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A roy adaptation model–based care program and its impact on quality of life in patients with acute coronary syndrome: A randomized controlled trial

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Abstract

BACKGROUND: Acute coronary syndrome (ACS), a clinical manifestation of chronic coronary artery disease, is often associated with multiple complications, recurrent hospitalizations, and diminished quality of life. Evaluating quality of life is a key outcome for determining the effectiveness of clinical and educational interventions. This study examined the impact of a care program grounded in the Roy Adaptation Model (RAM) on the quality of life of patients with ACS.

METHODS: In this randomized controlled trial, 76 patients with ACS were randomly assigned to either the intervention or control group. Data collection took place from July to December 2024. Participants in the intervention arm received a two-week educational care program grounded in the Roy Adaptation Model, delivered through in-person sessions and supplemented with an instructional booklet. Data were gathered using a demographic survey, the SF-36 quality-of-life instrument, and the Roy Adaptation Model assessment form, which were administered at baseline and at one and three months following the intervention.

RESULTS: Independent t-tests revealed no significant pre-intervention differences in physical, mental, or overall quality-of-life scores between the groups. Following the intervention, the intervention group demonstrated significant improvements. Repeated-measures ANOVA confirmed significant main effects of time and time-by-group interaction. Subscale analysis demonstrated significant improvements in seven of the eight SF-36 domains in the intervention group. In contrast, the control group exhibited a significant improvement only in general health.

CONCLUSION: The Roy Adaptation Model provides an effective framework for fostering adaptation and enhancing quality of life in cardiac patients.

Keywords: Roy Adaptation Model; Care Program; Quality of Life; Acute Coronary Syndrome; Patient Education

Introduction

Cardiovascular diseases (CVDs) persist as the primary global cause of mortality, contributing to an estimated 17.9 million deaths each year[1]. In Iran, according to the Ministry of Health, CVDs are responsible for 46% of all deaths and represent the primary cause of mortality in individuals over 35 years of age. Among these, coronary artery disease is the most common and life-threatening, frequently presenting as acute coronary syndrome (ACS)[2]. Globally, ACS contributes to approximately one-third of all deaths and accounts for about 11% of total years of life lost due to premature mortality and disability[3]. In Iran, its incidence continues to rise, largely due to the growing prevalence and variety of risk factors[4]. The high costs of diagnosis and treatment, along with diminished quality of life, increased disability, and elevated mortality, highlight the urgent need for effective management strategies for ACS[3].

Quality of life (QoL) assessment is a critical indicator for evaluating the outcomes of interventions in patients with coronary artery disease, as treatment goals extend beyond survival to include symptom alleviation and improvements in daily functioning[5]. Compared with the general population, ACS survivors often report reduced QoL across physical, psychological, and functional dimensions, adversely affecting their social and family roles while also increasing the risk of rehospitalization and mortality[6,7]. The multidimensional burden of cardiac events such as myocardial infarction markedly reduces QoL and self-efficacy, complicating patients' ability to adapt to their altered health status[8].

Patient education plays a pivotal role in disease management by enhancing awareness and fostering active participation in self-care; however, it is often underemphasized compared with clinical interventions[9,10]. The effectiveness of educational-care programs relies heavily on the integration of established educational theories and nursing models[11]. Applying nursing models in practice enhances the quality of care, reduces healthcare costs, and improves patient outcomes by ensuring consistency and a unified approach to care delivery[12]. Among these, the Roy Adaptation Model (RAM) is regarded as one of the most practical and influential nursing frameworks[13]. This model conceptualizes individuals as adaptive systems who respond to internal and external stimuli through four interrelated adaptive modes: the physiological–physical mode, the self-concept–group identity mode, the role-function mode, and the interdependence mode[14]. According to RAM, health is reflected in the level of adaptation achieved within these modes, and nursing interventions aim to promote positive adaptive responses by modifying stimuli and strengthening the patient's coping processes[15]. In RAM-based interventions, nurses systematically assess focal, contextual, and residual stimuli affecting the patient; identify adaptive or ineffective responses; and design targeted strategies to enhance physiological stability, emotional regulation, role performance, and supportive interactions[16]. Through this structured approach, RAM facilitates patient adaptation, promotes healthier lifestyles, improves satisfaction, and enhances quality of life across multiple domains, making it a strategic priority in nursing care planning and implementation[17].

With the rising prevalence of non-communicable diseases, the aging population, and the increasing incidence of coronary artery disease[18], the development and implementation of effective management strategies that address both the acute and long-term challenges of ACS are critical. Although the Roy Adaptation Model offers a strong theoretical foundation for nursing practice[8,19], there remains a paucity of empirical research evaluating its effects on the quality of life of ACS patients. Therefore, the purpose of this study was to critically evaluate the impact of a RAM-based care plan in improving quality of life among patients with ACS, thereby contributing to evidence-based, patient-centered approaches for optimizing disease management.

Materials and Methods

Study Design and Setting

This two-arm clinical trial, in conjunction with a three-stage assessment design, was conducted to evaluate the effect of a Roy Adaptation Model (RAM)–based care program on the quality of life in patients with acute coronary syndrome (ACS). The study was carried out between July and December 2024 in three hospitals affiliated with Isfahan University of Medical Sciences: Chamran, Al-Zahra, and Milad hospitals.

Sample Size and Randomization

The sample size was calculated based on the study by Rezazadeh et al.[20], using a two-tailed significance level of 0.05, statistical power of 80%, and an expected effect size of 5. To account for potential attrition, an additional 10% was added, resulting in a final sample size of 78. Patients were randomly allocated to intervention and control groups (n=39 each) using a random number table. The allocation sequence was generated by the researcher, and participants were enrolled by the same researcher. Allocation was performed by assigning odd and even numbers to the intervention and control groups, respectively. These numbers were sealed in opaque envelopes, which were opened at the time of enrollment to reveal group assignment. Blinding was not performed due to the nature of the intervention.

Eligibility Criteria

Inclusion criteria were: physician-confirmed diagnosis of ACS; age ≥18 years; medical clearance to participate without anticipated health risks; complete consciousness; first-time ACS diagnosis (no prior history of ACS); sufficient literacy to independently read and write; absence of coexisting cardiac conditions such as heart failure, cardiomyopathy, or congenital heart disease (other than ACS); no cognitive or memory impairment; clinical stability after diagnosis and treatment; and at least four weeks since diagnosis.

Exclusion criteria were: withdrawal of consent; development of any condition preventing continued participation; missing ≥2 educational sessions; or experiencing major life events (e.g., death of a close family member) during the study.

Recruitment and Baseline Assessment

At the start of the study, eligible patients were approached in the participating hospitals, and written informed consent was obtained. Participants then completed the RAM Assessment Form, a demographic survey, and the SF-36 instrument for assessing quality of life at baseline.

Intervention

A two-step needs assessment based on the RAM Assessment Form was conducted for participants in the intervention group. First, maladaptive behaviors were identified across the four adaptive modes of RAM: physiological, self-concept, role performance, and interdependence. Second, the contributing stimuli for each maladaptive behavior were determined and categorized as focal, contextual, or residual. Based on these findings, the researcher developed nursing diagnoses and set goals aligned with the adaptive modes.

A tailored care program was then designed (Table 1) and delivered by a multidisciplinary team consisting of a cardiologist, dietitian, clinical psychologist, and psychiatric nurse. The program combined theoretical education with practical training, supplemented by an educational booklet. The booklet contained detailed information on disease etiology, clinical manifestations, treatment options, and self-care practices structured around the four RAM dimensions.

The intervention consisted of four sessions (60–90 minutes each) delivered over two weeks at the Patient Education Centers of the affiliated hospitals. Patients and their caregivers were divided into two groups of 19. Weekly telephone follow-ups were conducted throughout the intervention period to reinforce adherence and provide ongoing support.

Following the educational sessions, additional

telephone follow-ups were conducted for up to four weeks to monitor adherence to the care plan. The SF-36 Quality of Life Questionnaire was re-administered at one month and three months post-intervention in both groups. Participants assigned to the control group received usual hospital care, which encompassed the standard educational services offered to patients. For ethical reasons, the educational booklet and a supplementary explanatory session were provided to the control group after study completion.

Data Collection Instruments

Demographic Questionnaire: Collected data on age, sex, marital status, education level, occupation, comorbidities, illness duration, hospitalization frequency, insurance status, housing situation, monthly income, and number of children through medical record review and patient or caregiver interviews.

Roy Adaptation Model Assessment Form: Patient behaviors were assessed across the four adaptive modes (physiological, self-concept, role function, and interdependence)[21]. Data collection methods included physical examination, measurement of physiological responses, and structured interviews. Behaviors were evaluated for presence or absence and for the effectiveness of regulatory processes. Stimuli were classified as focal, contextual, or residual and guided the development of nursing diagnoses, goals, and intervention plans. The form was also used to assess overall adaptation status at the end of the program.

Quality of Life Questionnaire (SF-36): The SF-36 is a 36-item standardized instrument that evaluates health status across eight dimensions: physical functioning, role limitations attributable to physical health, role limitations related to emotional health, vitality/fatigue, emotional well-being, social functioning, pain, and overall general health[22]. Responses are scored on dichotomous or Likert-type scales (3–6 points) and transformed to a 0–100 scale, with higher scores reflecting better health status. Developed by Ware and Sherbourne (1992), the SF-36 has been extensively validated. The Persian version has demonstrated validity coefficients around 0.4 and Cronbach's alpha values between 0.77 and 0.90[23].

Ethical Considerations

Written informed consent was obtained from all participants after providing full explanations of the study objectives and ensuring confidentiality. Participants were assured that no risks were associated with their involvement. The study protocol received approval from the Ethics Committee of Isfahan University of Medical Sciences (IR.MUI.NUREMA.REC.1403.018) and was registered in the Iranian Registry of Clinical Trials (IRCT20240528061928N1).

Statistical Analysis

Data analysis was performed using SPSS version 27. Descriptive statistics, including means, standard deviations, frequencies, and percentages, were used to summarize participants' demographics. Between-group comparisons of demographic and clinical characteristics were carried out using independent t-tests for continuous variables and Chi-square, Fisher's exact, or Mann–Whitney tests for categorical variables. Normality of data was examined using skewness and kurtosis indices, as well as Kolmogorov–Smirnov and Shapiro–Wilk tests. Independent t-tests were used to compare mean scores between groups, while repeated-measures ANOVA was employed to assess changes across baseline, one month, and three months post-intervention. A p-value <0.05 was considered statistically significant.

Results

Of the 78 patients initially enrolled, one participant from the intervention group was excluded due to missing more than two care sessions, and one from the control group was excluded due to the death of a close relative. Ultimately, 76 patients completed the study and provided questionnaires at three measurement stages: before the intervention, one month later, and three months later (Figure 1).

In the intervention group, participants were aged 40–83 years, while in the control group, ages ranged from 43 to 84 years. The majority of patients in both groups were married, retired, and had education levels below a high school diploma. Most participants also reported histories of hypertension, hyperlipidemia, and diabetes. As summarized in Table 2, no statistically significant differences were found between groups in demographic or clinical characteristics, confirming baseline homogeneity (p>0.05).

As shown in Table 3, Independent t-test results showed no significant group differences in mean scores for physical health, mental health, or overall quality of life at baseline (p>0.05). However, at both one and three months post-intervention, the intervention group achieved significantly higher scores in these domains compared with the control group (p<0.001). Repeated-measures analysis of variance (RM-ANOVA) revealed significant main effects of time and group-by-time interaction for physical health, mental health, and overall quality-of-life scores (p<0.05). Scores improved significantly over time (time effect), with the intervention group demonstrating greater improvements relative to the control group (interaction effect) (p<0.05).

As shown in Table 4, no significant differences were observed between groups in any of the eight quality-of-life subscales before the intervention (p>0.05). At one month post-intervention, all subscale scores were markedly greater in the intervention group than in the control group, except for role limitations due to emotional problems (p=0.29). At three months post-intervention, significant group differences persisted in all subscales except for general health (p=0.17) and limitations in role performance resulting from emotional problems (p=0.83).

Repeated-measures ANOVA further indicated significant time and group-by-time

Table 1. Educational Program Content Based on the Roy Adaptation Model (RAM)

Session	Educational Content	RAM Adaptive Mode	Duration	Instructor(s)
1st	Education focused on maladaptive behaviors and their related stimuli encompassed comprehensive information about the nature, etiology, diagnosis, treatment, and complications of acute coronary syndrome (ACS). The program included medication education accompanied by tailored counseling, an introduction to heart-healthy dietary groups and nutritional recommendations, and guidance on fluid intake, smoking cessation, alcohol consumption, and weight monitoring with interpretation. Additionally, recommendations regarding physical activity and the therapeutic role of exercise in disease management were provided. Symptom management strategies were also covered, followed by a question-and-answer session to evaluate patients' comprehension and reinforce learning	Physiological Mode	60–90 minutes	Research team and nutritionist
2nd	Education targeted maladaptive behaviors and their associated stimuli, covering stress and anger management techniques, sleep regulation strategies, and approaches to improve self-confidence and self-concept, concluding with a question-and-answer session to assess patient understanding.	Self-Concept Mode	60–90 minutes	Research team and psychologist/psychiatric nurse
3rd	Education addressing maladaptive behaviors and associated triggers encompassed spousal, social, and parental roles; discussions on sexual health; identification of stressors and coping mechanisms; and concluded with a question-and-answer session to evaluate patient comprehension.	Role Function Mode	60–90 minutes	Research team
4th	Education on maladaptive behaviors and related triggers included promoting independence in daily and personal activities, strategies for remembering medical appointments, awareness of medication schedules and administration, guidance on proper nutrition and avoidance of harmful foods, followed by a question-and-answer session to assess patient understanding.	Interdependence Mode	60–90 minutes	Research team

effects for physical functioning, restrictions in role performance related to physical health, pain, general health, energy/fatigue, and emotional well-being (p<0.05). Scores in these subscales improved significantly over time, with greater gains observed in the intervention group. In contrast, no significant effects of time or group-by-time interaction were detected for restrictions in role functioning attributable to emotional difficulties (p=0.81) or social engagement and functioning (p=0.67).

Discussion

This study evaluated the effect of a care program based on the Roy Adaptation Model (RAM) on the quality of life of patients with acute coronary syndrome (ACS). The findings demonstrated that a RAM-guided intervention significantly

Table 2. Baseline sociodemographic characteristics of the study participants

Sociodemographic	Intervention group	Control group	p-value
characteristics	N=38	N=38	
Gender, n (%)			0.65
Male	20 (52.6)	18 (47.4)	
Female	18 (47.4)	20 (52.6)	
Marital status, n (%)			0.50
Married	34 (89.5)	33 (86.8)	
Single	4 (10.5)	5 (13.2)	
Occupation			0.97
Employed	10 (26.3)	11 (28.9)	
Housewife	11 (28.9)	12 (31.6)	
Retired, n (%)	16 (42.1)	14 (36.8)	
Unemployed	1 (2.7)	1 (2.7)	
Health insurance coverage, n (%)			0.50
Yes	34 (89.5)	35 (92.1)	
No	4 (10.5)	3 (7.9)	
Housing status, n (%)			0.81
Homeowner	25 (65.8)	24 (63.2)	
Renter	13 (34.2)	14 (36.8)	
Educational level, n (%)			0.94
Below high school diploma	21 (55.3)	21 (55.3)	
High school diploma	7 (18.4)	7 (18.4)	
Associate degree	5 (13.2)	4 (10.5)	
Bachelor's degree	4 (10.5)	4 (10.5)	
Master's degree or higher	1 (2.6)	2 (5.3)	
Monthly income (Toman), n (%)			0.82
< 5 million	12 (31.6)	12 (31.6)	
5–10 million	0 (0)	1 (2.6)	
10–15 million	16 (42.1)	16 (42.1)	
> 15 million	10 (26.3)	9 (23.7)	
Age (years), Mean (SD)	59.97 (9.21)	59.24 (9.20)	0.73
Number of children, Mean (SD)	2.37 (1.60)	2.29 (1.61)	0.83
Duration of illness (years), Mean (SD)	1.74 (0.76)	1.68 (0.66)	0.75

Table 3. Comparison of the quality of life score and its main dimensions within (over time) and between-group interactions effects

Variables	Intervention (n=38)			Controls (n=38)			Group main effect			Time main effect	Group x Time main effect
	Before	After 1 month	After 3 month	Before	After 1 month	After 3 month	Before	After 1 month	After 3 month		
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	p-value	p-value	p-value	p-value	p-value
Physical Health score	20.99 (2.75)	28.68 (2.25)	28.31 (1.89)	20.34 (2.30)	20.34 (2.51)	21.03 (1.36)	0.27	0.001 >	0.001 >	0.001 >	0.001 >
Mental Health score	29.19 (2.13)	31.15 (1.93)	31.37 (2.01)	29.14 (2.32)	28.70 (2.51)	28.90 (2.61)	0.93	0.001 >	0.001 >	0.001 >	0.001 >
QOL score	50.43 (3.52)	60.32 (3.36)	60.20 (2.88)	49.82 (3.90)	49.39 (4.60)	50.26 (3.72)	0.47	0.001 >	0.001 >	0.001 >	0.001 >

QOL: Quality Of Life

Statistical tests used: independent t-test (Comparison of two independent groups) AND repeated measure ANOVA (Comparing a group over time)

Table 4. Comparison of the quality of life subscale scores within (over time) and between-group interactions effects

Variables	Intervention (n=36)			Controls (n=36)			Group main effect			Time main effect	Group x Time main effect
	Before	After 1 month	After 3 month	Before	After 1 month	After 3 month	Before	After 1 month	After 3 month		
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	p-value	p-value	p-value	p-value	p-value
PF score	11.49 (1.72)	16.97 (1.26)	16.42 (1.04)	11.49 (0.72)	11.57 (0.69)	11.45 (0.73)	1	0.001 >	0.001 >	0.001 >	0.001 >
RP score	1.47 (1.20)	2.37 (0.91)	2.42 (0.83)	1.05 (1.01)	0.84 (1)	0.84 (1)	0.10	0.001 >	0.001 >	0.02	0.001 >
P score	1.05 (0.21)	1.49 (0.16)	1.47 (0.22)	0.99 (0.64)	0.91 (0.66)	0.97 (0.70)	0.60	0.001 >	0.001 >	0.03	0.008
GH score	6.98 (1.54)	7.84 (1.27)	7.99 (0.89)	6.81 (1.54)	7.03 (1.54)	7.78 (0.37)	0.63	0.01	0.17	0.001 >	0.001 >
RE score	2 (0.46)	2.05 (0.73)	2 (1.14)	2.05 (0.87)	1.84 (0.97)	2.05 (0.98)	0.74	0.29	0.83	0.81	0.56
EF score	9.42 (0.63)	10.47 (0.75)	10.39 (0.71)	9.61 (0.58)	9.55 (0.55)	9.64 (0.59)	0.18	0.001 >	0.001 >	0.001 >	0.001 >
EW score	13.52 (1.87)	13.97 (1.58)	14.37 (1)	13.27 (1.06)	13.24 (1.11)	13.18 (1.11)	0.48	0.02	0.001 >	0.04	0.02
SF score	4.24 (0.95)	4.66 (0.95)	4.60 (0.63)	4.20 (1.22)	4.07 (1.42)	4.03 (1.45)	0.88	0.04	0.03	0.67	0.16

PF: Physical Functioning, RP: Role limitations due to Physical problems, P: Pain, GH: General Health, RE: Role limitations due to Emotional problems, EF: Energy/Fatigue, EW: Emotional Well-being, SF: Social Function
Statistical tests used: independent t-test (Comparison of two independent groups) AND repeated measure ANOVA (Comparing a group over time)

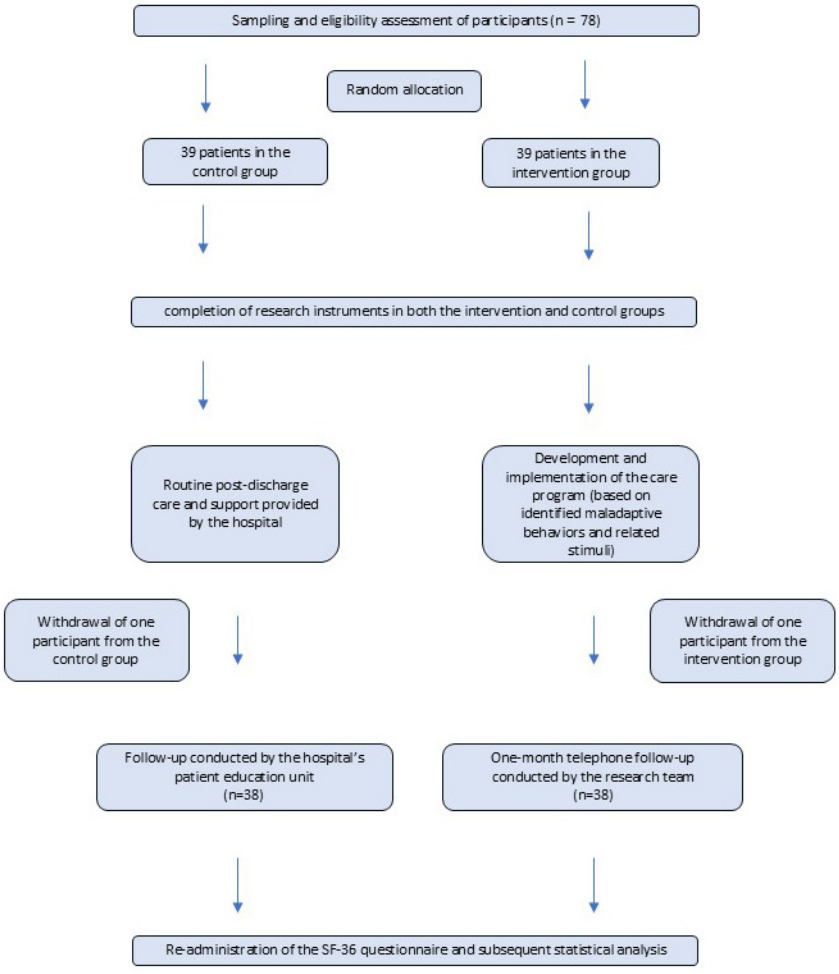

Figure 1. CONSORT Flow Diagram

enhanced patients' quality of life, confirming the model's potential as an effective framework in cardiac rehabilitation.

The RAM facilitates adaptive responses to internal and external stimuli through its regulator and cognator subsystems, thereby improving physical and psychological health and ultimately increasing life satisfaction. Quality of life is generally conceptualized in two major domains—physical and mental health—each comprising four subscales, all of which are closely linked to a patient's adaptive capacity[17,24].

Physical Health

The physical health dimension includes physical functioning, role limitations due to physical health, pain, and general health. In the present study, RAM-based care significantly improved all four subscales in patients with ACS. These findings are consistent with Majid et al., who reported that RAM-based interventions enhanced physical health among diabetic patients by improving activity, mobility, and nutrition[25]. Likewise, the model strengthens coping mechanisms, restores individual roles, and reduces dysfunction, thereby enhancing physical, psychological, and social functioning[26].

Similar outcomes have been reported in other patient populations, where RAM-based education reduced fatigue, improved daily functioning, alleviated pain, and enhanced overall quality of life[27-29]. In our study, the general health subscale improved significantly in the intervention group at one month, while in the control group this improvement appeared only at three months, possibly due to natural recovery processes and external factors such as family support, lifestyle adjustments, or socioeconomic influences. These findings align with Mansouri et al.[17] and Mohammadi et al.[30], who showed that family-based RAM interventions improved general health outcomes in patients with chronic illness.

Mental Health

The mental health dimension encompasses energy/fatigue, emotional well-being, social functioning, and role limitations due to emotional problems. Our results showed significant improvements in all subscales except role limitations due to emotional problems.

Consistent with these findings, Majid et al.[25] demonstrated improvements in energy and emotional well-being among diabetic patients following RAM-based interventions. Conversely, Azarmi et al.[31] and Afrasiabi[32] found no significant effects of RAM on emotional well-being or interdependence in amputees and hemodialysis patients, respectively. Such discrepancies may reflect variations in sample characteristics, intervention duration, or contextual factors such as marital status and social isolation.

In terms of social functioning, Feng (2024) reported improvements in bladder cancer patients[33], while Rezazadeh et al.[20] showed that tailored interventions enhanced social adaptation over time. However, Bazrafshan (2020) observed no impact among mothers of children with intellectual disabilities[34], likely due to elevated psychosocial stress. In our study, RAM-based care improved social functioning, but changes were not statistically significant, possibly due to limited sample size and insufficient statistical power. Evidence from a cohort study of patients undergoing multidisciplinary CR after ACS found that while most SF-36 domains improved post-rehabilitation, social functioning and role-emotional often improved more slowly or remained below normative levels compared to general population benchmarks[35].

Regarding role limitations due to emotional problems, no significant improvements were observed across study groups, consistent with Sadeghnezhad et al.[36]. In contrast, Peng (2023)[28] and Faghihi et al.[37] reported positive effects on emotional roles in other patient populations, suggesting that longer follow-up or more intensive interventions may be necessary to observe meaningful changes in this domain. A meta-analysis of cardiac rehabilitation programs similarly showed that improvements in mental and emotional domains are generally smaller

and less consistent than physical gains, likely because psychological recovery after acute coronary syndrome is shaped by complex factors—such as fear of recurrence, depressive symptoms, and social or occupational stress—that standard rehabilitation alone may not fully address[38].

RAM and Quality of Life

Theory-driven nursing practices, such as RAM, provide structured frameworks for developing patient-centered care strategies[39]. The findings of this study corroborate prior evidence[8,40,41] supporting RAM's effectiveness in improving quality of life. Nevertheless, Nezamol Eslami et al.[42] reported no significant improvement in overall or physical health scores, which may have been influenced by strong baseline social support among control participants.

In our study, most participants were married, which may have contributed to favorable outcomes through spousal support, emotional encouragement, and reduced psychological distress. This emphasizes the value of holistic approaches that engage both patients and families in care planning[20].

Limitations

This study has several limitations that warrant consideration. Although the final sample comprised 76 participants, this size may not have been sufficient to detect smaller differences across all SF-36 subscales, and larger samples would provide greater statistical power. Generalizability is also limited, as participants were recruited from a single province in Iran; cultural factors—particularly those related to family and spousal support—may differ in other contexts and affect the applicability of the findings. The absence of blinding for participants and outcome assessment introduces a potential risk of bias inherent to behavioral and educational interventions. Finally, despite efforts to schedule sessions separately and instruct participants not to share intervention content, the possibility of contamination between the intervention and control groups cannot be fully excluded.

Conclusion

This study implemented an interprofessional care program based on the Roy Adaptation Model, collaboratively developed with patients and healthcare professionals. The intervention significantly improved the quality of life in ACS patients by addressing both physical and psychosocial needs. Beyond enhancing individual adaptation, the program fostered collaborative care and shared learning, thereby underscoring the value of team-based, theory-driven educational strategies in cardiac rehabilitation. These findings highlight the potential of RAM-guided interventions to reduce hospital readmissions, improve long-term outcomes, and serve as a model for comprehensive cardiac care.

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Conflict of interests

The authors declare no conflict of interest.

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Author's Contributions

Study Conception or Design: MS, MM, SB
Data Acquisition: MM
Data Analysis or Interpretation: MS, MM
Manuscript Drafting: MS, MM
Critical Manuscript Revision: MS, MM, SB
All authors have approved the final manuscript and are responsible for all aspects of the work.

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