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Research Article

Referral, Participation and Completion Rates in the Birjand Cardiac Rehabilitation Cohort after Coronary Revascularization

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ABSTRACT

Introduction: Cardiac rehabilitation (CR) is a cornerstone of secondary prevention following coronary revascularization; however, its utilization remains suboptimal in underserved regions. This study aimed to evaluate referral, participation, and completion rates of CR and their associated factors in Birjand, Iran.

Materials and Methods: This retrospective cohort study included 758 consecutive patients undergoing percutaneous coronary intervention (PCI) or coronary artery bypass grafting (CABG) between April 2022 and May 2023. Data on demographics, insurance status, education level, and physician CR familiarity were collected using a structured checklist and phone follow-up. The CR program was defined as 36 supervised sessions. Multivariate logistic regression models were used to identify factors associated with referral, participation, and completion. All reported odds ratios were derived from fully adjusted models.

Results: Among 749 eligible patients, 19(26.3%) were referred to CR, 103(52.3% of referred) participated, and 69(67.0% of participants) completed the program. Multivariate analysis showed that higher education was the strongest predictor of referral (odds ratio [OR]=9.50, 95% confidence interval [CI], 4.9%, 18.27%, P<0.001), followed by male gender (OR=2.12, 95% CI, 1%, 4.49%, P=0.005). Furthermore, physicians familiar with CR had approximately a 3-fold higher referral rate compared to less-familiar colleagues. Insurance coverage was significantly associated with program completion (78% of insured vs 59% of uninsured completers; P=0.018).

Conclusion: Referral is the main systemic barrier to CR utilization in this underprivileged region. Participation and completion among referred patients reflect a selected group with adequate access, highlighting the need for system level interventions focused on physician referral practices—particularly for women and less educated patients—and improved insurance coverage to enhance equitable access to CR.

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Introduction

The global increase in the prevalence of coronary artery disease (CAD) presents a significant public health challenge. While advancements in primary prevention and acute care have helped reduce early mortality, secondary prevention strategies remain essential for long-term prognosis and quality of life [1].

Cardiac rehabilitation (CR), a critical component of secondary prevention, reduces all-cause mortality, lowers hospitalization rates, and improves the physical and psychological well-being of patients following events, such as myocardial infarction, angioplasty, and cardiac surgery [2-5].

Despite the clear evidence and strong clinical recommendations, there is a persistent and significant gap in referral, enrollment, and participation rates for CR programs worldwide. Reports indicate that only 20% to 50% of eligible patients participate [6]. This access disparity is particularly pronounced in low- and middle-income countries (LMICs), where essential CR infrastructure is often minimal [7]. Globally, only 38.8% of countries have CR programs, with the lowest prevalence in LMICs. For example, in the United States, only 62% of eligible patients are referred to CR, but attendance drops sharply: Only 23% participate in at least one session and 5% complete a full cycle of 36 sessions [7].

Barriers to participation are complex and multi-faceted, encompassing both systemic and patient-specific factors [1]. Systemic barriers include low referral rates by physicians and logistical issues, while patient-specific factors often involve socioeconomic status, education level, and geographical distance to the rehabilitation center [8]. A better understanding of these specific barriers is crucial for developing targeted interventions [9].

In Iran, efforts have been made to expand CR availability; the number of centers significantly increased between 2018 and 2023 [10, 11]. However, this growth has primarily been concentrated in provincial capitals, leaving vast segments of the population in non-capital cities or disadvantaged regions with limited or no access to life-saving services [11]. This disparity highlights a major ongoing challenge in achieving health equity.

Birjand, a city in a disadvantaged region of eastern Iran, exemplifies the challenges of limited access and health inequity. The true rates of referral, enrollment, and completion of CR programs in this specific context are unknown. Furthermore, the role of key local predictors, such as geographical distance, insurance status (as a socioeconomic proxy), and physician familiarity with CR benefits and referral protocols, has not been adequately studied.

Therefore, this study was conducted on patients who underwent angioplasty and cardiac surgery in Birjand to assess the rates of referral, participation, and completion of CR programs. Crucially, we sought to identify the impact of specific systemic and socioeconomic predictors on patient engagement in this underserved region.

Materials and Methods

Study design and population

This study was a retrospective cohort study. Patients were followed from hospital discharge through successive stages of CR utilization (referral, participation, and completion). All consecutive adult patients undergoing percutaneous coronary intervention (PCI) or coronary artery bypass grafting (CABG) at Razi Hospital between April 2022 and May 2023 were screened.

The exclusion criteria included in-hospital death, missing baseline medical records, inability to establish post-discharge follow-up, and death after discharge but before CR assessment (n=9). Excluding post-discharge deaths may introduce survivorship bias; however, these patients were not eligible for CR participation assessment.

Data collection

Data were collected using a researcher-designed checklist based on prior literature and expert review. Two cardiologists and one CR specialist assessed face validity. Clinical data were extracted from medical records, while referral status, participation, completion, and reasons for non-referral were obtained via structured telephone interviews. Telephone follow-up may introduce recall bias, a recognized limitation.

Variable definitions

Referral was defined as a documented physician recommendation for CR. Participation was defined as attendance at least one CR session following referral, while completion was defined as attendance at all 36 prescribed sessions per the local CR protocol. Physician familiarity with CR was categorized a priori based on clinical role and historical referral volume.

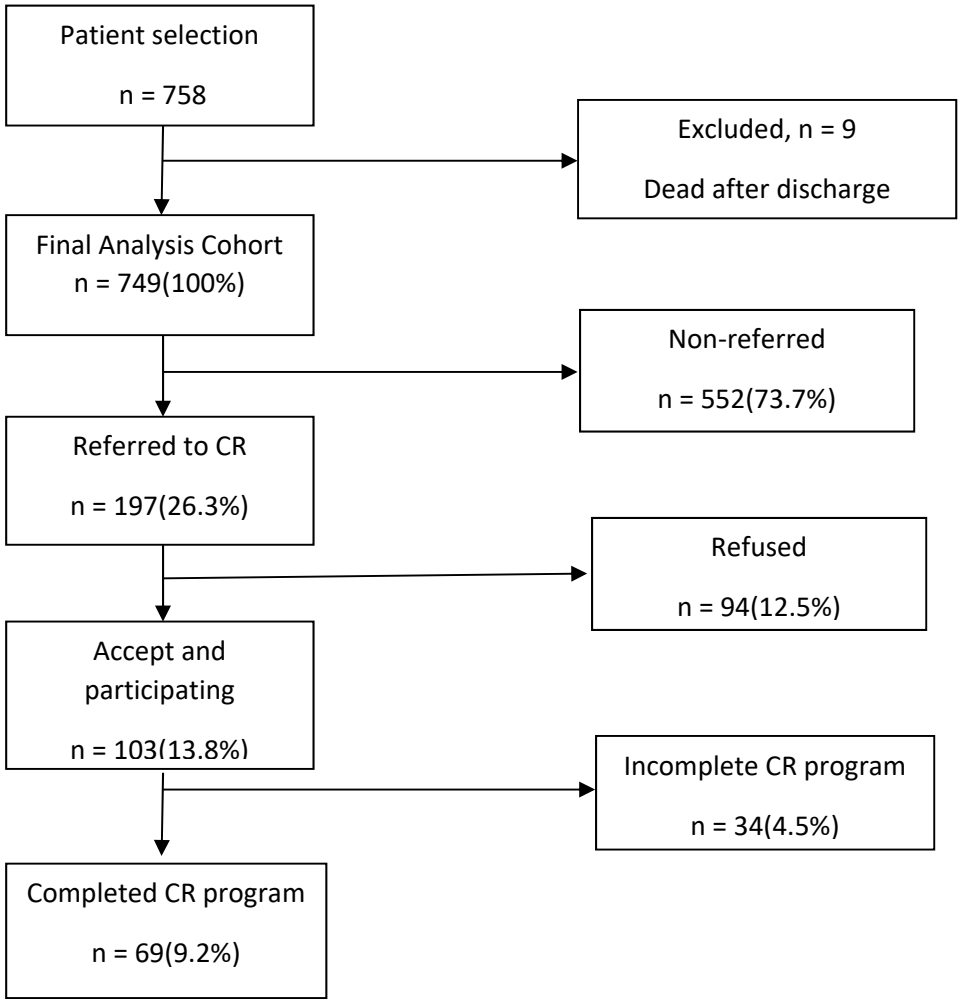

Figure 1. Flowchart of patient referral, participation, and completion of cardiac rehabilitation

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Statistical analysis

Normality was assessed descriptively. Given the large sample size, formal normality tests were interpreted cautiously. Multivariate logistic regression models were constructed using clinically relevant variables. Multicollinearity was assessed using variance inflation factors. Statistical significance was set at $P<0.05$.

Results

Patient flow and characteristics

A total of 758 patients were initially identified. Nine patients died after hospital discharge and before CR follow-up and were excluded, resulting in 749 patients included in the final analysis (Figure 1).

Baseline characteristics are presented in Table 1. Left ventricular ejection fraction was reported uniformly as Mean±SD.

Predictors of referral

Among eligible patients, 197(26.3%) were referred to CR. Referral was significantly associated with younger age, male sex, higher education, CABG surgery, insurance coverage, shorter distance to the CR center, and physician category. The large magnitude observed for university education (odds ratio [OR]=9.5) should be interpreted with caution due to the small subgroup size and potential residual confounding. Variation in referral across physicians suggests provider-level heterogeneity.

Table 1. Univariate characteristics associated with referral to cardiac rehabilitation

Characteristics		No. (%)/Mean±SD			P	Univariate OR (95% CI)
		All Patients (n=749, 100%)	Referral to CR (n=197, 26%)	Non-referral to CR (n=552, 73%)		
Age (y)		61.77±11.9	58.9±9.9	63±12.2	<0.001*	0.97 (0.96-0.99)
EF (%)		42.42±11.1	45	45	0.14	1.01 (1-1.03)
Sex	Female	223(29.8)	35(15.7)	188(84.3)	<0.001*	Ref
	Male	525(70.2)	162(30.9)	363(69.1)		2.40 (1.6-2.6)
Occupation	Housewife	212(28.4)	31(14.6)	181(85.4)	<0.001*	Ref
	Retired	176(23.6)	68(38.6)	108(61.4)		3.7 (2.26-5)
	Employee	37(5)	17(45.9)	20(54.1)		5 (2.34-10.5)
	Self-employment	321(43.1)	81(25.2)	241(74.8)		2 (1.25-3.1)
Education	Illiterate	235(31.5)	29(12.3)	206(87.7)	<0.001*	Ref
	Below university	481(64.5)	150(31)	331(69)		3.03 (2-4.7)
	University	30(4)	18(60)	12(40)		9.50 (4.9-18.27)
Marital status	Single	24(4)	4(16.7)	20(83.3)	0.27	Ref
	Married	725(96)	193(26.6)	532(73.4)		1.81 (0.61-5.37)
Insurance	No	521(70)	112(21.5)	409(78.5)	<0.001*	Ref
	Yes	224(30)	84(37.5)	140(62.5)		2.2 (1.6-3.08)
Cigarette smoker	No	606(81)	148(24.4)	458(75.6)	0.01*	Ref
	Yes	143(19)	49(34.3)	94(65.7)		1.61 (1.09-2.38)
Opium user	No	559(75)	153(27.4)	406(72.6)	0.26	Ref
	Yes	190(25)	44(23.2)	146(76.8)		0.8 (0.54-1.18)
FH of CAD	No	575(77)	144(25)	431(75)	0.15	Ref
	Yes	174(23)	53(30.5)	121(69.5)		1.31 (0.9-1.91)
Previous CAD history	No	414(55.3)	124(30)	290(70)	0.01*	Ref
	Yes	335(44.7)	73(21.8)	262(78.2)		0.65 (0.47-0.91)
Diabetes mellitus	No	546(73.1)	136(24.9)	410(75.1)	0.15	Ref
	Yes	203(26.9)	61(30)	142(70)		1.3 (0.91-1.85)
Dyslipidemia	No	530(71)	142(26.8)	388(73.2)	0.63	Ref
	Yes	219(29)	55(25.1)	164(74.9)		0.92 (0.64-1.32)
Hypertension	No	414(55.3)	124(30)	290(70)	0.01*	Ref
	Yes	335(44.7)	73(21.8)	262(78.2)		0.65 (0.47-0.91)

Characteristics		No. (%)/Mean±SD			P	Univariate OR (95% CI)
		All Patients (n=749, 100%)	Referral to CR (n=197, 26%)	Non-referral to CR (n=552, 73%)		
Intervention	PCI	613(81.7)	139(22.7)	474(77.3)	<0.001*	Ref
	CABG	125(16.8)	56(44.8)	69(55.2)		2.77 (1.86-4.13)
	Valvular surgery	10(1.6)	1(10)	9(90)		0.38 (0.05-3.02)
Doctor	Doctor 1	539(71.9)	128(23.7)	411(76.3)	<0.001*	Ref
	Doctor 2	82(10.9)	14(17.1)	68(82.9)		0.66 (0.36-1.22)
	Doctor 3	127(17.2)	55(43.3)	72(56.7)		2.45 (1.64-3.67)
Distance to CR center (km)	0-10	360 (48.5)	170(47.2)	190(52.8)	<0.001*	Ref
	10-30	35 (4.7)	7(20)	28(80)		0.28 (0.12-0.66)
	30-100	156(21)	13(8.3)	143(91.7)		0.10 (0.06-0.19)
	>100	192(25.8)	7 (3.6)	185(96.4)		0.04 (0.02-0.09)

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Abbreviations: CR: Cardiac rehabilitation; PCI: Percutaneous coronary intervention; CABG: Coronary artery bypass grafting; CAD: Coronary artery disease; OR: Odds ratio; CI: Confidence interval; EF: Ejection fraction.

Participation among referred patients

Among referred patients, 103(52.3%) attended at least one CR session (Table 2). These findings apply only to referred patients and should not be generalized to the entire eligible cohort.

Completion of CR

Of participating patients, 69(67%) completed the full CR program (Table 3). The small sample size and potential model overfitting limit interpretation. Variables with sparse data and unstable confidence intervals (CI) were excluded from the final model.

Discussion

Our study reveals a critical gap in CR utilization in Birjand, eastern Iran, with only 26.3% of eligible patients receiving physician referral, a rate markedly lower than most international benchmarks. For example, referral rates of approximately 80% have been reported in the Netherlands, where older age, higher ejection fraction, and greater distance were associated with reduced referral, while gender showed no association [12]. In contrast, Spain reported a referral rate of 13.8%, with age, gender, and CAD history as independent predictors [13]. In the United States, referral rates of approximately 40% have been described, with male sex and Black race associated with lower referral likelihood [14]. More recently, the Queensland Cardiac Outcomes Registry reported referral rates of 63% among over 33,000 eligible patients, largely attributed to system-level interventions such as automated electronic referrals, financial incentives, and dedicated qualityimprovement personnel [15]. Evidence from Southeast Asia further supports the effectiveness of automated referral systems, which doubled CR enrollment following CABG [16]. These findings highlight the potential role of structured referral pathways and providerlevel interventions.

Consistent with prior Iranian studies, CR referral rates in our setting remain notably low. Previous reports from Kermanshah and other regions have identified limited physician awareness, inadequate insurance coverage, and geographic barriers as major impediments to referral [17, 18]. Hybrid CR models have shown improved referral rates in western Iran, although distance and female gender continued to negatively influence access [19]. Our findings align with this literature, highlighting distance to CR centers and insufficient provider recommendations as key barriers. However, given the retrospective observational design, these associations should not be interpreted as causal, as distance and physician familiarity with CR may act as proxies for unmeasured patient, provider, or system-level confounders.

Table 2. Characteristics of patients who participated in cardiac rehabilitation

Characteristics		No. (%)/Mean±SD			P	OR (95% CI)
		All Patients (n=197, 100%)	Participation (n=103, 52%)	Non-participation (n=94, 48%)		
Age (y)		58.9±9.9	58.8 ±8.8	58.9±10.9	0.95	1 (0.98-1.03)
EF (%)		45±9.9	43.5±9.7	43.7±10.3	0.85	1 (0.97-1.03)
Sex	Female	35(18)	13(37.1)	22(62.9)	0.04*	Ref
	Male	162(82)	90(55.6)	72(44.4)		2.12 (1-4.49)
Occupation	Housewife	31(16)	13(41.9)	18(58.1)	0.45	Ref
	Retired	68(35)	40(58.8)	28(41.2)		1.98 (0.84-4.68)
	Employee	17(8)	9(52.9)	8(47.1)		1.56 (0.48-5.12)
	Self-employment	81(41)	41(50.6)	40 (49.4)		1.42 (0.62-3.28)
Education	Illiterate	29(15)	9(31)	20(69)	0.08	Ref
	Education below university	150(76)	82(55)	68(45)		2.58 (1.09-6.06)
	College/University	18(9)	12(66.7)	6(33.3)		4.24 (1.45-12.4)
Marital status	Married	193(98)	100(51.8)	93(48.2)	0.05*	
	Single	4(2)	0	4(100)		
Insurance	No	112(57)	61(54.5)	51(45.5)	0.43	Ref
	Yes	84(43)	41(48.8)	43(51.2)		0.80 (0.45-1.41)
Cigarette smoker	No	148(75)	81(54.7)	67(45.3)	0.23	Ref
	Yes	49(25)	22(44.9)	27(55.1)		0.67 (0.35-1.29)
Opium user	No	153(78)	82(53.6)	71(46.4)	0.49	Ref
	Yes	44(22)	21(47.7)	23(52.3)		0.80 (0.4-1.55)
FH of CAD	No	144 (63)	75 (52.1)	69 (47.9)	0.92	Ref
	Yes	53 (27)	28 (52.8)	25 (47.2)		1.03 (0.55-1.94)
Previous CAD history	No	124(63)	64(51.6)	60(48.4)	0.80	Ref
	Yes	73(37)	39(53.4)	34(46.6)		1.08 (0.6-1.92)
Diabetes mellitus	No	136(70)	68(50)	68(50)	0.21	Ref
	Yes	61(30)	35(57.4)	26(42.6)		1.35 (0.73-2.47)
Dyslipidemia	No	142(72)	70(49.3)	72(50.7)	0.47	Ref
	Yes	55(28)	31(56.4)	24(43.6)		1.26 (0.67-2.35)
Hypertension	No	124(43)	64(51.6)	60(48.4)	0.80	Ref
	Yes	73(37)	39(53.4)	34(46.6)		1.08 (0.6-1.92)

Characteristics		No. (%)/Mean±SD			P	OR (95% CI)
		All Patients (n=197, 100%)	Participation (n=103, 52%)	Non-participation (n=94, 48%)		
Intervention	PCI	139(67)	82(59)	57(41)	0.02*	Ref
	CABG	56(18)	20(35.7)	36(64.3)		0.39 (0.2-0.73)
	Valvular surgery	1(16)	0	1(100)		
Doctor	Doctor 1	128(59)	78(60.9)	50(39.1)	0.004*	2.73 (1.42-5.25)
	Doctor 2	14(89)	5(35.7)	9(64.3)		0.97 (0.28-3.3)
	Doctor 3	55(12)	20(36.4)	35(63.6)		Ref
Distance to CR center (km)	0-10	170(35)	90(52.9)	80(47.1)	0.91	1.50 (0.33-6.9)
	10-30	7(37)	4(57.1)	3(42.9)		1.78 (0.21-14.77)
	30-100	13(21)	6(46.2)	7(53.8)		1.14 (0.18-28)
	>100	7(18)	3(42.9)	4(57.1)		Ref

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Abbreviations: CR: Cardiac rehabilitation; PCI: Percutaneous coronary intervention; CABG: Coronary artery bypass grafting; CAD: Coronary artery disease; OR: Odds ratio; CI: Confidence interval; EF: Ejection fraction.

Among the 197 patients who were referred, 52.3% participated in at least one CR session, a rate lower than that reported in the Netherlands but comparable to or higher than several international and regional estimates [12, 20, 21]. Prior studies have consistently shown reduced participation among women, older adults, and patients with lower educational attainment, while higher participation has been observed among men and those with greater socioeconomic resources [21–24]. In our cohort, female gender was similarly associated with lower participation, whereas marital status and stronger provider recommendations appeared to facilitate engagement. PCI patients also demonstrated higher participation than CABG patients, potentially reflecting differences in recovery trajectories, perceived illness severity, or functional capacity at discharge.

Although 67% of participating patients completed all 36 prescribed CR sessions, this completion rate should be interpreted with caution. Comparable studies have reported substantially lower completion rates in real-world settings [25, 26], while others, particularly in highly organized systems, have achieved higher rates [12]. In observational cohorts such as ours, elevated completion rates likely reflect selection and survivorship effects, whereby patients who successfully overcome early barriers to referral and participation represent a highly selected subgroup with greater capacity or motivation to persist in the program. Consequently, completion among participants should not be interpreted as evidence of uniformly high adherence across the broader eligible population.

Overall, while international comparisons provide valuable context, mechanistic explanations for the observed local gender disparities remain incompletely elucidated. The findings primarily highlight systemic shortcomings in referral pathways and access, emphasizing the need for cautious interpretation of participation and completion metrics and for future prospective studies to better disentangle patient, provider, and system-level determinants of CR utilization.

Limitations

This study is limited by its retrospective design, reliance on partly self-reported data, and single-center setting, which restricts causal inference and generalizability. Although major comorbidities were reviewed, incomplete documentation and limited statistical power precluded their inclusion in multivariable models, raising the possibility of residual confounding. Physician-level clustering and heterogeneity in referral behavior were not fully accounted for, likely influencing referral estimates. Additionally, hospital and system-level factors (e.g. institutional referral pathways and resource avail-

Table 3. Characteristics of patients who completed cardiac rehabilitation

Characteristics		All Patients (n=103, 100%)	CR Completion (n=69, 67%)	Non-completion of CR (n=34, 33%)	P	OR (95% CI)
Age (y)		58.8 ± 8.8	59.5±8.7	57.6 ± 9.3	0.29	1.03 (0.98-1.08)
EF (%)		43.5 ± 9.7	43.4±10.1	43.6 ±9.1	0.90	1 (0.96-1.04)
Sex	Female	90(87)	59(65.6)	31(34.4)	0.41	1.75 (0.45-6.83)
	Male	13(13)	10(76.9)	3(23.1)		Ref
Occupation	Housewife	13(13)	10(76.9)	3(23.1)	0.70	2.13 (0.51-9)
	Retired	40(39)	28(70)	12(30)		1.49 (0.6-3.76)
	Employee	9(9)	6(66.7)	3(33.3)		1.3 (0.28-5.86)
	Self-employment	41(39)	25(61)	16(39)		Ref
Education	Illiterate	9(9)	7(77.8)	2(22.2)	0.34	Ref
	Education below university	82(80)	53(65)	29(35)		0.46 (0.09-2.37)
	College/University	12(11)	9(75)	3(25)		1.21 (0.18-8.22)
Marital status	Married	103(100)	69(67)	34(33)	2.03	
	Single	0	0	0		Ref
Insurance	No	61(60)	36(59)	25(41)	0.04*	Ref
	Yes	41(40)	32(78)	9(22)		2.47 (1.01-6.06)
Cigarette smoker	No	81(79)	55(68.9)	26(32.1)	0.56	Ref
	Yes	22(21)	14(63.6)	8(36.4)		0.83 (0.31-2.22)
Opium user	No	82(80)	57(69.5)	25(30.5)	0.28	No
	Yes	21(20)	12(57.1)	9(42.9)		0.59 (0.22-1.56)
FH of CAD	No	75(73)	49(65.3)	26(34.7)	0.55	Ref
	Yes	28(27)	20(71.4)	8(28.6)		1.33 (0.51-3.42)
Previous CAD history	No	64(62)	40(62.5)	24(37.5)	0.21	Ref
	Yes	39(38)	29(74.4)	10(25.6)		1.74 (0.72-4.2)
Diabetes mellitus	No	68(66)	44(64.7)	24(35.3)	0.49	Ref
	Yes	35(34)	25(71.4)	10(28.6)		1.36 (0.56-3.31)
Dyslipidemia	No	72(70)	44(61.1)	28(38.9)	0.06	Ref
	Yes	31(30)	25(80.6)	6(19.4)		2.65 (0.97-7.27)
Hypertension	No	64 (62%)	40(62.5)	24(37.5)	0.21	Ref
	Yes	39 (38%)	29(74.4)	10(25.6)		1.74 (0.72-4.19)

Characteristics		All Patients (n=103, 100%)	CR Completion (n=69, 67%)	Non-completion of CR (n=34, 33%)	P	OR (95% CI)
Intervention	PCI	82(80)	52(63.4)	30(36.6)	0.25	Ref
	CABG	20(20)	16(80)	4(20)		2.31 (0.71-7.54)
	Valvular surgery					
Doctor	Doctor 1	78(76)	52(66.7)	26(33.3)	0.04*	Ref
	Doctor 2	5(5)	1(20)	4(80)		0.13 (0.01-1.18)
	Doctor 3	20(19)	16(80)	4(20)		2 (0.61-6.6)
Distance to CR center (km)	0-10	90(88)	61(67.8)	29(32.2)	0.38	4.21 (0.37-48.31)
	10-30	4(4)	2(50)	2(50)		2 (0.09-44.35)
	30-100	6(6)	5(83.3)	1(16.7)		10 (40-250.42)
	>100	3(2)	1(33.3)	2(66.6)		Ref

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Abbreviations: CR: Cardiac rehabilitation; PCI: Percutaneous coronary intervention; CABG: Coronary artery bypass grafting; CAD: Coronary artery disease; OR: Odds ratio; CI: Confidence interval; EF: Ejection fraction.

ability) were not assessed despite their potential impact on access and adherence. The exclusion of patients who died after discharge may have introduced survivorship bias, potentially inflating participation and completion estimates.

Conclusion

Physician referral constitutes the main systemic barrier to CR utilization in this underprivileged region, with marked disparities affecting women, older adults, and lesseducated patients. Although participation and completion rates were moderate among referred patients, these outcomes reflect a selected subgroup and are likely influenced by survival and selection effects. The substantial attrition across the CR cascade underscores the need for system-level interventions targeting physician referral practices, insurance coverage, and geographic accessibility to improve equitable access to CR.

Ethical Considerations

Compliance with ethical guidelines

The study protocol was approved by the Ethics Committee of Birjand University of Medical Sciences, Birjand, Iran (Code: IR.BUMS.REC.1401.189).

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Authors' contributions

Conceptualization: Toba Kazemi, Maryam Sadat Rahimi, and Azar Zare Noughabi; Methodology: Seyed Mohammad Riahi; Supervision and writing: Azar Zare Noughabi, and Maryam Sadat Rahimi; Data analysis: Fateme Mahdizadeh; Data collection and final approval: All authors.

Conflict of interest

The authors declared no conflict of interest.

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