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Exploring the Relationships Between Health Literacy and Enrollment Barriers in Post-Acute Coronary Syndrome Cardiac Rehabilitation: A Prospective Study

Akut Koroner Sendrom Sonrası Kardiyak Rehabilitasyona Katılım Engelleri ve Sağlık Okuryazarlığı Arasındaki İlişkilerin Araştırılması: Prospektif Bir Çalışma

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This study was presented orally as a summary at the 30th National Physical Medicine and Rehabilitation Congress with International Participation in March 7-10, 2024, Antalya, Türkiye.

ABSTRACT Objective: This study aimed to investigate the predictive role of health literacy (HL) in cardiac rehabilitation (CR) enrollment following acute coronary syndrome (ACS) and to assess the relationship between HL and barriers to CR enrollment. **Material and Methods:** Between August 2022 and December 2023, 60 patients with ACS eligible for CR were enrolled pre-discharge from the coronary intensive care unit. Data on demographics, clinical profiles, physical performance, quality of life, and HL were collected using the Turkish Health Literacy Scale-32 (THLS-32). All patients received CR information and were scheduled to start the program. The Cardiac Rehabilitation Barriers Scale was used to assess barriers for non-attendees during follow-up. Logistic regression and correlation analyses examined associations between HL, demographics, and CR participation barriers. **Results:** Sixty-two percent of patients had THLS-32 scores below 33, indicating problematic or inadequate HL, particularly in disease prevention and health promotion. Only 18% of patients enrolled in CR had no significant predictors. Work/time conflicts and the perception of not needing CR were prominent barriers. Poor physical performance, older age, and lower HL were correlated with barriers related to comorbidity and low motivation, whereas higher THLS-32 scores were correlated with the perception of not needing CR. **Conclusion:** HL was associated with barriers to CR rather than directly predicting CR enrollment. These findings highlight the need for tailored interventions that address HL deficits to help overcome CR barriers on an individual level.

Keywords: Cardiac rehabilitation; acute coronary syndrome; health literacy; enrollment barriers

ÖZET Amaç: Bu çalışma, akut koroner sendromu (AKS) takiben kardiyak rehabilitasyona (KR) katılımda sağlık okuryazarlığının (SOY) öngörücü rolünü araştırmayı ve SOY ile KR'ye katılım engelleri arasındaki ilişkiyi değerlendirmeyi amaçladı. **Gereç ve Yöntemler:** Ağustos 2022-Aralık 2023 tarihleri arasında, KR'ye uygun 60 AKS hastası koroner yoğun bakım ünitesinden taburcu edilmeden önce değerlendirildi. Hastaların demografik ve klinik özellikleri kaydedildi, fiziksel performans ve yaşam kalitesi değerlendirildi. SOY düzeyi Türkiye Sağlık Okuryazarlığı Ölçeği-32 (TSOY-32) ile ölçüldü. Tüm hastalara KR hakkında bilgi verildi ve programa başlama randevusu planlandı. KR'ye katılmayanlara ulaşılıp Kardiyak Rehabilitasyon Engelleri Skalası (KRES) uygulandı. Lojistik regresyon ve korelasyon analizleriyle, SOY, demografik ve klinik özellikler ve KR katılım engelleri arasındaki ilişkiler incelendi. **Bulgular:** Hastaların %62'sinin THLS-32 skorları 33'ün altında olup, özellikle hastalıkların önlenmesi ve sağlığın teşviki alanlarında problemli veya yetersiz SOY'u gösterdi. Hastaların yalnızca %18'i KR'ye katıldı ve katılım açısından anlamlı bir öngörücü belirlenemedi. İş/zaman çatışmaları ve KR'ye ihtiyaç duyulmama algısı, belirgin engeller arasında yer aldı. Zayıf fiziksel performans, ileri yaş ve düşük SOY düzeyi, komorbidite ve düşük motivasyonla ilişkili engellerle korele bulunurken; daha yüksek THLS-32 skorları, KR'ye ihtiyaç duymama algısı ile ilişkili bulundu. **Sonuç:** SOY düzeyi KR'ye katılımı doğrudan öngörmese de KR'ye katılım engelleriyle ilişkiliydi. Bu bulgular, KR'ye katılım engellerine bireysel zeminde çözüm üretmek için SOY düzeyini dikkate almamız gerektiğini vurgulamaktadır.

Anahtar Kelimeler: Kardiyak rehabilitasyon; akut koroner sendrom; sağlık okuryazarlığı; katılım engelleri

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Cardiac rehabilitation (CR) interventions following acute coronary syndrome (ACS) have proven instrumental in diminishing mortality rates and readmissions stemming from recurrent cardiac events, while simultaneously enhancing functional capacity and quality of life.[1] Despite its benefits, referral and access rates to CR remain below expectations.[2] Factors attributed to patients, health professionals, and healthcare systems have been implicated in the underutilization of CR services.[3] Sociodemographic barriers, including advanced age, female sex, and low socioeconomic status, have been identified as independent predictors of CR participation.[4,5] While inadequate referral continues to pose a significant barrier, insufficient patient engagement in secondary prevention following cardiac events represents another facet of the issue.[6,7]

In recent years, there has been a surge in interest regarding the effects of health literacy (HL) on various outcomes, including but not limited to treatment adherence, recurrent events, mortality, and readmission after cardiovascular incidents.[8] HL refers to the personal characteristics and social resources enabling individuals to access, comprehend, and effectively utilize health information and services to make informed health decisions.[9] Given the multidimensional nature of HL, covering aspects like accessing, comprehending, appraising, and applying knowledge, individuals may exhibit diverse HL characteristics.[10] Challenges in HL are associated with diminished self-efficacy, decreased quality of life, and impaired functional ability in individuals diagnosed with coronary artery disease.[11,12] Furthermore, patients with cognitive impairments are particularly susceptible to experiencing deficits in HL, further worsening their health-related vulnerabilities.[13] Efforts to improve HL for the secondary prevention of coronary artery diseases include interventions targeting HL in health professionals and patients.[14] Educational interventions in CR programs have been demonstrated to enhance disease-related knowledge and HL.[15] Conversely, HL challenges may act as barriers to adhering to CR programs and maintaining exercise routines post-CR program completion.[16,17] A limited number of studies conducted across various countries have yielded conflicting results regarding the influence of HL on the decision to enroll or participate in CR.[18,19] However, the influence of HL dimensions on CR enrollment rates and barriers has yet to be thoroughly investigated in the post-ACS period. Hence, this study investigated two primary inquiries:

1. Does HL independently predict post-ACS CR participation?

2. Is there any relationship between HL and actual patient-reported CR barriers?

MATERIAL AND METHODS

PARTICIPANTS

This study was conducted between August 2022 and December 2023. Patients hospitalized in the intensive care unit (ICU) with a diagnosis of ACS that could walk without physical assistance were considered candidates. The exclusion criteria were as follows (1) residual unstable angina; (2) hemodynamic instability; (3) other cardiac conditions, such as complex arrhythmias, moderate or severe valvular dysfunction heart failure, and congenital heart diseases; (4) neuropsychiatric conditions preventing the evaluation; and (5) contraindication for exercise-based CR. After the clinical stabilization of patients, research cardiologists (OBŞ and ST) evaluated the patients according to the inclusion and exclusion criteria. After obtaining informed consent, patients were assessed for demographics, clinical data, and outcome measures by the rehabilitation team (LK, AUK and İO) in the ICU visits. Subsequently, they were informed by a brochure and verbally about the scope, main components, and benefits of the CR program. They then answered their questions during the face-to-face interview.[20] All participants met the same rehabilitation team to minimize potential differences due to variations in information and referral procedures.

Each participant was scheduled to start phase 2 CR covered by national health insurance one month later. The 20-session rehabilitation program included personalized exercise training, heart-healthy lifestyle counseling encompassing physical activity, nutritional guidance, lifestyle education, and psychosocial support. To allow for scheduling flexibility, participants were provided with contact details for the CR

unit, enabling them to reschedule appointments if needed. Following the 2-month follow-up, individuals who missed their appointments were contacted via telephone. They were asked whether they had attended a CR or exercise program at any facility. Patients who did not enroll in any CR program, whether within or outside our healthcare facility, were questioned about the actual barriers to CR enrolment.[21]

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Gazi University Clinical Research Ethics Committee (approval number: 2022-406 (date: May 30, 2022). The Clinical Trials Database registry number is NCT05551429.

OUTCOME MEASURES

Participants' demographic and clinical data were collected during the same session as the informational visit to the ICU, along with measurements of physical performance, quality of life, and HL level. Barriers to CR enrollment were assessed using the Turkish version of the Cardiac Rehabilitation Barriers Scale (CRBS).

Physical Performance Measurements: Physical performance evaluations included muscle strength, mobility, and endurance measurements in the ICU. Muscle strength was assessed using the dominant hand's hand grip strength (HGS), which was measured using a calibrated Jamar Hand Dynamometer according to the standard method recommended by the American Society of Hand Therapists.[22] Results were compared with age- and sex-specific normative values.[23] Participants' mobilization capacity was assessed using the timed up-and-go test, measuring the time taken to complete the task.[24] The 2-min Step Test was used to assess endurance by instructing participants to march in place for 2 min while recording the number of times their right knee reached a marked height midway between the patella and iliac crest.[25]

World Health Organization Quality of Life-Bref (WHOQOL-BREF): The participants' quality of life was assessed using the Turkish version of the WHOQOL-BREF questionnaire, which was validated by Eser et al. in 1999. The instrument covered domains such as physical health (seven items), psychological well-being (six items), social relationships (three items), and environmental factors (eight items).[26] Respondents were required to rate their satisfaction with various aspects of their lives using a response scale ranging from one to five for each item. Subsequently, scores obtained from the responses were linearly transformed into a 0-100 scale for each dimension.[27]

Turkish Health Literacy Scale-32 (THLS-32): The THLS-32 is a scale developed by a working group established under the leadership of the Turkish Ministry of Health. This 32-item scale was chosen for its alignment with the conceptual framework of the HLS-EU consortium and its adaptation to the cultural characteristics of the Turkish people.[10] The internal consistency of the THLS-32 was demonstrated with a Cronbach's alpha value of 0.927.[28] The scale's inclusive approach encompasses two core domains: health care (HC) and disease prevention and health promotion (DP/HP). HL is evaluated across multidimensional information processing stages, including accessing, understanding, appraising, and applying health-related information for each core domain (Appendix 1). Participants provided responses to items using a response scale ranging from 4 (very easy) to 1 (very difficult). The scores derived from the participants' responses were subjected to linear transformation using the formula "Index=(mean score-1) x (50/3)", resulting in a 0-50 scale. The scoring is categorized as follows: 0-25 points indicating inadequate, >25-33 points denoting problematic-limited, >33-42 points reflecting adequate; and >42-50 points indicating perfect HL.[28]

CRBS: The CRBS aims to evaluate patients' perceptions regarding obstacles at the patient, provider, and health-system levels that impede enrollment and adherence to phase 2 CR. Comprising 21 items, each rated on a five-point Likert scale, the scale also included an open-ended item to capture additional barriers. It has been translated into various languages, with most versions incorporating certain subscales. In our study, CRBS was analyzed across five domains: comorbidities/poor motivation, perception of not needing CR, inadequate information/referral, logistical factors, and work/time conflicts (Appendix 2).[21,29] The score for each domain was determined on a scale from 0 to 5 by averaging

APPENDIX 1: English translation of the THLS-32 scale.

How difficult is it for you to do the following? Please select the most appropriate option for each task.

Item	Task Description	Very Easy	Easy	Difficult	Very Difficult	No Idea
1	When you have a health concern, researching and determining if it is a symptom of a disease.	[ ]	[ ]	[ ]	[ ]	[ ]
2	When you have a health concern, reading and understanding any related material (such as brochures, booklets, posters).	[ ]	[ ]	[ ]	[ ]	[ ]
3	When you have a health concern, evaluating whether advice from your family or friends is reliable.	[ ]	[ ]	[ ]	[ ]	[ ]
4	When you want to visit a healthcare facility, researching and finding out which doctor to consult.	[ ]	[ ]	[ ]	[ ]	[ ]
5	When you want to visit a healthcare facility, researching and figuring out how to make an appointment.	[ ]	[ ]	[ ]	[ ]	[ ]
6	When you want to visit a healthcare facility, making an appointment by phone or internet.	[ ]	[ ]	[ ]	[ ]	[ ]
7	Researching and finding information about the treatments for diseases that concern you.	[ ]	[ ]	[ ]	[ ]	[ ]
8	Understanding your doctor's explanations about your illness.	[ ]	[ ]	[ ]	[ ]	[ ]
9	Evaluating the advantages and disadvantages of the different treatment options your doctor recommends.	[ ]	[ ]	[ ]	[ ]	[ ]
10	Using your medications as recommended by healthcare professionals (such as doctors, pharmacists).	[ ]	[ ]	[ ]	[ ]	[ ]
11	Understanding the instructions on the medication box on how to use the medication.	[ ]	[ ]	[ ]	[ ]	[ ]
12	Deciding whether you need a second opinion from another doctor.	[ ]	[ ]	[ ]	[ ]	[ ]
13	Understanding the information related to pre-test/pre-examination preparations (such as following a diet).	[ ]	[ ]	[ ]	[ ]	[ ]
14	Finding the location of the department (such as laboratory, polyclinic) you want to reach in the hospital.	[ ]	[ ]	[ ]	[ ]	[ ]
15	Deciding what to do in an emergency (such as an accident, sudden health problem).	[ ]	[ ]	[ ]	[ ]	[ ]
16	Calling an ambulance when necessary.	[ ]	[ ]	[ ]	[ ]	[ ]
17	Having regular health follow-ups and check-ups as recommended by your doctor.	[ ]	[ ]	[ ]	[ ]	[ ]
18	Researching and finding information about conditions that can be harmful to your health (such as being overweight, high blood pressure).	[ ]	[ ]	[ ]	[ ]	[ ]
19	Understanding health warnings related to conditions that can be harmful to your health (such as being overweight, high blood pressure).	[ ]	[ ]	[ ]	[ ]	[ ]
20	Researching and finding information on how to cope with unhealthy behaviours (such as smoking, lack of physical activity).	[ ]	[ ]	[ ]	[ ]	[ ]
21	Understanding health warnings related to unhealthy behaviours (such as smoking, lack of physical activity).	[ ]	[ ]	[ ]	[ ]	[ ]
22	Researching and finding information about the health screenings you need to have based on your age, gender, and health status (such as screenings for breast cancer in women and prostate cancer in men).	[ ]	[ ]	[ ]	[ ]	[ ]
23	Understanding the information suggested by sources such as the internet, newspapers, television, and radio to be healthier.	[ ]	[ ]	[ ]	[ ]	[ ]
24	Deciding whether the information suggested by sources such as the internet, newspapers, television, and radio to be healthier is reliable.	[ ]	[ ]	[ ]	[ ]	[ ]
25	Understanding the information on food packaging that you think may affect your health.	[ ]	[ ]	[ ]	[ ]	[ ]
26	Evaluating the positive and negative features of your living environment (such as house, street, neighbourhood) that affect health.	[ ]	[ ]	[ ]	[ ]	[ ]
27	Finding information on what can be done to make your living environment (such as house, street, neighbourhood) healthier.	[ ]	[ ]	[ ]	[ ]	[ ]
28	Evaluating which of your daily behaviours (such as exercising, eating healthy, not smoking) affect your health.	[ ]	[ ]	[ ]	[ ]	[ ]
29	Changing your lifestyle (such as exercising, eating healthy, not smoking) for your health.	[ ]	[ ]	[ ]	[ ]	[ ]
30	Following the diet plan given in writing by a dietitian.	[ ]	[ ]	[ ]	[ ]	[ ]
31	Giving advice to your family or friends on how to be healthier.	[ ]	[ ]	[ ]	[ ]	[ ]
32	Interpreting changes in health-related policies.	[ ]	[ ]	[ ]	[ ]	[ ]

	Healthcare Domain	Disease Prevention and Health Promotion Domain
Accessing Information	1, 4, 5, 7	18, 20, 22, 27
Understanding Information	2, 8, 11, 13	19, 21, 23, 25
Appraising Information	3, 9, 12, 15	24, 26, 28, 32
Applying Information	6, 10, 14, 16	17, 29, 30, 31

Components of THLS-32 in a 2X4 Matrix and Corresponding Items

APPENDIX 2: Subgrouping the Cardiac Rehabilitation Barriers Scale (In the original questionnaire, it's important to note that grouping was not included, and the questions were presented in a mixed order.)

I was not enrolled in the cardiac rehabilitation program because:

1. Comorbidities/Poor Motivation
- . . .I don't have the energy
- . . .I find exercise tiring or painful
- . . .other health problems prevent me from going
- . . .I am too old

2. Decreased Perceived Need for CR
- . . .I don't need CR
- . . .I can manage on my own
- . . .many people with heart problems don't go to CR and they are fine
- . . .I prefer to take care of my health alone
- . . .I already exercise at home or in my community

3. Inadequate Information/Referral
- . . .my doctor didn't feel it was necessary
- . . .I didn't know about CR
- . . .I think I was referred but the rehab program didn't contact me
- . . .it took too long to get referred and into the program

4. Logistical factors
- . . .of cost
- . . .of transportation problems
- . . .of distance
- . . .of family responsibilities
- . . .severe weather

5. Work/Time Conflicts
- . . .of work responsibilities
- . . .of time constraints
- . . .travel

the scores of its respective items. Elevated scores indicated a greater degree of obstacles to CR enrollment and adherence.

SAMPLE SIZE CALCULATION

Unfortunately, no literature information addressing the relationship between the THLS-32 score and CR participation has been obtained. However, approximately 60% of patients with ACS in Türkiye were found to have THLS 32 scores below 33, indicating inadequate or problematic HL.[30] Walters et al. reported approximately a 40% difference (89% vs. 50%) in awareness of CR referral between patients with low and high levels of HL.[31] Based on these data, the study was designed to include a minimum of 55 patients, aiming for a statistical power of 0.80 and a significance level (alpha) of 0.05.

STATISTICAL ANALYSIS

SPSS Statistics (IBM Corp. Released 2019. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp) was used for statistical analysis. Nominal data, such as enrollment rates, are reported as percentages. The normal distribution of continuous variables was assessed using the Shapiro-Wilk test and histograms. Student's t-test and Mann–Whitney U test were used for pairwise comparisons. Univariate binary logistic regression analysis was used to assess the predictive impact of demographic and clinical data, physical performance, and THLS-32 scores on CR enrollment. For patients not participating in CR, the relationships between the CRBS score and explanatory variables, including the THLS-32 score, were examined using Pearson's correlation and multivariate stepwise linear regression methods. The results are presented with a 95% confidence interval. Statistical significance was defined as a p-value 0.05.

RESULTS

The study included 60 patients with ACS (Figure 1). Sixty-two percent of the patients had a total THLS-32 score 33, indicating problematic or inadequate HL.

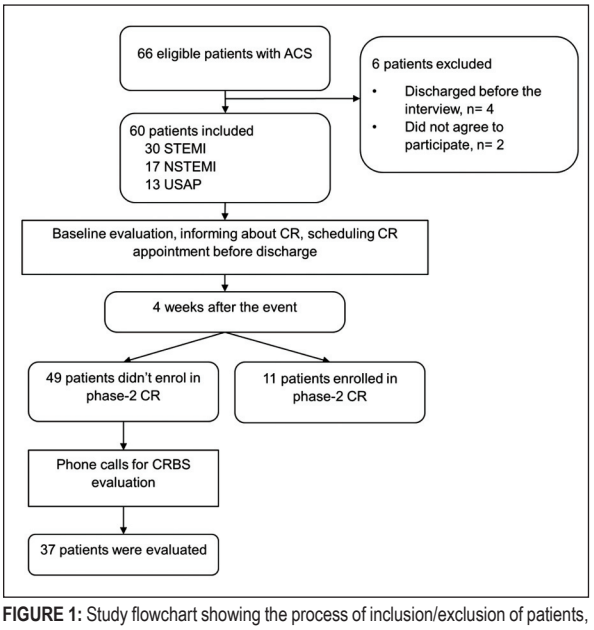

FIGURE 1: Study flowchart showing the process of inclusion/exclusion of patients, follow-up and number of patients included analysis.
ACS: Acute coronary syndrome; CR: Cardiac rehabilitation; CRBS: Cardiac Rehabilitation Barriers Scale; NSTEMI: Non-ST-elevation myocardial infarction; STEMI. ST-elevation myocardial infarction; USAP: Unstable angina pectoris.

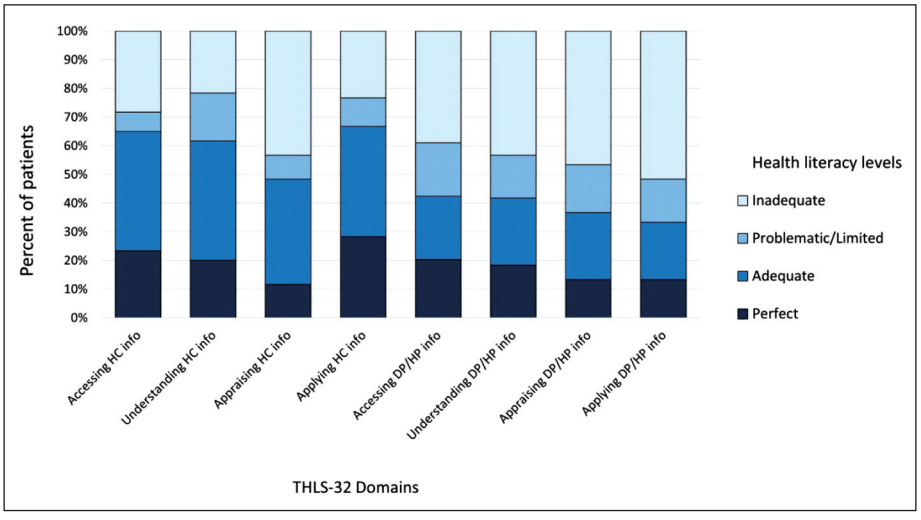

FIGURE 2: The bar chart depicting the cumulative percentages of patients' health literacy levels across the THLS-32 domain. DP/HP: Disease prevention/health promotion; HC: Health care; THLS-32: Turkish Health Literacy Scale-32.

Notably, the mean score of DP/HP-related domains was lower [mean±SD: 27.8±11.9 vs 32.6±10.8; t(59)=4.54, p<0.001] than that of HC (Figure 2). Females had lower scores than males in total the THLS-32 (16.4 vs 31.3; z=2.97, p=0.001), as well as in both the HC domain (17.7 vs 34.4; z=2.44, p=0.012) and the DP/HP domain (14.1 vs 29.2; z=3.09, p<0.001). The THLS-32 score showed a positive correlation with both the WHOQOL-BREF score (r=0.356; 95% CI: 0.112 to 0.559; p=0.005) and education level (r=0.372; 95% CI: 0.130 to 0.572; p=0.003), but was negatively correlated with age (r=-0.320; 95% CI: -0.531 to -0.072; p=0.013). In the multivariate regression analysis, the THLS-32 score was the sole significant predictor of the total WHOQOL-BREF score (β=0.362; 95% CI: 0.022 to 0.695; p=0.037).

Eleven patients (18%) were enrolled in the CR program (Figure 1). The demographic and clinical characteristics did not differ regarding enrollment status (Table 1). Neither physical performance parameters nor WHOQOL-BREF or THLS-32 scores predicted enrollment in CR (Table 2).

Among those who did not enroll in CR, 37 patients were contacted by telephone and subsequently completed the CRBS. The CRBS results are presented in Figure 3. The highest-scoring CRBS domains were work/time conflicts (2.96±0.8) and the perception of not needing CR (2.84±0.8), followed

TABLE 1: Patient demographics.

Characteristics	Enrolled in CR n=11	Not enrolled in CR n=49	p value[a]
Sex, n (%)			
Female	1 (9)	5 (10)	0.911
Male	10 (91)	44 (90)	
Age, X̄±SD	57±8.2	54.8±11.7	0.545
Employment status, n (%)			
Active	6 (54.5)	24 (49)	0.739
Inactive	5 (45.5)	25 (51)	
Residence, n (%)			
Within the province	11 (100)	39 (80)	0.999
Out of province	0 (0)	10 (20)	
Education level, n (%)			
Primary school or below	2 (18.2)	15 (30.6)	
Secondary school	1 (9.1)	7 (14.3)	0.314
High school	4 (36.4)	14 (28.6)	
College or higher	4 (36.4)	13 (26.5)	
Primary diagnosis, n (%)			
STEMI	5 (46)	25 (51)	0.881
NSTEMI	3 (27)	14 (29)	0.932
Unstable angina pectoris	3 (27)	10 (20)	0.630
Days from cardiac event to evaluation, X̄±SD	2.45±0.82	2.33±0.75	0.610
Number of previous cardiac event, X̄±SD	1.36±1.4	0.63±0.6	0.091
Number of comorbidity, X̄±SD	1.27±1.1	1.6±1.3	0.417
Body mass index (kg/m^2), X̄±SD	26.4±3.1	29±5.1	0.109
Smoking status, n (%)			
Smoker	5 (46)	31 (63)	0.541
Never smoked	2 (18)	7 (14)	0.541
Ex-smoker	4 (36)	11 (23)	0.481
Cumulative smoking volume (pack-year), X̄±SD	27.3±10.1	33.9±22.7	0.394

[a]Binary logistic regression; CR: Cardiac rehabilitation; NSTEMI: Non-ST-elevation myocardial infarction; STEMI: ST-elevation myocardial infarction; SD: Standard deviation.

TABLE 2: Physical performance, quality of life and health literacy results.

Characteristics	Enrolled in CR n=11	Not enrolled in CR n=49	p value[a]
HGS (kg), $\bar{X}$±SD	37.9±6	38.9±10	0.752
Number of patients with low[b] HGS, n (%)	1 (9.1)	4 (8.2)	1.000
Timed up-and-go (second), $\bar{X}$±SD	8±1.9	9.3±3.5	0.268
Two-minute Step Test, $\bar{X}$±SD	68.5±17.7	61.4±19.6	0.269
WHO Quality of Life-Bref, $\bar{X}$±SD			
General health	56.8±23.3	53.1±20.3	0.585
Physical health	70.5±15.1	64.5±14.3	0.221
Psychological health	65.15±22.8	67.4±15.1	0.678
Social relationships	62.9±13.6	65.9±19.9	0.619
Environment	67.6±15.7	64.8±15.6	0.584
THLS-32 Health Care Domain, $\bar{X}$±SD			
Accessing information	30.3±12.5	33.2±13.5	0.505
Understanding information	31.4±10.1	34.5±10.2	0.364
Appraising information	25.4±11.9	30.3±11.2	0.203
Applying information	32.9±10.6	34.4±13.6	0.731
Overall	30±9.6	33.1±11	0.389
THLS-32 Disease Prevention and Health Promotion Domain, $\bar{X}$SD			
Accessing information	31.1±12.8	27.3±14.8	0.435
Understanding information	32.9±10.3	29.5±12.2	0.383
Appraising information	27.7±17.3	26.1±13.8	0.746
Applying information	29.9±13.9	25.8±12.2	0.330
Overall	30.4±12.6	27.2±11.7	0.416

[a]Binary logistic regression; [b]Below the lower limit of age and sex-specific values; CR: Cardiac rehabilitation; HGS: Hand grip strength; THLS-3: Turkish Health Literacy Scale-32; WHO: World Health Organization.

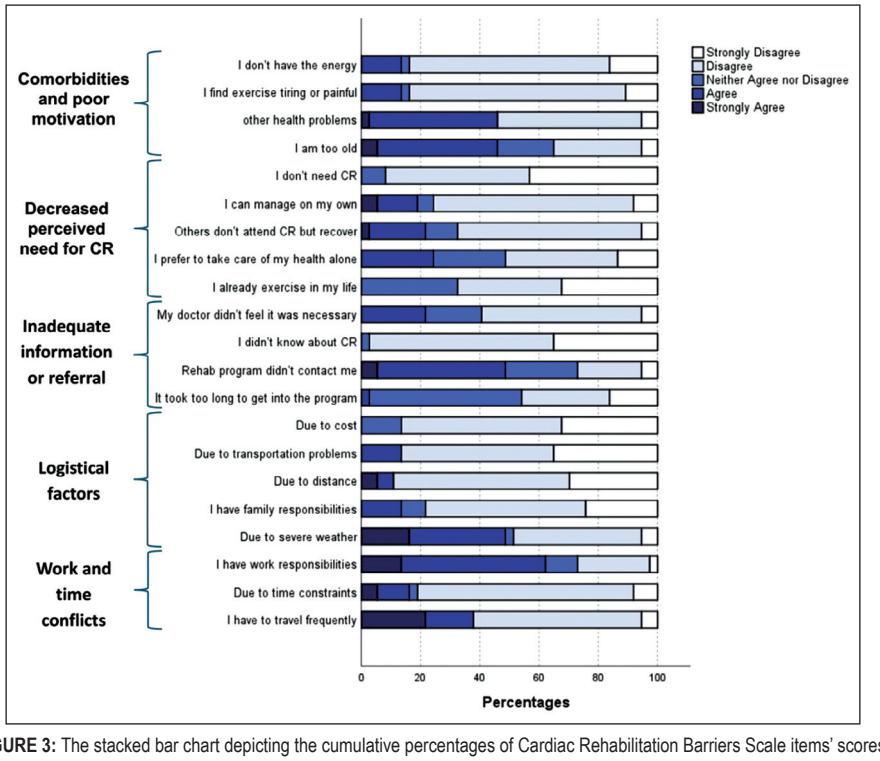

FIGURE 3: The stacked bar chart depicting the cumulative percentages of Cardiac Rehabilitation Barriers Scale items' scores. CR: Cardiac rehabilitation.

by logistic factors (2.52±0.6), comorbidities/poor motivation (2.03±0.8), and inadequate information/referral (1.77±0.5). Patients who were employed prior to the cardiac event scored higher on CRBS-work/time conflicts (3.33±0.76 vs. 2.65±0.73; p=0.009) and CRBS-perception of not needing CR (3.11±0.62 vs. 2.61±0.80; p=0.009) compared with unemployed patients.

The correlations between CRBS scores and clinical, demographic, and HL parameters are summarized in Table 3. CRBS-comorbidity and low motivation scores showed a positive correlation with age and timed up and go, but a negative correlation with handgrip strength and 2-minute step count. CRBS-work/time conflict was positively correlated with handgrip strength and 2-minute step count, while the perception of not needing CR was positively correlated with the WHOQOL-BREF physical health score. CRBS-inadequate information/referral score was associated with specific domains of the THLS-32, including understanding HC information, as well as appraising and applying information on DP/HP. Similarly, CRBS-work/time conflicts were positively correlated with the appraisal and applying information regarding DP/HP. Moreover, CRBS-perception of not needing CR was positively correlated with accessing, understanding, and applying HC information. Conversely, CRBS-comorbidity and low motivation scores were negatively correlated with accessing and applying HC information and understanding information related to DP/HP.

The multivariate regression results are presented in Table 4. Being actively employed before the cardiac event and having higher levels of HL in ap-

TABLE 3: The results of correlation analysis between cardiac rehabilitation barriers and the other parameters.

	Cardiac rehabilitation barriers			
	Comorbidities and poor motivation	Perception of not needing CR	Inadequate information and referral	Work and time conflicts
Age	0.426[b] (0.119, 0.659)			
Handgrip strength	-0.337[a](-0.596, -0.014)			0.439[b](0.134, 0.668)
Timed up-and-go	0.331[a](0.008, 0.591)			
2-minute step count	-0.379[a](-0.626, -0.063)			0.451[b](0.144, 0.676)
WHOQOL-BREF physical health score		0.411[a](0.09, 0.654)		
HL-healthcare				
Accessing the info	-0.325[a](-0.587, -0.001)	0.335[a](0.012, 0.595)		
Understanding the info		0.429[b](0.122, 0.661)	0.428[b](0.121, 0.660)	
Applying the info	-0.339[a](-0.598, -0.017)	0.504[b](0.215, 0.712)		
HL-disease prevention and health promotion				
Understanding the info	-0.360[a](-0.613, -0.041)			
Appraising the info			0.368[a](0.050, 0.618)	0.418[b](0.109, 0.654)
Applying the info			0.363[a](0.045, 0.615)	0.333[a](0.010, 0.593

[a]Pearson correlation analysis p<0.05; [b]Pearson correlation analysis p<0.01; Results are presented as correlation coefficient and (95% CI); CR: Cardiac rehabilitation; HL: Health literacy; WHOQOL-BREF: World Health Organization Quality of Life-Bref.

TABLE 4: The results of multivariate linear regression analysis examining cardiac rehabilitation barriers.

Dependent variable	Predictor variable	Beta (β)	95% CI	p value
CRBS-work and time conflicts	Being actively employed	0.392	0.105, 0.679	0.009
	Appraising DP/HP information	0.384	0.096, 0.656	0.010
CRBS-comorbidities and poor motivation	Age	0.426	0.110, 0.742	0.008
CRBS-inadequate information and referral	Understanding HC information	0.428	0.107, 0.731	0.008
CRBS-perception of not needing CR	Applying HC information	0.504	0.216, 0.810	0.001

CR: Cardiac rehabilitation; CRBS: Cardiac Rehabilitation Barriers Scale; DP/HP: Disease prevention and health promotion; HC: Health care.

praising DP/HP information independently predicted the CRBS-work/time conflicts score. Age was a positive predictor of CRBS comorbidity and low motivation score. Understanding HC information was the sole significant predictor of the CRBS-inadequate information/referral score. Furthermore, higher levels of HL when applying HC information predicted a higher score in the CRBS perception of not needing CR.

DISCUSSION

In our study, we observed a low enrollment rate (18%) in post-ACS phase-2 CR, despite pre-discharge information and appointment scheduling. The THLS-32 results indicated a moderate level of HL across all domains, particularly lower in DP/HP. HL emerged as a significant predictor of quality of life. Although no factor emerged as a significant predictor of CR enrollment, we observed certain explanatory effects of age, physical performance, and HL on CR barriers.

CR enrollment rate remained lower in our sample than the reported range of approximately 20%-70% in the recent reviews.[32] Contrary to the prevailing literature, age and sex were not associated with enrollment.[33] This inconsistency may partly stem from our study's smaller and more homogeneous sample of relatively younger male patients with ACS. These individuals may have perceived primary ACS treatment as adequate or encountered work commitments hindering their CR participation. Alternatively, their optimistic but erroneous perception of health may have influenced their decision-making. Notably, a significant portion of our sample demonstrated THLS-32 scores indicating inadequate or problematic HL, with lower scores in the DP/HP domains compared with HC.[19] These results are consistent with those of previous studies showing insufficient HL levels among patients with CR.[34]

The existing literature on HL's impact on CR participation and adherence yields conflicting results.[31] Aaby et al. reported outcomes similar to ours, suggesting no discernible effects of sociodemographic characteristics and HL on CR participation in Denmark.[19] Conversely, Beauchamp et al. noted a contradictory trend among CR participants in Australia, wherein individuals with higher healthcare system navigation confidence were more likely to discontinue CR programs.[18] These conflicting findings suggest that the relationships between HL, sociodemographic characteristics, and CR enrollment may vary depending on contextual factors and cultural differences.

Patients' negative perceptions, such as the belief that exercise induces fatigue, significantly impact their adherence to exercise regimens.[35] Our study revealed that poor physical performance during the early post-ACS period and advanced age were associated with CR barriers attributed to comorbidities and low motivation. Specifically, advanced age predicted enrollment barriers due to comorbidities and low motivation, which are linked to difficulties in accessing, understanding, and applying health information. These findings underscore the importance of enhancing HL to increase CR participation, particularly among elderly ACS patients with comorbidities and low motivation.[5] Conversely, obstacles related to work and time conflicts for CR were more common among employed individuals, who also demonstrated higher levels of muscle strength and endurance, suggesting greater physical activity levels in their jobs before the cardiac event. Alternative methods, such as telerehabilitation, may be advantageous for addressing this challenge.[36]

The most prevalent obstacles to CR enrollment in our study were work and time conflicts, along with the perception of not needing CR. A previous study in Türkiye investigated CR barriers within a heterogeneous patient group in a cardiology outpatient clinic and reported that the perception of not needing CR was the third most prevalent barrier.[37] Our study identified "inadequate information and referral" as the obstacle with the least impact, likely due to the face-to-face information provision and appointment scheduling conducted before ICU discharge. Despite the emphasis on CR during ICU interviews, inadequate information and referral as barriers to CR enrollment were associated with higher scores in understanding healthcare information on the THLS-32. Although rated the lowest among the identified barriers, this outcome suggests that some patients

may have deemed ICU interviews insufficient. Customized incentive methods tailored to individual patient needs may enhance CR participation.[38]

Another barrier, the perception of not needing CR, did not correlate with better physical performance but was linked to heightened self-reported physical health quality and self-confidence in applying health information. These findings initially appear to challenge the existing literature, which commonly reports enhanced compliance with healthy lifestyle choices and treatment adherence among cardiac patients with elevated HL levels.[7,39] A plausible explanation for this unexpected observation may stem from the method used to measure HL in our study. Given the subjective nature of the THLS-32 scale, patients may have rated their HL skills higher than the actual level, a phenomenon known as the Dunning-Kruger effect.[40] Individuals who overestimate their physical health may have refrained from enrolling in cardiac rehabilitation programs. This finding aligns with previous research, which identified irrational health beliefs, elevated self-efficacy, a perceived lack of treatment control, and a perceived lack of necessity for CR as factors associated with non-participation and dropout from CR programs.[14] Furthermore, Lu et al. reported decreased medication adherence among patients with greater knowledge of heart disease.[39] This cognitive bias underscores that individuals with lower HL tend to exhibit poorer health behaviors but are more confident in understanding health information than those with higher HL levels. The complex relationships between enrollment barriers and HL outcomes reflect patients' ambivalent attitudes toward exercise-based rehabilitation programs in post-ACS disease management.[41]

This study has some limitations that deserve acknowledgment. Owing to our relatively small sample size and low enrollment rate in the CR program among the included patients, factors associated with enrollment may not have been precisely determined. Specifically, dropouts from the CRBS assessment may compromise the statistical robustness of the findings. Furthermore, the lack of data on the physical activity level of patients before and after ACS prevented us from addressing physical activity as a potential factor influencing CR enrollment and barriers. Lastly, our sample consisted solely of post-ACS patients from a single facility, limiting the generalizability of our results to the broader society and rehabilitation efforts targeting other heart diseases.

CONCLUSION

Our study provides a novel exploration of how HL influences CR enrollment and barriers, using the THLS-32 scale tailored to the cultural context. Despite initiatives such as multidisciplinary clinic visits and early appointment systems aimed at strengthening CR participation, our findings revealed consistently lower enrollment rates than expected. While demographic factors and HL outcomes did not directly predict enrollment decisions, they shed light on the social and cognitive factors contributing to CR barriers, extending beyond referral and informational challenges. Further research is necessary to thoroughly examine the complex relationships between sociocultural dynamics regarding HL and the secondary prevention of heart disease.

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

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