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ORIGINAL ARTICLE

Barriers to Cardiac Rehabilitation Enrollment and Secondary Prevention Adherence in Patients with Coronary Heart Disease Following Percutaneous Coronary Intervention: A Cross-sectional Survey

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Abstract

Objectives: **This study aimed to evaluate adherence to secondary prevention measures and to identify barriers to cardiac rehabilitation enrolment among patients with coronary heart disease after percutaneous coronary intervention.**

Methods: **An observational cross-sectional survey was conducted through computer-assisted telephone interviews to assess recently treated percutaneous coronary intervention patients at the Prince Sultan Cardiac Center in Saudi Arabia.**

Results: **Out of 104 surveyed patients with coronary heart disease, 85 (82%) were male, with an average age of 59.5 years. The obesity rate was 28% ($n = 29$), with a high prevalence of comorbidities: 82 (79%), 63 (61%), and 62 (60%) patients had hyperlipidemia, diabetes, and hypertension, respectively. Despite high medication compliance (97%), adherence to secondary prevention measures was low (21%). Adherence to physical exercise and weight monitoring for fluid body build-up was notably poor at 35% and 9%, respectively. Only 11 (10.6%) patients were referred for cardiac rehabilitation, of whom only four (36.4%) attended. Significant barriers such as a lack of staff contact, insufficient physician support, and distance to cardiac rehabilitation facilities were particularly noted by 69% of rural patients.**

Conclusions: **This study underscores the significant cardiac risk factors and low adherence to secondary prevention measures among post revascularization patients with coronary heart disease in Saudi Arabia. Low referral and other organizational barriers, as well as the travel distance to hospital-based cardiac rehabilitation, hinder program enrolment. To improve cardiac rehabilitation accessibility, it is crucial to revise the discharge plans, implement automated referral systems, expand the services across all regions, and utilize alternative delivery models.**

Keywords: Coronary heart disease (CHD), Percutaneous coronary intervention (PCI), Adherence, Cardiac rehabilitation (CR), Enrollment barriers

1. Introduction

Cardiovascular diseases (CVDs) are the leading cause of mortality and have been recognized as major contributors to global morbidity, with an increasing incidence rate in low-/middle-income countries (LMICs) [1]. Notably, the CVD-related mortality rate has markedly increased in developing countries, especially the Kingdom of Saudi Arabia (KSA). These health concerns account for more than 45% of deaths in the Saudi population [2]. In particular, coronary heart disease (CHD) accounts for 30–50% of all reported CVD cases and is the predominant cause of mortality in both developed and developing nations [3]. The 2019 Global Burden of Disease Study reported that the mortality rate

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due to CHD reached its peak at 23.1% in Saudi Arabia in 2019, establishing CHD as the primary cause of death [4].

Given the mortality rate and declining quality of life associated with cardiac diseases, the implementation of secondary prevention measures is imperative to identify, mitigate, and manage risk factors and disease-associated morbidities. Cardiac rehabilitation (CR) represents a comprehensive interdisciplinary secondary prevention approach that has been shown to be efficacious in reducing the mortality rate [5,6], enhancing health-related quality of life [5], and decreasing overall treatment costs [5,7]. Comprehensive CR programs encompass the principal elements of patient education, risk factor management, lifestyle modification, physical exercise training and monitoring, and mental health support [6,8]. Enrollment in CR programs following a cardiac event or revascularization procedure is endorsed as a Class I recommendation by prominent international guidelines, such as those established by the American Heart Association, American College of Cardiology, and European Society of Cardiology [6]. Nevertheless, CR programs are globally underutilized [5,9], and the participation rate of eligible patients does not exceed 30% in developed countries with advanced health systems, such as the United States of America, Canada, and the United Kingdom [9]. Furthermore, the availability of CR programs in developing nations remains insufficient, with CR programs implemented in only <25% of these countries [10]. Even when such programs are available, their utilization is very poor [10].

The healthcare system in KSA is segmented into two primary sectors: governmental, which offers free services to citizens, and private, which operates on a fee basis. The majority (60%) of governmental institutions are directly managed and funded by the Ministry of Health, while the remaining 40% are overseen by various other agencies, including military and educational institutions [11]. Recent reviews reveal that merely five governmental hospitals currently offer CR services in Saudi Arabia, underscoring the limited access to these effective interventions [12,13]. The low uptake of CR programs, despite their well-established benefits and international recommendations, is attributed to patient-, clinician-, and health system-level factors that have been broadly studied in most high-income countries [14,15].

Information on the multilevel barriers to CR enrollment is widely needed in nations heavily burdened by high rates of CVDs, including LMICs and KSA [5]. Within the kingdom, the management of these conditions cost the government $3.5 billion in 2016, with projections indicating a potential tripling by 2035, highlighting the urgent need for improvements in healthcare and prevention strategies to alleviate these burdens [16]. There is a notable gap in research concerning secondary prevention care and CR enrollment among patients with CHD within KSA [17]. Therefore, the present study aimed to assess adherence to secondary prevention measures in patients with CHD after percutaneous coronary intervention (PCI) and to delineate the patient-level barriers to CR enrollment at a leading cardiac center in Saudi Arabia, which is at the forefront of CR services.

List of abbreviations

CHD	Coronary heart disease
CR	Cardiac rehabilitation
CREO	Cardiac Rehabilitation Enrollment Obstacles
CVDs	Cardiovascular diseases
GCC	Gulf Cooperation Council
KSA	Kingdom of Saudi Arabia
LMICs	Low and middle-income countries
MOS-SAS	Medical Outcomes Study Specific Adherence Scale
PCI	Percutaneous coronary intervention
STROBE	Strengthening the Reporting of Observational Studies in Epidemiology

2. Materials and methods

2.1. Design and procedure

For this study, an observational cross-sectional survey was conducted through computer-assisted telephone interviews to collect data. This study adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guidelines for cross-sectional studies. The study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki as reflected in a priori approval by the institution's human research committee.

2.2. Setting

This study was conducted at the Prince Sultan Cardiac Center in Riyadh, Kingdom of Saudi Arabia. The Prince Sultan Cardiac Center operates within the Prince Sultan Military Hospital City and functions as an independent facility offering comprehensive medical services, including therapeutic and preventive care, to members of the Saudi

Armed Forces and their families, as well as to other eligible patients.

2.3. Participants and recruitment

This study targeted a population comprising adult individuals aged ≥18 years who were diagnosed with CHD and recently underwent a PCI procedure at the center. Individuals with significant orthopedic, auditory, visual, cognitive, mental, or neuromuscular impairments that could hinder their participation in CR programs were excluded. Inpatients who met the inclusion criteria were recruited from July 1 to September 30, 2023. The primary author extended invitations to all eligible patients to participate in the study and obtained their personal telephone numbers for follow-up at one month after the procedure. The participants provided verbal consent at the time of recruitment and reaffirmed their consent during subsequent telephone interviews.

2.4. Variables and data collection

2.4.1. Demographics and cardiac risk factors

The survey collected the demographic data of the respondents (including age, sex, city of residence, educational level, and marital status) and captured their medical health attributes (weight, height, smoking status, familial predisposition to cardiac diseases, and current diagnoses of mental health disorders, diabetes, hypertension, and hyperlipidemia). (see Supplementary material, (https://www.j-saudi-heart.com/cgi/editor.cgi?article¼1392&window¼additional_files&context¼jsha), which includes a file showing all survey questions).

2.4.2. Adherence to secondary prevention measures

Adherence to secondary prevention measures was evaluated via the Medical Outcomes Study Specific Adherence Scale (MOS-SAS) [18]. The MOS-SAS is a valid and reliable tool (coefficient $\alpha = 0.78$; test−retest correlation $r = 0.55$) commonly employed by researchers in medical outcome studies, especially in studies involving patients with CHD [19,20]. The following eight secondary prevention behaviors were measured: exercising regularly, taking prescribed medicines, reducing alcohol consumption, reducing or stopping smoking, eating low-salt food, eating low-fat food, measuring body weight daily, and monitoring symptoms. The participants were asked to rate the frequency of their actions related to each behavior over the past four weeks on a six-point Likert scale from 0 ("none of the time") to 5 ("all the time").

2.4.3. Barriers to CR enrollment

Barriers to CR enrollment were evaluated via the Cardiac Rehabilitation Enrollment Obstacles (CREO) scale. The CREO scale was developed, evaluated, and tested by expert researchers and academics from Sydney, Australia, in 2007 [21]. The CREO scale instrument is a 15-item self-report survey that requires participants to indicate the extent to which each item represents a barrier to participation in CR. The participants were asked to rate a list of potential barriers from 1 ("strongly agree") to 5 ("strongly disagree").

2.4.4. Preference for different models of CR

The survey concluded with an additional question regarding prospective strategies derived from current international evidence aimed at enhancing patient engagement in CR. It solicited the preferences of participants regarding their choice among home-based CR, center-based CR, and a combination of both modalities (i.e., the hybrid mode).

2.5. Bias

Cross-sectional studies are susceptible to outcome bias, which often stems from potential disparities between responders and non-responders. Furthermore, certain questions in the survey relied on the ability of patients to recall information, thereby potentially introducing bias into the results.

2.6. Data analysis

Patient survey data were analyzed via R (version 4.3.1) [22] and RStudio (version 2023.09.1) [23]. The survey sample was characterized in terms of patient demographics and clinical characteristics via descriptive statistics. Additionally, adherence to the MOS-SAS was evaluated both overall and at the item level, with good adherence defined as an overall score of >31 (≥80%) or an item score of "all the time" or "most of the time," as established in previous studies [24–26]. For the CREO scale items, responses were categorized as "agreed barrier" (responses of "strongly agree" and "agree") or "not a barrier" (responses of "unsure," "disagree," and "strongly disagree").

Continuous data are presented as the means and standard deviations, whereas categorical data are reported as frequencies and percentages. Bivariate associations were assessed via Pearson's χ^2 test of independence for categorical variables. Relationships among patient demographics, clinical characteristics, and adherence to the MOS-SAS were explored via univariate logistic regression.

Multivariable logistic regression was not attempted due to the low number of events in the proportion of compliance in several of the MOS-SAS items. Missing data were rare (six missing items for four patients), allowing for a complete case analysis. Statistical significance was set at $P < 0.05$.

3. Results

3.1. Participants

Initially, 130 post-PCI inpatients at the Prince Sultan Cardiac Center were recruited, of whom 104 (80%) participated in telephone surveys (85 males and 19 females). Two patients with disabilities and two other patients who declined participation were excluded from this study. Four participants were unreachable owing to incorrect contact information, two were readmitted to the ICU, and one died at two weeks after discharge. The remaining 15 patients failed to respond to repeated telephone calls.

3.2. Participants demographics and cardiac risk factors

Table 1 summarizes the demographic and clinical characteristics of the participants. The mean age was 59.5 years, with a predominantly male cohort ($n = 85$; 82%), reflecting the demographic trends of cardiac diseases within the community. Over 80% ($n = 84$) of the patients were married, and 22% ($n = 23$) had a university-level education.

Table 1. Survey participant demographics, clinical characteristics and cardiac rehabilitation referral status (n = 104).

Variable Counts (Percentage)	Not Referred/Unknown (N = 93)	Referred (N = 11)	Overall (N = 104)
Sex (male)	74 (79.6%)	11 (100%)	85 (81.7%)
Partnered (married, yes)	74 (79.6%)	10 (90.9%)	84 (80.8%)
Education			
High school or less	77 (82.8%)	4 (36.4%)	81 (77.9%)
University or more	16 (17.2%)	7 (63.6%)	23 (22.1%)
Location			
Rural	23 (24.7%)	3 (27.3%)	26 (25.0%)
Regional	15 (16.1%)	2 (18.2%)	17 (16.3%)
Urban	7 (7.5%)	0 (0%)	7 (6.7%)
Capital	48 (51.6%)	6 (54.5%)	54 (51.9%)
BMI (missing = 7)			
Underweight	1 (1.1%)	0 (0%)	1 (1.0%)
Normal weight	34 (36.6%)	2 (18.2%)	36 (34.6%)
Overweight	25 (26.9%)	6 (54.5%)	31 (29.8%)
Obese	26 (28.0%)	3 (27.3%)	29 (27.9%)
Smoking status (missing = 10)			
No	69 (74.2%)	7 (63.6%)	76 (73.1%)
Occasionally	1 (1.1%)	1 (9.1%)	2 (1.9%)
Yes	13 (14.0%)	3 (27.3%)	16 (15.4%)
Family medical history of cardiovascular disease (yes)	37 (39.8%)	6 (54.5%)	43 (41.3%)
Comorbidities[a]			
Hyperlipidemia	73 (78.5%)	9 (81.8%)	82 (78.8%)
Diabetes	58 (62.4%)	5 (45.5%)	63 (60.6%)
Hypertension	57 (61.3%)	5 (45.5%)	62 (59.6%)
None of them	9 (9.7%)	1 (9.1%)	10 (9.6%)
Number of comorbidities			
None	9 (9.7%)	1 (9.1%)	10 (9.6%)
One	16 (17.2%)	4 (36.4%)	20 (19.2%)
Two	32 (34.4%)	3 (27.3%)	35 (33.7%)
Three	36 (38.7%)	3 (27.3%)	39 (37.5%)
Referred to Cardiac Rehabilitation	93 (89.4%)	11 (10.6%)	11 (10.6%)
Then, attend Cardiac Rehabilitation (n = 11)		4 (36.4%)	4 (36.4%)
Cardiac rehabilitation program type preferred			
Hospital-based CR	15 (16.1%)	3 (27.3%)	18 (17.3%)
Home-based CR	53 (57.0%)	8 (72.7%)	61 (58.7%)
Hybrid Hospital/Home	12 (12.9%)	0 (0%)	12 (11.5%)
Unknown	13 (14.0%)	0 (0%)	13 (12.5%)
Age			
Mean (SD)	60.4 (12.8)	52.5 (13.8)	59.5 (13.0)
Median (Min–Max range)	62.0 [18.0, 86.0]	52.0 [31.0, 71.0]	60.5 (18–86)

[a] More than one selection possible.

Geographically, a quarter ($n = 26$) of the participants resided in rural areas, whereas the majority ($n = 62$, 58%) lived in urban locations, including Riyadh, the capital city. The prevalence of obesity was 28% ($n = 29$), and 15% ($n = 16$) of the participants were regular smokers. Additionally, 43 (41%) participants reported a family history of CVDs. Comorbid conditions were prevalent, with 82 (79%), 63 (61%), and 62 (60%) participants reporting hypercholesterolemia, diabetes, and hypertension, respectively. Notably, nearly one-third ($n = 39$) of the participants had all three conditions, whereas only 10 (9.6%) reported having no comorbidities. None of the 104 patients reported a mental health issue.

3.3. Adherence to secondary prevention measures (MOS-SAS)

Overall, 21% ($n = 22$) of the surveyed patients were adherent, with an average MOS-SAS score of 27.9 (SD = 5.37; range: 12−40). The scores for each MOS-SAS item are shown in Fig. 1. Adherence was the highest for reduced (or no) alcohol consumption, reflecting national restrictions and religious practices. The medication adherence rate was 97%, and the smoking reduction or cessation rate was 81%. Adherence to dietary modifications was moderate, with a 67% reduction in fat and a 63% reduction in salt. Patients monitored their symptoms at a compliance rate of 64%. Only 35% of patients adhered to physical exercise, as manifested by walking for 20 min on average at least three times per week. Very few patients (9%) complied with daily weight monitoring for fluid build-up.

None of the 19 females in this study were adherent. The mean MOS-SAS score did not differ from that of 85 males (27.8% vs. 27.9%). However, the MOS-SAS score of males ranged from 12 to 40 (SD 5.8), whereas the MOS-SAS score of females ranged from 20 to 31, which was just below the compliance threshold of 32 (with a reduced SD of 2.7). This association was statistically significant ($\chi^2 = 4.813$, $P = 0.028$).

Interactions among patient demographics, clinical characteristics, and overall MOS-SAS score and its individual items were investigated via univariate logistic regression. Table 2 presents the odds ratios (ORs) with 95% confidence intervals (CIs) for these results, as well as the significance of these results. An OR of <1 indicated that the demographic category resulted in lower adherence to the MOS-SAS item, whereas an OR of >1 indicated that the demographic category improved adherence.

Among the MOS-SAS items, physical exercise was the item most influenced by demographic variables. Males were 12 times more likely to adhere to physical exercise than females were, older patients performed less exercise (5% less per year of age), and married patients were six times more likely to comply than unpartnered patients were (single, divorced, or widowed). Patients with a university education were 2.5 times more likely to be adherent than those with a high school (or less) education. Patients with diabetes were 43% less likely to be adherent, and those with multiple comorbidities were 62% less likely to exercise. Patients who preferred a hospital-based CR program were 7.8 times more likely to adhere to exercise than those who preferred the hybrid program.

Smoking reduction was significant in patients with diabetes, who were 3.7 times more compliant,

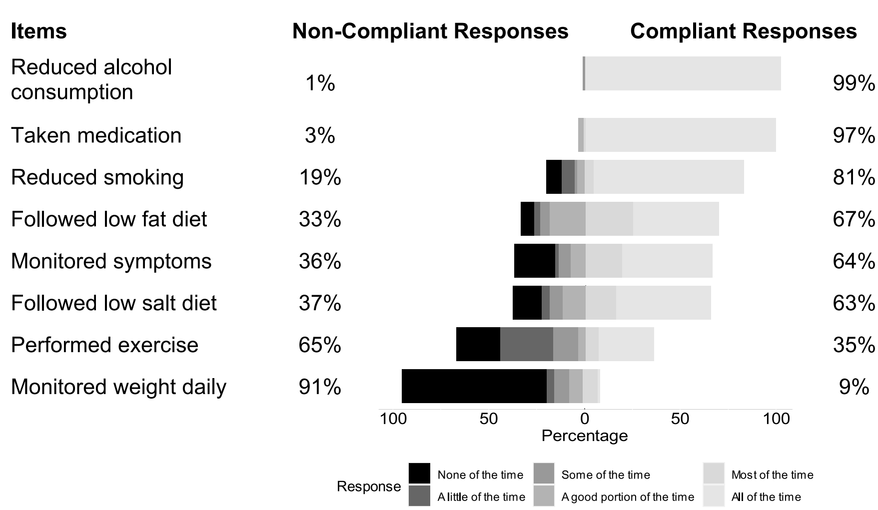

Fig. 1. Item results of the Medical Outcomes Specific Adherence Scale (MOS-SAS) (no legends needed).

Table 2. Univariate logistic regression of patient demographic variables against MOS-SAS compliance (yes/no) [OR (95% CI), P (Wald's test)] (n = 104).

Demographic Variables[a]	Physical exercise	Medication taken	Smoking reduction[b]	Low salt diet	Low fat diet	Monitored weight daily	Monitored symptoms[b]	Overall Compliance[c,d]
Sex (Male vr Female)	12.6 (1.61,98.8) 0.016	NA[e]	NA	0.76 (0.26,2.21) 0.62	0.69 (0.23,2.1) 0.514	1.87 (0.22,15.91) 0.567	0.79 (0.27,2.29) 0.663	NA
Age (per year)	0.95 (0.92,0.98) 0.003	1.04 (0.96,1.13) 0.335	1.04 (1,1.08) 0.046	1.005 (0.975,1.037) 0.729	1.03 (1,1.06) 0.069	0.96 (0.91,1.01) 0.128	1.008 (0.978,1.04) 0.597	0.96 (0.93,1) 0.039
Marital Status (Married vr Other)	6.12 (1.33,28.1) 0.02	NA	0.43 (0.09,2.04) 0.289	1.2 (0.44,3.26) 0.721	1.14 (0.41,3.17) 0.807	NA	0.79 (0.27,2.29) 0.663	5.51 (0.69,44.1) 0.108
Education (University vr High School or less)	2.59 (1.01,6.68) 0.049	0.56 (0.05,6.43) 0.639	1.19 (0.35,3.98) 0.781	1.1 (0.42,2.91) 0.843	0.89 (0.33,2.35) 0.809	3.2 (0.78,13.08) 0.105	1.37 (0.51,3.72) 0.535	1.78 (0.62,5.1) 0.283
Location (Urban and Capital vs Regional and Rural)	1.4 (0.61,3.21) 0.431	NA	0.91 (0.34,2.47) 0.86	0.36 (0.15,.85) 0.02	0.38 (0.16,0.93) 0.035	1.45 (0.34,6.17) 0.611	0.93 (0.41,2.1) 0.852	0.9 (0.35,2.33) 0.828
Obesity (Obese vr Normal/Overweight)	1.12 (0.46,2.76) 0.805	0.85 (0.07,9.74) 0.895	1.19 (0.38,3.7) 0.76	0.95 (0.39,2.33) 0.913	0.97 (0.39,2.43) 0.95	0.65 (0.13,3.31) 0.6	0.42 (0.17,1.04) 0.062	0.56 (0.17,1.86) 0.345
Smoking Status (Yes vr No)	1.96 (0.68,5.63) 0.209	0.46 (0.04,5.37) 0.535	NA	1.23 (0.42,3.65) 0.704	0.41 (0.14,1.16) 0.093	0.5 (0.06,4.27) 0.527	0.65 (0.22,1.9) 0.434	0.35 (0.07,1.69) 0.192
Family History (Yes vr No)	1.13 (0.49,2.56) 0.777	NA	0.88 (0.33,2.37) 0.807	1.36 (0.6,3.11) 0.465	0.91 (0.4,2.09) 0.823	1.78 (0.45,7.05) 0.414	0.69 (0.31,1.57) 0.383	0.93 (0.35,2.44) 0.883
High Cholesterol (Yes vr No)	0.71 (0.27,1.86) 0.486	NA	2.44 (0.83,7.16) 0.104	1.61 (0.62,4.18) 0.33	1.23 (0.46,3.3) 0.68	0.93 (0.18,4.85) 0.935	0.79 (0.29,2.17) 0.651	0.36 (0.12,1.02) 0.054
Diabetic (Yes vr No)	0.43 (0.19,0.98) 0.045	3.18 (0.28,36.25) 0.352	3.65 (1.31,1.17) 0.013	1.42 (0.63,3.19) 0.401	1.6 (0.7,3.68) 0.268	2.44 (0.48,12.36) 0.282	1.77 (0.78,4.02) 0.172	1.52 (0.56,4.16) 0.411
High Blood Pressure (Yes vr No)	0.46 (0.2,1.04) 0.063	3.05 (0.27,34.76) 0.369	2.05 (0.76,5.5) 0.154	2.22 (0.98,5.03) 0.055	2.16 (0.94,4.97) 0.071	0.31 (0.07,1.3) 0.108	1.17 (0.52,2.65) 0.703	0.64 (0.25,1.66) 0.356
Number of Conditions (Continuous 0–3)	0.62 (0.41,0.95) 0.027	1.39 (0.46,4.19) 0.564	1.95 (1.18,3.23) 0.009	1.45 (0.96,2.2) 0.075	1.42 (0.93,2.15) 0.104	0.89 (0.45,1.77) 0.744	1.16 (0.77,1.74) 0.49	0.8 (0.5,1.3) 0.375
Cardiac Rehabilitation Referral (Yes vr No)	3.89 (1.05,14.41) 0.042	0.12 (0.01,2.01) 0.139	0.52 (0.12,2.2) 0.373	0.46 (0.13,1.63) 0.231	0.88 (0.24,3.23) 0.841	0.99 (0.11,8.74) 0.991	0.99 (0.27,3.64) 0.984	0.79 (0.15,4.02) 0.774
Preferred Program Type (Hospital Based vr Home Based only	1.36 (0.43,4.35) 0.599	NA	0.82 (0.2,3.28) 0.775	1.32 (0.46,3.83) 0.607	1.19 (0.39,3.68) 0.757	1.52 (0.17,13.9) 0.712	0.59 (0.19,1.88) 0.374	0.81 (0.22,2.94) 0.752
(Hospital Based vr Hybrid (both)	7.8 (1.48,41.21) 0.016	NA	2.2 (0.2,24.07) 0.518	2.4 (0.48,11.93) 0.285	1 (0.2124,4.7091) 1	5.67 (0.51,62.66) 0.157	1.03 (0.19,5.51) 0.976	2.71 (0.53,13.85) 0.232

Legends:

[a] All-cell OR (95% CI), P (Wald's test).

[b] n=103, missing=1.

[c] Alcohol consumption item removed from the table because no events were included in the overall compliance result.

[d] n=99, missing=5 (mostly alcohol consumption item).

[e] Insufficient events to calculate parameters (NA).

as well as in older patients and those with an increased number of comorbidities, who were 1.95 times more compliant per comorbidity. Dietary adherence was influenced by the patient's location, with those in urban areas being less likely to adhere to lower-fat and lower-salt diets, with 36% and 38% lower compliance, respectively.

Univariate logistic regression of the overall MOSSAS score and sex could not be performed because there were no events in the female category, although the χ^2 association between these two variables was significant ($P = 0.028$). Overall adherence was influenced by age, with older patients being less adherent (4% per year).

3.4. Barriers to CR enrollment (CREO SCALE)

Only one in ten patients (n = 11, 10.6%) was referred by their cardiologists to a CR program, of whom only four were subsequently attended. Patients were asked which barriers significantly affected their CR attendance. The barriers and responses are shown in Fig. 2. Barriers are divided into issues related to health organizations and those that are particular to patients. Most survey patients thought that a lack of contact with the CR staff was a significant barrier (91%), followed by a lack of support from their doctor (88%) and not being informed about the program (78%). Almost none of the patients considered that their doctor deemed it unnecessary or that there were waiting periods to access the program.

Most patients (69%) considered the hospital-based CR program to be too distant to travel. Patients from rural and regional locations considered this a barrier at higher rates than patients from urban areas did (86–57%, $\chi^2 = 8.43$, $P = 0.004$). Several patients believed that they might not have had the time (29% agreed) or that their family might not support their attendance at the program (27% agreed). Less important was work conflict (19% agreed); the patient thought it was unnecessary (15% agreed), the patient lacked motivation (15% agreed), and the patient feared pain (12% agreed). Fewer than 10% of the patients agreed that the time the program was available, language difficulties, or dislike of group activities were barriers.

3.5. Preference for different models for CR

Patients demonstrated a preference for home-based CR programs ($n = 61$, 58.7%) over hospital-based ($n = 18$, 17.3%) or hybrid models ($n = 12$, 11.5%), with 13 patients (12.5%) reporting insufficient knowledge of these options. The participants from rural and regional areas preferred home-based programs more strongly (78.4%) than did those from urban areas did (59.3%); however, this difference did not reach statistical significance ($\chi^2 = 4.12$, $P = 0.249$).

4. Discussion

To the best of our knowledge, this is the first study conducted in Saudi Arabia to assess risk factors, evaluate adherence to secondary prevention measures, and identify barriers to CR enrollment in patients with CHD after revascularization. Nevertheless, a previous cross-sectional study surveyed the residents of Tabuk, a regional city in northern Saudi Arabia, with a focus on identifying the prevalence of CVD risk factors [27]. Other studies have focused primarily on the infrastructure of existing CR programs and explored the factors limiting their effectiveness, as outlined in recent reviews by Adam et al. (2023) [12] and Rashed et al. (2020) [13].

Our sample indicated a familial link to the incidence of CHD, with 41.3% ($n = 43$) of patients reporting a family history of CVDs. The mean age of the included patients was 59.5 years (M = 58.2, F = 65.6), and men were younger and wider in age than females were. Although premature incidence of CHD is defined as the onset of the disease before the age of 55 years in men and 65 years in women [28], a recent case–control study established that a self-reported family history of CVD was independently associated with the premature development of CHD (OR = 9.0; 95% CI = 4.7–17.3) [29]. While genetic factors are non-modifiable, a family history of CVD may also reflect shared family behaviors and environmental factors [30]. Therefore, addressing other lifestyle-related risk factors is crucial to mitigate future morbidity and mortality in patients with a pronounced family history of CHD [29]. These factors include smoking, obesity, high blood glucose levels, high blood pressure, and hyperlipidemia, which were found to be prevalent at alarming rates in this study.

Patients' adherence to secondary prevention measures after PCI and at one month after hospital discharge emphasizes the critical need for enrollment in CR programs. Among our study participants, the lowest adherence rates were observed in underrepresented groups, such as women, elderly individuals, those with comorbidities, unmarried persons, and those with lower educational levels. These demographics, along with patients residing far from CR facilities, have been associated with reduced participation in and adherence to CR programs in countries such as the United States and across Europe [31]. For example, according to a 2020

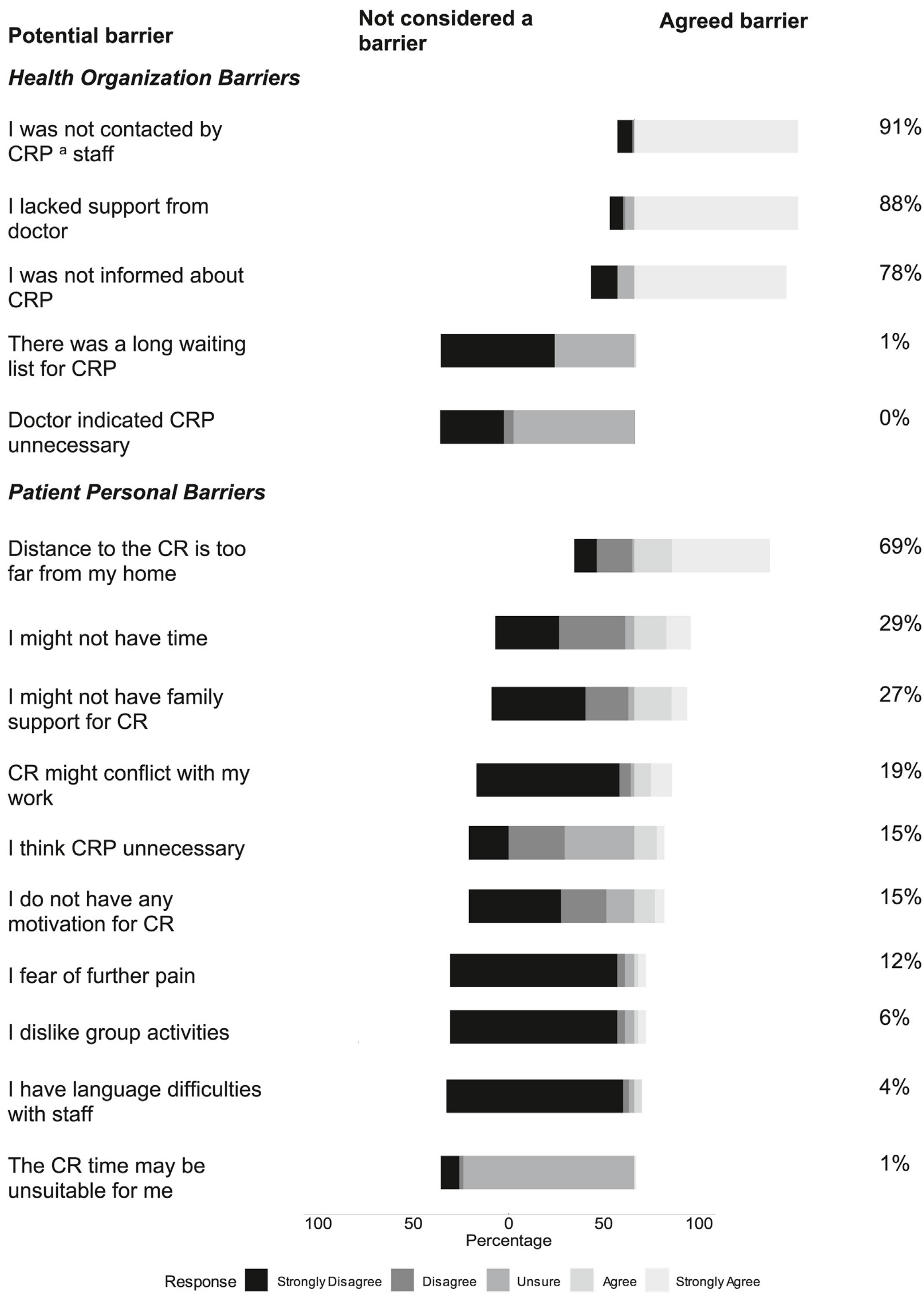

Fig. 2. Patient-identified barrier items for the cardiac rehabilitation program (n = 104). (Abbreviations: [a]CRP, Cardiac Rehabilitation Program).

national report, only 18.9% of women and 9.8% of elderly patients in the United States participated in CR programs [32].

Travel distance to hospital-based CR emerged as the principal personal barrier reported by our survey participants (69%), particularly by those residing in regional and rural areas, with no differences observed between males and females. Borg and colleagues (2019) [33], found that a commuting distance greater than 16 km significantly increased the likelihood of non-attendance among 31,297 coronary patients in Sweden. Similarly, patients in Iran who had to drive to service site for training sessions for longer than 30 min were less likely to participate [34].

Survey respondents from both genders equally identified critical organizational factors impeding their enrollment in CR, including inadequate contact from service providers, lack of physician support and insufficient information about the rehabilitation program. This corresponds with the identified low referral rate, where only 11 patients (10.6%) were recommended for CR. The issue of physicians failing to refer and encourage eligible patients to participate in CR programs is a global challenge. A recent cohort study in Portugal, found that 65% of heart failure patients did not attend CR, primarily due to the absence of a medical referral, reported by 31% of participants [35].

The availability of such programs is limited in KSA, with only a few cardiac centers offering CR services [12,13]. Davies et al. (2010) [36] suggested that referral rates could be increased through the broader distribution of CR programs across various administrative regions and the incorporation of automated referral systems. Additionally, the level of awareness of cardiologists and their perceptions of the benefits of CR play significant roles in their referral practices [37]. Research has shown that physician encouragement and computerized referrals increase patient enrollment and participation, including in underserved groups [38].

Implementing strategies to increase patient awareness of the benefits of CR [13] and improving accessibility through alternative delivery models, such as home-based CR, will also lead to increased engagement in secondary prevention [39,40]. In our study, the participants from rural and regional areas expressed a strong preference for such models, which can be attributed to proximity concerns. A three-arm RCT was recently published, marking the first study on the benefits of CR in Saudi Arabia and the broader Gulf Cooperation Council (GCC) region [17]. This study assessed the impact of home-based CR on outpatient-based CR (intervention groups) and usual care (control group) in patients with CHD following coronary artery bypass grafting. The findings indicate that home-based CR was as effective as outpatient CR and demonstrated superior capacity to maintain improvements after the intervention period.

4.1. Limitations

Our study had several limitations that warrant careful consideration. The use of a cross-sectional design limited our ability to recruit a broad patient base and restricted data collection to a brief time window. However, the survey conducted through computer-assisted telephone interviews enhanced our ability to recruit a larger number of patients. Another limitation affecting the generalizability of our findings is the singular cardiac center setting for the research, despite the presence of other additional centers in the country that provide similar rehabilitation services. Furthermore, the sample size of our study was relatively modest and predominantly male, complicating the extrapolation of our results to the broader population of patients with CHD in Saudi Arabia, for which current prevalence data are lacking. This limitation also restricted our ability to use statistical techniques that could control confounding demographic or clinical variables. Additionally, legal and cultural sensitivities regarding a MOS-SAS question regarding alcohol consumption, which reportedly has an adherence rate of nearly 100%, may have introduced a significant response bias, potentially skewing the perceived overall rate of adherence to secondary prevention measures.

5. Conclusion

This study revealed the prevalence of risk factors among Saudi patients with CHD at one month after PCI and after hospital discharge. These findings indicate low adherence to secondary prevention measures and a markedly low referral rate for CR programs. Additionally, the survey identified self-perceived barriers to enrollment in secondary prevention programs categorized into organizational and personal factors. The most frequently cited barriers were organizational barriers such as insufficient contact from CR staff, inadequate support from physicians, and a lack of information about the program. A significant proportion of patients reported personal barriers, notably long distances to CR facilities. To improve the CR referral rate in Saudi Arabia, discharge plans should be revised to identify eligible patients more effectively and implement automated referral systems. Furthermore, expanding the capacity of CR services to cover all regions of the country and utilizing alternative delivery models could increase accessibility and attendance rates. Future research within the country should explore barriers to CR enrollment at both the clinician and health system levels to fully understand the underlying causes of low referral, enrollment, and attendance rates in these programs.

Author's contribution

Conception and design of Study: AMA, JO, JD. Literature review: AMA, JO, JD. Acquisition of data: AMA, JO, JD. Analysis and interpretation of data: AMA, AD, JD. Research investigation and analysis: AMA, AD, JD. Data collection: AMA, JO, JD.

Drafting of manuscript: AMA, JO, JD. Revising and editing the manuscript critically for important intellectual contents: AMA, JO, AD, JD. Data preparation and presentation: AMA, JO, JD. Supervision of the research: JO, JD. Research coordination and management: JO, JD.

Ethical approval

The study was approved by the University Human Research Ethics Committee of the Queensland University of Technology (approval number: LR 2023-6924-14433). Patients' verbal consent was obtained at recruitment and at data collection time.

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Conflict of interest

None declared.

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