presented as n(%), except if otherwise specified.
†Anaemia was defined as haemoglobin level ≤12 g/dL for women and ≤13 g/dL for men.
‡Impaired renal function was defined as serum creatinine level ≥1.5 mg/dL.
ACS, acute coronary syndrome; BMI, body mass index; CABG, cardiac artery bypass graft; CR, cardiac rehabilitation; LVSD, left ventricular systolic dysfunction; MI, myocardial infarction; NER, north-east region; NSTEACS, non-ST-elevation acute coronary syndrome; PCI, percutaneous coronary intervention; SBP, systolic blood pressure; STEMI, ST-elevation myocardial infarction.

Consistent with the results reported in the EUROASPIRE III,[16] our study showed that a high proportion of referred patients from the Porto district completed the CR programme. Nonetheless, in the NER, the proportion of those failing to complete the programme (33.3%) contributed to the underuse of CR. According to patients in the NER region, the main barriers to their participation in CR were distance to the centre and financial costs, in line with previous research that identified those as important predictors of non-participation.[34 35] The geographic maldistribution of CR centres is a well-known barrier to access CR in Portugal, with significantly fewer centres in inland areas compared with the coast and in the south compared with the north.[10 11] In the Porto district, there were seven centres, either public hospital-based or private community-based, whereas in the NER, there was

Table 3 Predictors of CR referral among patients following an acute coronary syndrome by region

	Adjusted OR (95% CI)		
	All	Porto district	NER of Portugal
Region*			
Porto district	1	–	–
NER of Portugal	0.93 (0.48 to 1.79)	–	–
Sex*			
Female	1	1	1
Male	0.81 (0.47 to 1.38)	1.01 (0.53 to 1.93)	1.76 (0.58 to 5.38)
Age (years)	0.96 (0.94 to 0.99)	0.95 (0.93 to 0.97)	0.95 (0.91 to 0.98)
Schooling years (years)			
≤4	1	–	1
>4	1.72 (1.07 to 2.76)	–	3.10 (1.09 to 8.84)
Monthly household income (€)			
≤1500	1	–	1
>1500	2.79 (1.65 to 4.72)	–	4.83 (1.84 to 12.71)
No response	0.85 (0.46 to 1.58)	–	0.49 (0.10 to 2.40)
Social class			
Low	–	1	–
Lower-middle	–	2.20 (1.17 to 4.14)	–
Higher-middle/high	–	2.30 (0.94 to 5.61)	–
No response	–	1.02 (0.50 to 2.08)	–
Health insurance coverage			
No	–	1	–
Yes	–	2.11 (1.23 to 3.62)	–
Travel time to CR centre (min)			
<30	1	1	1
≥30	0.19 (0.09 to 0.39)	0.18 (0.04 to 0.92)	0.18 (0.07 to 0.42)
Current smoker			
No	1	1	–
Yes	1.75 (1.13 to 2.72)	1.89 (1.12 to 3.20)	–
Number of comorbidities			
0	1	1	–
1	0.37 (0.20 to 0.68)	0.40 (0.19 to 0.80)	–
≥2	0.40 (0.15 to 0.12)	0.22 (0.05 to 1.01)	–
PCI			
No	1	1	–
Yes	3.00 (1.87 to 4.80)	3.24 (1.85 to 5.66)	–
Impaired renal function†			
No	1	–	–
Yes	0.21 (0.05 to 0.85)	–	–

All independent variables were included in the model as categorical, except age (continuous).
Dash line - this variable was no included in the model.
*Variables were forced into models.
†Impaired renal function was defined as serum creatinine level ≥1.5 mg/dL.
CR, cardiac rehabilitation; NER, north-east region; PCI, percutaneous cardiac intervention.

only one private community-based centre. These inequalities are even more prominent because the costs of public centres are partially supported by the NHS, whereas CR programmes running in private centres are not funded by the government. During the study period, however, the private centre in the NER was supported by a specific protocol established with the government between 2012 and 2015, covering the costs of CR. Even so, costs were still mentioned as an important barrier to participation which may be explained by the indirect financial costs of participating in CR, namely the high transportation costs especially in more remote areas and for patients of lower socioeconomic status. Furthermore, patients from the Porto district identified delays to initiate the CR programme and lack of awareness of the benefits of CR as the main barriers, whereas limited time availability was identified by patients from both regions. In line with our results, a review that included 34 qualitative studies identified as key the physical barriers, such as lack of transport, financial cost or work commitment, and personal barriers, including embarrassment about participation or lack of perceived benefit of CR.[34]

Limitations

This study includes a multitude of factors that give important insights about access to CR in Portugal, although the findings should be interpreted in the context of the following potential limitations. First, recall bias may be at play as a result of the amount of time that elapsed between discharge and completion of the 6-month follow-up. However, using information about CR use based on patients' self-report may be more accurate than using physicians' chart. Previous research has shown that despite high concordance between self-reported and chart report, physicians' referral may be influenced by the barriers identified by patients during the CR referral discussion, which may result in lower referral reporting in chart.[25] Lastly, our results may not be generalised to other settings with different characteristics, although the study was conducted in two hospitals, one university hospital and one tertiary-level hospital, allowing the comparison of different urban and rural settings.

CONCLUSION

CR remains insufficiently implemented in Portugal, with major inequalities between regions. Our results show clear differences in access among vulnerable subpopulations, such as rural populations, elders, high-risk patients and socioeconomically deprived. The achievement of optimal CR use requires a multilevel approach addressing barriers related to healthcare system, providers and patients in order to improve provision, referral and participation.

Contributors AA conceived and designed the study. MV and AB raised the hypotheses and drafted the first version of the manuscript. MV, AB, CA and OL participated in data collection. MV, AB, AIR, NL and AA analysed and interpreted the data. CA, AR, OL, PD, MJM, IM, NL and AA reviewed the article critically for important intellectual content. All authors read and approved the final manuscript.

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Competing interests None declared.

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