Am J Transl Res 2026;18(3):2719-2738
www.ajtr.org /ISSN:1943-8141/AJTR0169745

Original Article

Factors affecting quality of life after percutaneous coronary intervention in elderly patients with coronary heart disease: effects of the cardiac rehabilitation nursing model

Hua Guo[1*], Xiulan Qi[2*], Juan Zhang[3], Zhu Liu[4], Xiaoyan Zhao[5], Chunyuan Wang[6], Yan Hou[7]

[1]Department of Nursing, Turpan People's Hospital, Turpan 838000, Xinjiang Uygur Autonomous Region, China; [2]ENT Department, Turpan People's Hospital, Turpan 838000, Xinjiang Uygur Autonomous Region, China; [3]Department of Nephrology, Turpan People's Hospital, Turpan 838000, Xinjiang Uygur Autonomous Region, China; [4]Department of Neurology, Turpan People's Hospital, Turpan 838000, Xinjiang Uygur Autonomous Region, China; [5]Department of Cardiology, Turpan People's Hospital, Turpan 838000, Xinjiang Uygur Autonomous Region, China; [6]Department of Rehabilitation and Pain, Turpan People's Hospital, Turpan 838000, Xinjiang Uygur Autonomous Region, China; [7]Internal Medicine Area, Turpan People's Hospital, Turpan 838000, Xinjiang Uygur Autonomous Region, China. [*]Equal contributors.

Received November 3, 2025; Accepted February 14, 2026; Epub March 25, 2026; Published March 30, 2026

Abstract: Objective: To analyze factors influencing the quality of life (QoL) of elderly patients with coronary heart disease (CHD) undergoing percutaneous coronary intervention (PCI) and to evaluate the clinical value a cardiac rehabilitation nursing model. Methods: This randomized controlled trial assigned 112 elderly PCI patients to a control group (routine care) or an observation group (cardiac rehabilitation model), both receiving 6-month interventions. Outcome indicators were then compared between the two original groups at preoperative, 7-day postoperative, and 6-month follow-up time points. The control group was further stratified by post-PCI QoL scores into good and poor QOL subgroups for multivariate analysis. Results: Age, smoking, Self-Rating Depression Scale (SDS) score, and P-selectin glycoprotein ligand-1 were identified as independent risk factors for poor QoL ($P < 0.05$). The observation group demonstrated significantly higher QoL scores, greater improvement in 6-minute walking test, left ventricular ejection fraction, and subtype segment resolution at both 7-day and 6-month follow-ups ($P < 0.05$). For T-wave inversion and left ventricular end-diastolic dimension (LVEDd), the observation group showed significantly greater improvement in T-wave inversion and lower LVEDd at 6-month follow-up ($P < 0.05$). Greater reductions in Self-Rating Anxiety Scale and SDS scores and inflammatory markers were also observed in the observation group at both time points ($P < 0.05$). Conclusion: Age, smoking history, SDS scores, and PSGL-1 are key predictors of postoperative QoL. The cardiac rehabilitation nursing model significantly outperformed routine care by improving patients' QoL, psychological state, cardiac function, and inflammation.

Keywords: Elderly coronary heart disease, percutaneous coronary intervention, quality of life, cardiac rehabilitation nursing, influencing factors

Introduction

Coronary heart disease (CHD) is one of the leading causes of death worldwide, with incidence and mortality rates increasing significantly with age [1-3]. As of 2016, approximately 126 million people worldwide were estimated to suffer from CHD [4]. According to preliminary survey results from the *China Cardiovascular Disease and Risk Factors Monitoring Project* (2020-2022), which covered 262 monitoring points across 31 provinces, autonomous regions and municipalities, the prevalence of CHD in Chinese residents aged ≥ 18 years was 758 per 100,000 [5]. Percutaneous coronary intervention (PCI), including balloon dilation and stent implantation, is currently the most common treatment for CHD, accounting for 80% of all CHD-related surgeries, apart from medication [6, 7]. PCI has multiple advantages, includ-

https://doi.org/10.62347/HAEQ2495

ing faster recovery, more direct clinical improvement, higher success rates, and lower postoperative mortality [8, 9]. However, PCI primarily restores coronary patency and does not eliminate risk factors for CHD [10, 11]. Continuation of unhealthy behaviors after PCI, such as inadequate physical exercise, smoking, and alcohol consumption, contribute to high rates of disease recurrence and readmission. Therefore, many elderly patients experience problems such as limited mobility, emotional instability, and reduced social participation after PCI, leading to a significant decline in postoperative quality of life (QoL).

The QoL of post-PCI CHD patients is influenced by various factors. Previous studies [12, 13] have shown that QoL in patients with CHD is significantly lower than that in healthy individuals. Du et al. [14] reported that patients undergoing PCI exhibited poor psychological, physical, and social functioning, and that health interventions were helpful in improving QoL. Accordingly, effective nursing interventions to improve medication compliance and QoL have become a major focus in rehabilitation nursing.

Routine care after PCI is an essential component of postoperative rehabilitation, including regular monitoring of vital signs and timely management of abnormal conditions [15]. Additionally, health education, disease awareness promotion, explanation of PCI-related advantages, and guidance on post-discharge precautions are also of great importance. Although these measures can effectively promote patient recovery adaptation, limitations in communication and interdisciplinary collaboration within conventional care models may compromise care effectiveness and patient outcomes [16, 17]. In recent years, cardiac rehabilitation nursing has been effectively improved through a comprehensive approach involving exercise training, psychological interventions, nutritional guidance and health education. Such programs are shown to reduce cardiovascular events and promote functional recovery in CHD patients after PCI [18]. However, research into cardiac rehabilitation training for elderly patients undergoing PCI in China is still in its exploratory stages, particularly with regard to localized intervention programs tailored to cultural background and healthcare system characteristics.

This study aims to identify factors influencing QoL in elderly CHD patients after PCI and evaluate the effects of a cardiac rehabilitation nursing intervention on their QoL. The study seeks to provide scientific evidence to inform clinical nursing practice, improve heart function in elderly PCI patients, reduce the risk of adverse cardiovascular events, and enhance their quality of life.

Materials and methods

Study design

In this prospective, randomized controlled trial, a total of 112 elderly patients with CHD who underwent PCI at Turpan People's Hospital between January and October 2024 were enrolled. Using a random number table method, patients were divided into a control group and an observation group, with 56 subjects in each group. Patients in the observation group received a structured cardiac rehabilitation nursing program alongside routine nursing care for a total of six months. Additionally, patients in the control group was further categorized into good or poor QoL groups according to the World Health Organization Quality of Life-BREF (WHOQoL-BREF) [19] score. Factors influencing QoL in the control group after PCI were subsequently analyzed. This study was conducted in accordance with the Declaration of Helsinki protocol and approved by the Ethics Committee of the Chinese Academy of Medical Sciences (ethics no. TLFSRMYY-ER-2025-003). The trial was registered in Chinese Clinical Trial Registry (Registration No: ChiCTR2100049454). Written informed consent was obtained from all patients prior to study enrollment.

A random sequence was generated using Microsoft Excel by investigators who were blind to the study. The allocation results were recorded on a dedicated form. After eligibility screening, patients were assigned to the corresponding groups according to the numerical order.

Sample size calculation

The sample size was calculated based on the data of previous studies [20]. The significance

level was set at 5% (two-sided test), with a test power of 1-β = 0.9. Finally, 112 cases were included after considering 20% dropout rate.

Diagnostic criteria

Diagnostic criteria for hypertension: According to the *2018 Chinese Guidelines for Prevention and Treatment of Hypertension* [21], hypertension can be diagnosed in individuals not receiving antihypertensive when systolic blood pressure (SBP) ≥ 140 mmHg and/or diastolic blood pressure (DBP) ≥ 90 mmHg, measured on at least three separate occasions on different days. For patients with a previous history of hypertension who are currently on antihypertensive medications, a diagnosis of hypertension can be retained even if blood pressure is below 140/90 mmHg.

Diagnostic criteria for diabetes: According to the *2020 Chinese Guidelines for Prevention and Treatment of Type 2 Diabetes* [22], diabetes can be diagnosed in the presence of "three polys and one less" symptoms (polyuria, polydipsia, polyphagia, and unexplained weight loss), along with at least one of the following criteria: fasting plasma glucose (FPG) ≥ 7 mmol/L, 2-hour postprandial blood glucose ≥ 11.1 mmol/L, or glycated hemoglobin (HbA1c) ≥ 6.5%. Any of these three indicators can be used as diagnostic criteria for diabetes.

Diagnostic criteria for hyperlipidemia: According to the *2016 Chinese Guidelines for Prevention and Treatment of Adult Dyslipidemia* [23], hyperlipidemia can be diagnosed if any of the following conditions are met: total cholesterol (TC) ≥ 5.2 mmol/L, triglycerides (TG) ≥ 1.70 mmol/L, high-density lipoprotein (HDL) < 1.04 mmol/L, or low-density lipoprotein (LDL) ≥ 3.4 mmol/L.

Smoking criteria: Smoking is defined according to WHO as a history of continuous or cumulative smoking for at least 6 months during the individual's lifetime [24].

Alcohol consumption criteria: according to the *Guidelines for the Diagnosis and Treatment of Alcoholic Liver Disease* [25], long-term alcohol consumption is defined as alcohol intake for more than 5 years, corresponding to a daily alcohol consumption of ≥ 40 g for men and ≥ 20 g for women, or a history of heavy alcohol consumption within the past 2 weeks.

Body Mass Index (BMI) calculation: BMI is calculated as weight (kg)/height squared (m^2). According to the *2022 Consensus of Chinese Experts on Obesity Prevention and Treatment* [26], a BMI value of 24.0-27.9 is considered overweight, and a BMI value > 28 is considered obese.

CHD diagnosis: according to the *Guidelines for the Diagnosis and Treatment of Acute Myocardial Infarction* [27], the diagnosis of acute myocardial infarction (MI) should meet at least two of the following criteria: 1) A history of ischemic chest pain; 2) Dynamic changes in electrocardiogram (ECG) consistent with the diagnosis; 3) Dynamic changes in cardiac biomarkers indicative of myocardial injury.

Inclusion criteria

1) Met the diagnostic criteria for CHD [27]; 2) Diagnosed with CHD and treated with PCI, with complete required examination data for this study; 3) First-time PCI treatment; 4) Expected survival time > 1 year; 5) Normal cognitive and language function, with the ability to cooperate with treatment and assessments; 6) Favorable postoperative condition with stable hemodynamics.

Exclusion criteria

1) Presence of severe comorbidities, including malignancies or heart-kidney dysfunction; 2) Incomplete clinical data; 3) Language, visual, or hearing impairments that prevent cooperation with normal examination; 4) Lack of basic educational or cultural background preventing completion of study procedures; 5) History of mental illness or cognitive dysfunction.

Dropout criteria

1) Patients who voluntarily withdraw from study or whose family members request withdrawal; 2) Patients who experience serious adverse events.

Exclusion criteria during the study period

1) Participants involved in other experimental studies during the research period; 2)

Development of physical discomfort that prevented continued participation in the study.

Routine nursing care

Routine nursing care after PCI includes ECG monitoring, puncture-site care, limb care, psychological support, medication and dietary guidance, and regular follow-up. Nurses regularly checked ECG changes, promptly identified abnormalities, and reported to physicians. The puncture site was pressed and observed for bleeding and swelling, with timely intervention as indicated. Limb temperature, swelling, and pain were regularly assessed, and limb elevation or analgesic measures were provided when necessary. Psychological support was provided through active communication. Medication guidance on dosage and time was provided to ensure medication adherence. Dietary guidance emphasized a low-salt, low-fat and low-sugar diet, as well as smoking cessation and alcohol abstinence. Regular follow-up was conducted to assess rehabilitation status and needs, with nursing plans were adjusted accordingly.

Cardiac rehabilitation nursing model

Establishment of a cardiac rehabilitation team: A cardiac rehabilitation team was established and led by a cardiac rehabilitation specialist nurse. The team consisted of six medical staff members, with the head nurse of the ward serving as the team leader. The cardiac rehabilitation specialist nurse was responsible for delivering rehabilitation education, conducting heart function assessment, providing activity guidance, and operating the mHealth monitoring platform. The attending physician supervised patient safety during the rehabilitation process, while bedside nurses were responsible for observing the patient's condition and keeping records.

A quality control loop was established: a weekly team meeting was held to review patient progress (psychological status data, 6-minute walk test (6MWT) results, and vital signs), enabling real-time protocol adjustments. On this basis, individualized nursing management plans were formulated, regularly assessed, and dynamically adjusted to ensure the smooth progress of nursing care and rehabilitation effectiveness.

In-Hospital Care (Within 3 days post-PCI): During the hospitalization period, the primary goals were to reduce postoperative complications, promote early recovery, and enhance cardiopulmonary function. Patients underwent close cardiopulmonary monitoring and were encouraged to initiate early mobilization under supervision (e.g., joint movements, muscle massage, and deep-breathing exercises) to help improve blood circulation and enhance pulmonary function. A standardized exercise protocol was adopted, with the target heart rate maintained at 50-60% of the age-predicted maximum heart rate (220-*age*), and a Borg fatigue score $\leq$ 11 (light exertion). Biomarker-guided dynamic adjustment: Patients with preoperative P-selectin glycoprotein ligand-1 (PSGL-1) > 75th percentile received reduced exercise intensity (20%) and enhanced ECG monitoring, while those < 25th percentile were allowed earlier progression of activity, provided no contraindications were present. Exercise was immediately discontinued if systolic blood pressure exceeded 180 mmHg or if chest pain or dyspnea occurred. For nutrition, high-protein, high-calorie foods such as lean meat, legumes, eggs, and vitamin C-rich foods (like citrus and tomatoes) were provided to promote wound healing and immune system recovery, with a target intake of 1500-2000 kcal. Sample meal plan: Breakfast - 1 boiled egg (50 g) + 250 mL low-fat milk + 2 slices whole-wheat bread; Lunch - 100 g steamed fish + 150 g multigrain rice + 200 g broccoli + 10 mL olive oil; Snack - 1 apple + 15 g walnuts. Quantitative standards: Protein intake 1.2 g/kg body weight/day (e.g., 72 g for 60 kg patient), sodium < 5 g/day. In terms of exercise interventions, nurses will begin performing bed exercises 2-3 times a day, each session lasting 10-15 minutes. These exercises included upper and lower limb stretching and deep breathing exercises, aimed at enhancing physical endurance and flexibility. Cardiopulmonary function was assessed through left ventricular ejection fraction (LVEF) and the 6MWT to ensure stable heart and lung function.

Transitional care (1 month post-surgery): The focus of the transitional period was to enhance physical capacity and improve psychological well-being. Patients gradually increased their activity levels, with personalized exercise pre-

scriptions developed by nursing staff. The activities included 3 sessions of aerobic exercise per week (walking or stationary cycling), each lasting 20-30 minutes, with a target heart rate of resting heart rate + 20 beats/min. Wearable devices (Xiaomi Smart Band 7, <$40) transmitted real-time heart rate to the CardioRehab Link app, artificial intelligence (AI) alerts triggered nurse callbacks if HR exceeded target by > 10 bpm or Borg > 13. Specific actions: ① 5 min warm-up (slow walking); ② 20 min main exercise (brisk walking or stationary cycling); ③ 5 min cool-down (stretching). Safety rule: Speed was reduced if HR exceeds target by > 10 bpm or Borg > 13. The patient's heart rate and respiratory rate was monitored to assess the effects of exercise. For nutrition, high-nutrient meals was continually provided, with a focus on increasing fish, lean meat, and other high-protein foods to promote muscle growth. Mediterranean diet pattern: Daily olive oil 20-25 ml, deep-sea fish 3×/week (100 g each), nuts 30 g/day (walnuts + almonds), whole grains account for 1/2 of staple foods. Sample menu: Breakfast - oatmeal with blueberries and yogurt; Lunch - salmon salad with whole - wheat bread; Dinner - chicken breast with brown rice and spinach. Fiber-rich foods such as whole grains, vegetables, and fruits were included to support digestive function. Nurses emphasized the quality and combination of foods. In terms of psychological care, to address potential anxiety or depression, mindfulness-based stress reduction therapies (such as meditation and deep breathing exercises) were integrated to help alleviate postoperative anxiety and enhance emotional regulation. Standardized 4-week mindfulness program: Week 1 - abdominal breathing (5 min/session, twice daily, audio - guided). Week 2 - body scan meditation (10 min/session, before bedtime). Week 3 - mindful walking (10 min slow walking in ward, focusing on footsteps). Week 4 - emotion awareness diary. Nurse training: 8-hour mindfulness certification required, using standardized scripts. Standardized 4-week mindfulness program (breathing-body scan-walking exercises) will be implemented; all nurses complete 8-hour certification. Regular communication will take place to track the patient's recovery progress and help them understand the importance of the recovery process, boosting confidence.

Maintenance care (2-6 months post-surgery): During the maintenance period, the goal was to maintain long-term health and improve QoL. Nursing staff adjusted exercise and diet plans based on the patient's recovery, gradually increasing the weekly exercise volume by 10%. Exercise activities included brisk walking, swimming, yoga, and more, with 4-5 sessions per week, each lasting 40 min, aimed at improving cardiovascular endurance, flexibility, and strength. Progressive protocol: Months 2-3: 4×/week brisk walking 40 min + resistance training (elastic bands, 3 sets × 12 reps). Months 4-6: 5×/week, add swimming/yoga, 45 min/session. Advancement principle: Increase volume by 10% monthly, Borg score ≤ 14. For nutrition, a low-fat diet was maintained, avoiding fried foods, and increasing foods rich in omega-3 fatty acids (such as fish and nuts) to reduce the risk of cardiovascular diseases. Long-term dietary prescription: Fat < 25% of total calories, saturated fat < 7%, omega - 3 fatty acids 2 g/day. Specific combination: 200 g salmon/week + 150 g walnuts/week + 20 g flaxseed daily. Avoidance: No organ meats or fried foods. The patient also increased the intake of vegetables, fruits, and whole grains to provide antioxidants and dietary fiber, supporting long-term health. Nurses provided ongoing personalized exercise recommendations by remote monitoring, conducted regular checks on the patient's weight, blood pressure, and blood glucose levels to ensure the maintenance of a healthy lifestyle. Monthly physical health assessments were conducted, including weight, body fat percentage, and exercise endurance, to ensure good rehabilitation progress and adjust the care plan accordingly.

Implementation requirements: In tertiary hospitals, the program requires: ① 1 cardiac rehabilitation nurse specialist (40-hour training certification); ② 6-MWT corridor (30 m); ③ CardioRehab Link app synchronized with Xiaomi Smart Band 7 (<$40) for real-time heart rate variability monitoring and AI alerts; In primary hospitals: phased rollout with month 1-3 using simplified app (manual data entry) + weekly tele-consults with tertiary specialists, and month 4-6 introducing shared device pool (5 trackers/ward), reducing per-patient cost from $30 to <$8 while maintaining adherence tracking. Simplified version for primary hospitals:

Reduce exercise frequency to 2×/week, replace HR monitoring with Borg scale, use food models instead of precise meal planning for nutrition guidance.

Data collection

Baseline data: Patient demographic and clinical data were collected from the electronic medical record system, including sex, age, BMI, smoking and alcohol consumption history, educational level, marital status, medical payment, family economic status, and comorbidities (diabetes, hypertension, hyperlipidemia).

Psychological status: Anxiety and depression were assessed using the Self-Rating Anxiety Scale (SAS) [28] and Self-Rating Depression Scale (SDS) [29] at three points: before PCI, 7 days after PCI, and 6 months after PCI. The SAS consists of 20 items rated on a four-point Likert scale (1-4) according to symptom frequency. Fifteen items are negatively worded and scored from 1 to 4, while five items (items 5, 9, 13, 17, and 19) are positively worded and reverse-scored from 4 to 1. The raw score is multiplied by 1.25, and the integer value is taken as the standardized score. According to Chinese norms, a standardized SAS score < 50 indicates no anxiety, 50-59 mild anxiety, 60-69 moderate anxiety, and ≥ 70 severe anxiety. The SDS also comprises 20 items rated on a four-point scale, including to positively scored and 10 negatively scored. The total score ranges from 0 to 80, and the standardized score is calculated as the same method as the SAS.

Cardiac function indicators: Exercise tolerance was measured using the 6-minute walk test (6MWT) before PCI, 7 days and 6 months after PCI. Based on the results of the 6MWT, patients were classified into four levels: level 1 (< 300 m), level 2 (300-374 m), level 3 (375-450 m), and level 4 (> 450 m). The lower the level, the poorer the cardiopulmonary function [30]. In addition, the patient's T-wave inversion and Subtype (ST) segment depression were recorded using a 12-lead digital electrocardiograph (model: EP-12C, manufacturer: Shanghai Optical Medical Electronics Co., Ltd.). LVEF and left ventricular end-diastolic diameter (LVEDd) were measured using an ultrasound echocardiograph (model: GE Vingmed E9, manufacturer: General Electric (GE Healthcare)) by the same physician in a blinded manner.

Serological inflammatory markers: Serum levels of PSGL-1, soluble CD14 ST (sCD14-ST), and macrophage inflammatory protein-1 alpha (MIP-1α) were detected before PCI, 7 days and 6 months after PCI using Enzyme-Linked Immunosorbent Assay (ELISA).

QoL score: The WHOQOL-BREF [19] was used to assess the QoL patients before PCI, 7 days and 6 months after PCI. WHOQOL-BREF contains 26 items, covering four domains: physical, psychological, social relationships, and environment. Each item is rated on a scale from 1 (very dissatisfied) to 5 (very satisfied), with the total score ranging from 26 to 130. The higher the score, the better the QoL. Based on the mean total score of the sample, patients were classified as having good QoL (total score > mean) or poor QoL (total score ≤ mean).

All follow-up assessments were conducted by investigators who had received standardized training and used uniform evaluation tools. Data accuracy was ensured through double data entry and cross-validation. The entire follow-up process strictly adhered to the research protocol to maintain the integrity and reliability of the data.

Statistical analysis

Statistical analyses were performed using SPSS 27.0 software. Missing data were handled using multiple imputations. For quantitative data, the Shapiro-Wilk test was used to assess normality. Quantitative data that followed a normal distribution were presented as mean ± standard deviation (SD) and compared between groups using independent sample *t*-tests. Non-normally distributed data were presented as M (Q_{25}, Q_{75}) and analyzed using the Mann-Whitney U test. Categorical data were expressed as frequencies and percentages (n, %) and compared using the χ^2 test or Fisher's exact test, as appropriate. Logistic regression analysis was used to identify factors influencing QoL of patients in the control group after PCI. Comparisons of the same indicator across different time points were performed using repeated measures analysis of variance. A two-sided P value < 0.05 was considered significant.

Table 1. Comparison of baseline data between the control group and the observation group

Characteristics		Control Group (n = 56)	Observation group (n = 56)	t/χ^2	*P*
Sex (n, %)	Male	35 (62.50)	36 (64.29)	0.038	0.844
	Female	21 (37.50)	20 (35.71)		
Age (years, mean ± SD)		74.26 ± 5.28	75.69 ± 6.78	1.251	0.214
BMI (kg/m^2, mean ± SD)		23.94 ± 2.72	24.25 ± 3.30	0.547	0.585
Smoking history (n, %)	Yes	33 (58.93)	36 (64.29)	0.340	0.560
	No	23 (41.08)	20 (35.71)		
Alcohol consumption history (n, %)	Yes	32 (57.14)	34 (60.71)	0.148	0.701
	No	24 (42.86)	22 (39.29)		
Educational level (n, %)	Primary school and below	13 (23.21)	18 (32.14)	1.159	0.560
	Junior/senior secondary	27 (48.21)	23 (41.07)		
	College degree or above	16 (28.58)	15 (26.79)		
Marital status (n, %)	Married	40 (71.43)	37 (66.07)	0.374	0.541
	Divorced or widowed	16 (28.57)	19 (33.93)		
Method of medical payment (n, %)	Out of pocket	27 (48.21)	31 (55.36)	0.572	0.449
	Health care	29 (51.79)	25 (44.64)		
Family economic status (n, %)	Good	19 (33.93)	21 (37.50)	1.000	0.607
	General	23 (41.07)	18 (32.14)		
	Poor	14 (25.00)	17 (30.36)		
Comorbid hypertension (n, %)	Yes	34 (60.71)	36 (64.29)	0.152	0.696
	No	22 (39.29)	20 (35.71)		
Comorbid diabetes (n, %)	Yes	29 (51.79)	32 (57.14)	0.324	0.569
	No	27 (48.21)	24 (42.86)		
Comorbid hyperlipidemia (n, %)	Yes	35 (62.50)	33 (58.93)	0.150	0.699
	No	21 (37.50)	23 (41.07)		

Note: BMI, Body Mass Index.

Results

Comparison of baseline data between the two groups

No significant differences were observed between the two groups in terms of sex, age, BMI, smoking or alcohol consumption history, educational level, marital status, medical payment approach, family economic status, or comorbid hypertension, diabetes and CHD ($P > 0.05$) (**Table 1**), indicating that the baseline characteristics of the two groups were comparable.

Comparison of QoL scores between the two groups

There were no significant differences in QoL scores across the physical, psychological, social relationship, or environmental domains between the control group and the observation group before PCI (all $P > 0.05$). At both 7 days and 6 months after PCI, the scores across all four domains in the observation group were significantly higher than those of the control group (all $P < 0.05$) (**Figure 1**).

Comparison of psychological status between the two groups

There were no significant differences in SAS or SDS scores between the two groups before PCI ($P > 0.05$). In both groups, the SAS and SDS scores gradually decreased at 7 days and 6 months after PCI compared with baseline values ($P < 0.05$). Notably, the SAS and SDS scores in the observation group were significantly lower than those of the control group (both $P < 0.001$) (**Figure 2**).

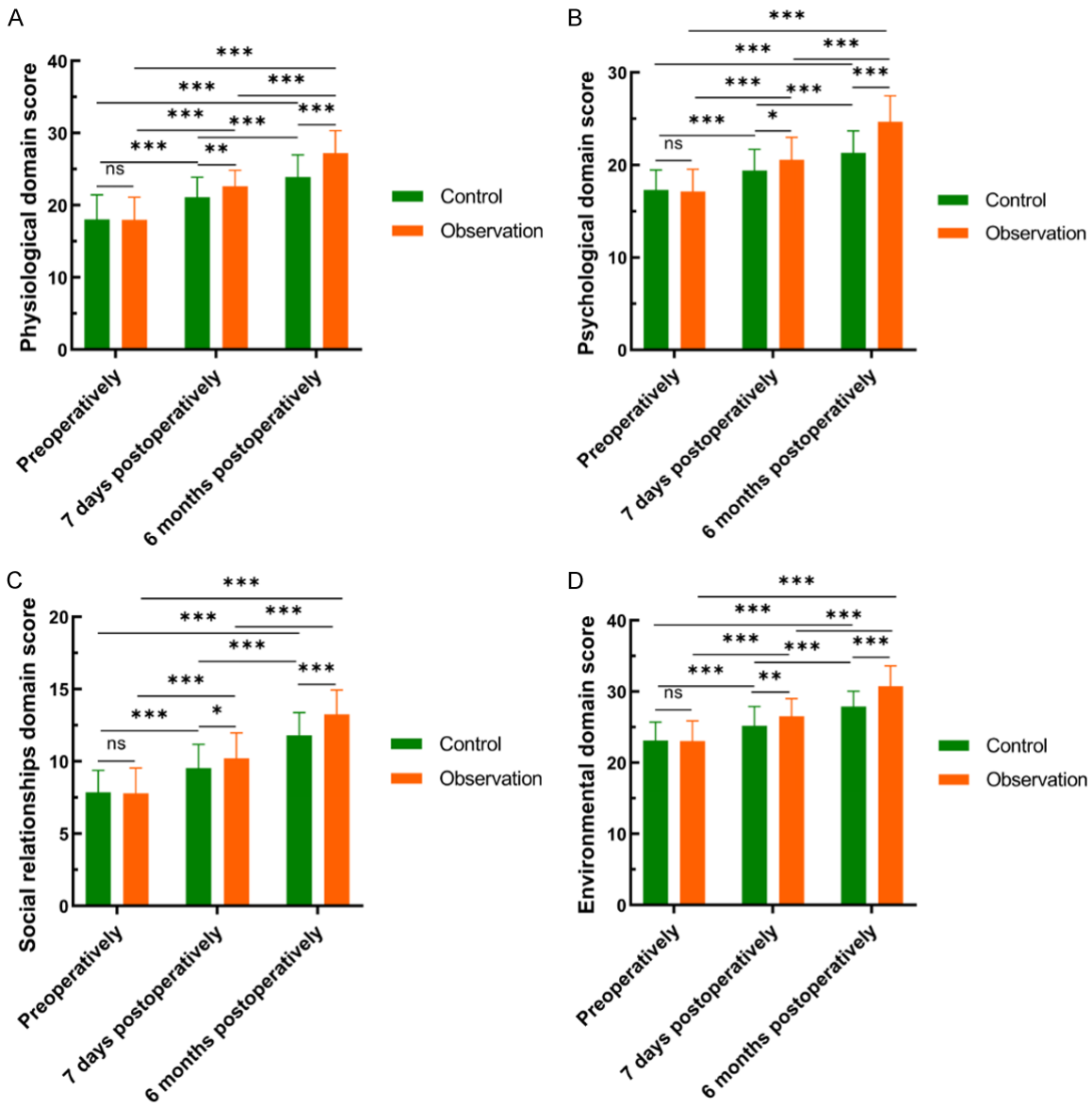

Figure 1. Comparison of QoL scores between the two groups before PCI, 7 days and 6 months after PCI. A: Physiological domain score; B: Psychological domain score; C: Social relationship domain score; D: Environmental domain score. Note: QoL, quality of life; PCI, percutaneous coronary intervention; $^{ns}P > 0.05$; $*P < 0.05$; $**P < 0.01$; $***P < 0.001$.

Comparison of cardiac function between the two groups

Before PCI, there were no significant differences between the two groups in 6MWT, T-wave inversion rate, ST-segment regression rate, LVEF, or LVEDd (all $P > 0.05$). Compared with baseline data, the T-wave inversion rate in both groups increased at 7 days after PCI and decreased at 6 months after PCI ($P < 0.05$). The ST-segment regression rate, 6MWT, and LVEF were significantly increased in both groups at 7 days and 6 months after PCI ($P < 0.05$), while LVEDd decreased significantly at 6 months after PCI ($P < 0.05$).

In addition, at both 7 days and 6 months after PCI, the ST-segment regression rate, 6MWT and LVEF were significantly higher in the observation group than in the control group ($P < 0.05$). No significant differences were observed in T-wave inversion rate or LVEDd between

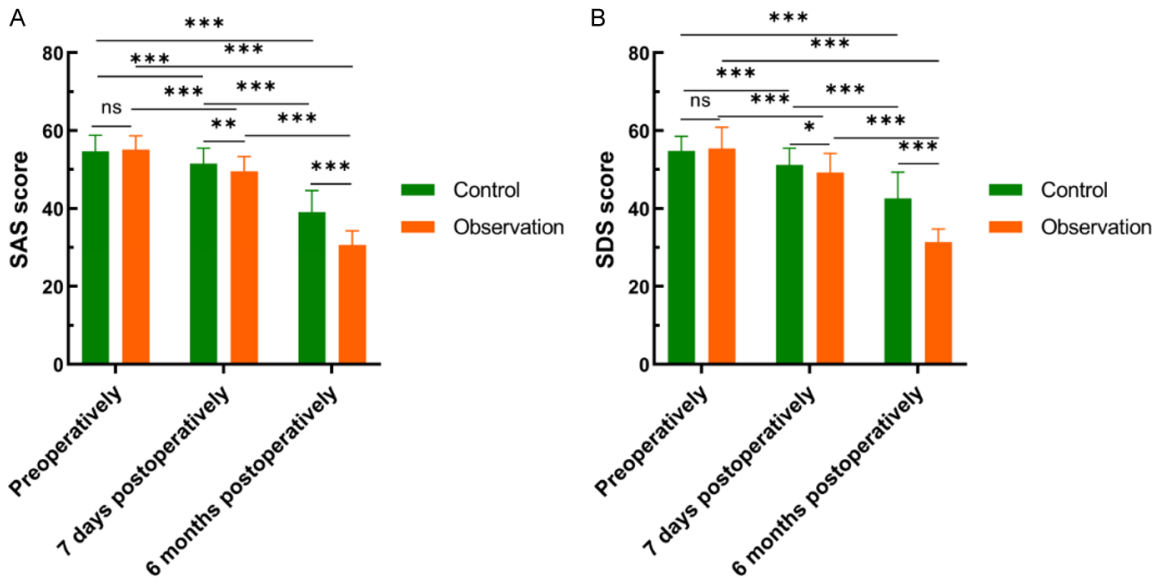

Figure 2. Comparison of SAS and SDS scores between the two groups before PCI, 7 days and 6 months after PCI. A: SAS score; B: SDS Score. Notes: SAS, Self-Rating Anxiety Scale; SDS, Self-Rating Depression Scale; PCI, percutaneous coronary intervention; ^{ns}indicates $P > 0.05$; *indicates $P < 0.05$; **indicates $P < 0.01$; ***indicates $P < 0.001$.

the two groups at 7 days after PCI ($P > 0.05$). However, 6 months after PCI, the T-wave inversion rate and LVEDd in the observation group were significantly lower than those of the control group ($P < 0.05$) (**Table 2**).

Comparison of inflammatory markers between the two groups

There were no significant differences in PSGL-1, sCD14-ST or MIP-1α levels between the two groups before PCI ($P > 0.05$). The levels of these markers gradually decreased in both groups compared with the baseline levels ($P < 0.001$). Furthermore, at both 7 days and 6 months after PCI, the PSGL-1, SCD14-ST, and MIP-1α levels in the observation group were significantly lower than those of the control group (all $P < 0.05$) (**Table 3**).

Univariate analysis of factors associated with QoL in elderly CHD patients after PCI

Patients in the control group were further classified into two groups according to their QoL score: a good QoL group (n = 28) and a poor QoL group (n = 28). Univariate analysis revealed that age, smoking history, marital status, combined hypertension, SAS score, SDS score, T-wave inversion, LVEF, PSGL-1, MIP-1α were significantly associated with QoL in elderly CHD patients after PCI (all $P < 0.05$) (**Table 4**).

Collinearity analysis of factors influencing QoL in elderly CHD patients after PCI

Multicollinearity among the 10 independent variables screened by univariate analysis was assessed using variance inflation factor (VIF) and tolerance values, with a VIF > 5 or tolerance < 0.2 indicating the existence of multicollinearity. As shown in **Table 5**, all independent variables had VIF values < 5 and tolerance values > 0.2, indicating the absence of multicollinearity, allowing subsequent multivariate Logistic regression analysis.

Multivariate Logistic regression analysis of factors influencing QoL in elderly CHD patients after PCI

Multivariate Logistic regression analysis further identified age, smoking history, SDS score, and PSGL-1 as independent risk factors for poor QoL in elderly CHD patients after PCI ($P < 0.05$) (**Table 6**).

Development and validation of a predictive nomogram for poor QoL after PCI in elderly CHD patients

Based on the four independent predictors identified by multivariate analysis (age, smoking history, SDS score, and PSGL-1 level), a nomo-

Table 2. Comparison of cardiac function between the two groups before PCI, 7 days and 6 months after PCI

Indicator			Preoperatively	7 days postoperatively	6 months postoperatively	F/χ^2	*P*
6MWT (n, %)	Control Group (n = 56)	Level 1	32 (57.14)	17 (30.36)*	8 (14.29)*,#	31.009	< 0.001
		Level 2	16 (28.57)	23 (41.07)	18 (32.14)		
		Level 3	6 (10.72)	11 (19.64)	19 (33.93)		
		Level 4	2 (3.57)	5 (8.93)	11 (19.64)		
	Observation group (n = 56)	Level 1	33 (58.93)	12 (21.43)*	3 (5.36)*,#	61.347	< 0.001
		Level 2	17 (30.36)	13 (23.21)	9 (16.07)		
		Level 3	4 (7.14)	20 (35.71)	23 (41.07)		
		Level 4	2 (3.57)	11 (19.65)	21 (37.50)		
	χ^2		0.446	8.503	8.779		
	P		0.931	0.037	0.032		
T-wave inversion (n, %)	Control Group (n = 56)	Yes	27 (48.21)	38 (67.86)*	16 (28.57)*,#	17.308	< 0.001
		No	29 (51.79)	18 (32.14)	40 (71.43)		
	Observation group (n = 56)	Yes	28 (50.00)	40 (71.43)*	7 (12.50)*,#	40.320	< 0.001
		No	28 (50.00)	16 (28.57)	49 (87.50)		
	χ^2		0.036	0.169	4.432		
	P		0.850	0.681	0.035		
ST segment depression (n, %)	Control Group (n = 56)	Yes	16 (28.57)	25 (44.64)*	37 (66.07)*,#	15.938	< 0.001
		No	40 (71.43)	31 (55.36)	19 (33.93)		
	Observation group (n = 56)	Yes	17 (30.36)	36 (64.29)*	51 (91.07)*,#	43.969	< 0.001
		No	39 (69.64)	20 (35.71)	5 (8.93)		
	χ^2		0.043	4.356	10.394		
	P		0.836	0.037	0.001		
LVEF (%, mean ± SD)	Control Group (n = 56)		39.16 ± 4.43	41.75 ± 4.50*	47.14 ± 5.93*,#	52.619	< 0.001
	Observation group (n = 56)		38.93 ± 5.26	44.10 ± 5.89*	60.01 ± 5.67*,#	204.432	< 0.001
	t		0.249	2.373	11.733		
	P		0.804	0.019	< 0.001		
LVEDd (mm, mean ± SD)	Control Group (n = 56)		61.43 ± 5.28	61.79 ± 5.26*	57.78 ± 3.21*,#	23.047	< 0.001
	Observation group (n = 56)		61.59 ± 4.44	60.46 ± 4.87*	55.63 ± 2.89*,#	35.043	< 0.001
	t		0.178	1.390	3.735		
	P		0.859	0.167	< 0.001		

Note: *$P < 0.05$, compared with preoperatively; #$P < 0.05$, compared with 7 days postoperatively; ST, Subtype; LVEF, left ventricular ejection fraction; LVEDd, left ventricular end-diastolic diameter; PCI, percutaneous coronary intervention.

Table 3. Comparison of inflammatory markers between the two groups before operation, 7 days and 6 months after operation

Indicator		Preoperatively	7 days postoperatively	6 months postoperatively	*F*	*P*
PSGL-1 (U/mL, mean ± SD)	Control Group (n = 56)	323.39 ± 41.61	308.73 ± 37.88*	280.23 ± 33.98*,#	22.447	< 0.001
	Observation group (n = 56)	324.34 ± 42.80	295.05 ± 31.75*	262.37 ± 35.87*,#	40.905	< 0.001
	t	0.118	2.072	2.705		
	P	0.906	0.041	0.008		
sCD14-ST (ng/L, mean ± SD)	Control Group (n = 56)	561.22 ± 72.72	515.96 ± 71.70*	394.52 ± 38.97*,#	102.462	< 0.001
	Observation group (n = 56)	566.89 ± 64.18	478.07 ± 54.04*	337.53 ± 52.15*,#	219.431	< 0.001
	t	0.438	3.158	6.551		
	P	0.662	0.002	< 0.001		
MIP-1α (ng/L, mean ± SD)	Control Group (n = 56)	499.25 ± 42.18	480.60 ± 53.44*	443.50 ± 54.49*,#	15.303	< 0.001
	Observation group (n = 56)	499.85 ± 56.08	460.82 ± 48.72*	413.21 ± 38.43*,#	54.258	< 0.001
	t	0.065	2.046	3.399		
	P	0.949	0.043	< 0.001		

Note: *$P < 0.05$, compared with preoperatively; #$P < 0.05$, compared with 7 days postoperatively; PSGL-1, P-selectin Glycoprotein Ligand-1; sCD14-ST, soluble CD14 Subtype; MIP-1α, Macrophage Inflammatory Protein-1 Alpha.

Table 4. Univariate analysis of factors associated with QoL in elderly CHD patients after PCI

Characteristic		Good group (n = 28)	Poor group (n = 28)	t/χ^2	*P*
Sex (n, %)	Male	16 (57.14)	19 (67.86)	0.686	0.408
	Female	12 (42.86)	9 (32.14)		
Age (years, mean ± SD)		70.94 ± 3.57	77.57 ± 4.63	6.002	< 0.001
BMI (kg/m^2, mean ± SD)		23.33 ± 2.39	24.55 ± 2.92	1.704	0.094
Smoking history (n, %)	Yes	10 (35.71)	23 (82.14)	12.469	< 0.001
	No	18 (64.29)	5 (17.86)		
Alcohol consumption history (n, %)	Yes	15 (53.57)	17 (60.71)	0.292	0.589
	No	13 (46.43)	11 (39.29)		
Educational level (n, %)	Primary school and below	5 (17.86)	8 (28.57)	0.979	0.613
	Junior/senior secondary	14 (50.00)	13 (46.43)		
	College degree or above	9 (32.14)	7 (25.00)		
Marital status (n, %)	Married	24 (85.71)	16 (57.14)	5.600	0.018
	Divorced or widowed	4 (14.29)	12 (42.86)		
Method of medical payment (n, %)	Out of pocket	12 (42.86)	15 (53.57)	0.644	0.422
	Health care	16 (57.14)	13 (46.43)		
Family economic status (n, %)	Good	12 (42.86)	7 (25.00)	1.993	0.369
	General	10 (35.71)	13 (46.43)		
	Poor	6 (21.43)	8 (28.57)		
Comorbid hypertension (n, %)	Yes	13 (46.43)	21 (75.00)	4.791	0.029
	No	15 (53.57)	7 (25.00)		
Comorbid diabetes (n, %)	Yes	12 (42.86)	17 (60.71)	1.788	0.181
	No	16 (57.14)	11 (39.29)		
Comorbid hyperlipidemia (n, %)	Yes	17 (60.71)	19 (67.86)	0.311	0.577
	No	11 (39.29)	9 (32.14)		
SAS score (points, mean ± SD)		35.86 ± 5.07	42.32 ± 7.05	3.940	< 0.001
SDS score (points, mean ± SD)		39.68 ± 3.26	45.57 ± 7.99	3.613	< 0.001
6MWT (n, %)	Level 1	2 (7.14)	6 (21.43)	5.635	0.131
	Level 2	7 (25.00)	11 (39.29)		
	Level 3	11 (39.29)	8 (28.57)		
	Level 4	8 (28.57)	3 (10.71)		
T-wave inversion (n, %)	Yes	4 (14.29)	12 (42.86)	5.600	0.018
	No	24 (85.71)	16 (57.14)		
ST segment depression (n, %)	Yes	21 (75.00)	16 (57.14)	1.991	0.158
	No	7 (25.00)	12 (42.86)		
LVEF (%, mean ± SD)		48.81 ± 5.48	45.47 ± 5.99	2.174	0.034
LVEDd (mm, mean ± SD)		57.62 ± 3.30	59.02 ± 3.34	1.583	0.119
PSGL-1 (U/mL, mean ± SD)		264.31 ± 20.67	296.15 ± 37.39	3.944	< 0.001
sCD14-ST (ng/L, mean ± SD)		327.18 ± 44.19	341.90 ± 49.45	1.174	0.245
MIP-1α (ng/L, mean ± SD)		409.22 ± 32.49	431.49 ± 41.14	2.249	0.029

Note: CHD, coronary heart disease; QoL, quality of life; PCI, percutaneous coronary intervention; BMI, Body Mass Index; SAS, Self-Rating Anxiety Scale; SDS, Self-Rating Depression Scale; 6MWT, 6-minute walk test; ST, Subtype; LVEF, left ventricular ejection fraction; LVEDd, left ventricular end-diastolic diameter; PSGL-1, P-selectin Glycoprotein Ligand-1; sCD14-ST, soluble CD14 ST; MIP-1α, Macrophage Inflammatory Protein-1 Alpha.

gram was developed to individually estimate the risk of poor QoL in elderly CHD patients after PCI (**Figure 3**). The total score of the nomogram ranged from 0 to 260, corresponding to a predicted probability of poor QoL ranging from 1% to 90%.

Table 5. Collinearity analysis of influencing factors for QoL in elderly CHD patients after PCI

Characteristic	VIF	Tolerance
Age (years, mean ± SD)	1.859	0.538
Smoking history (n, %)	1.206	0.829
Marital status (n, %)	1.251	0.799
Combined hypertension (n, %)	1.335	0.749
SAS score (points, mean ± SD)	1.646	0.607
SDS score (points, mean ± SD)	1.300	0.769
T-wave inversion (n, %)	1.285	0.778
LVEF (%, mean ± SD)	1.186	0.843
PSGL-1 (U/mL, mean ± SD)	1.543	0.648
MIP-1α (ng/L, mean ± SD)	1.275	0.784

Note: CHD, coronary heart disease; QoL, quality of life; PCI, percutaneous coronary intervention; SAS, Self-Rating Anxiety Scale; SDS, Self-Rating Depression Scale; LVEF, left ventricular ejection fraction; PSGL-1, P-selectin Glycoprotein Ligand-1; MIP-1α, Macrophage Inflammatory Protein-1 Alpha.

The nomogram demonstrated outstanding discriminative ability. The area under the curve (AUC) for the model was 0.977 (95% CI: 0.946 to 1.000), with a sensitivity of 96.4% and a specificity of 92.9% (**Table 7**). The ROC curves for both the nomogram and each individual predictor are presented in **Figure 4**. As detailed in **Table 7**, age exhibited the strongest predictive ability, with an AUC of 0.876, a sensitivity of 82.1%, and a specificity of 85.7%. The AUC for smoking history was 0.732 with a sensitivity of 82.1% and a specificity of 64.3%. The AUCs were 0.777 and 0.763 for SDS score and PSGL-1 level, respectively, with a sensitivity of 78.6% and a specificity of 60.7% for SDS score and 75% and 82.1% for PSGL-1 level, respectively.

Discussion

PCI can relieve stenosis and improve cardiac function in CHD patients; however, it is not curative. The reported restenosis rate ranges 20% to 60%, with a 10-year mortality rate exceeding 30% [31-33]. Cardiac rehabilitation care aims to promote comprehensive recovery and improve the quality of life by improving lifestyle, mental state, and physical function. Therefore, this study sought to develop a predictive model for poor QoL and to identify factors influencing QoL in elderly CHD patients after PCI, while also evaluating the effectiveness of a cardiac rehabilitation nursing mode.

Our findings identified age, smoking history, SDS score, and PSGL-1 level as independent risk factors for poor QoL after PCI in elderly patients with CHD. In addition, the cardiac rehabilitation nursing care significantly improved cardiorespiratory function, mental health, and exercise endurance through comprehensive interventions, such as personalized exercise training and structured psychological counseling, thus effectively improving postoperative QoL.

The developed nomogram demonstrated exceptional predictive performance, with an overall AUC of 0.977. While previous studies have developed valuable nomograms for predicting clinical outcomes such as mortality [34] and psychological outcomes like post-AMI depression [35], our model uniquely integrates physiological, behavioral, psychological, and inflammatory data to reflect the multifactorial nature of QOL recovery. Critically, this predictive tool directly informs rehabilitation intensity stratification, translating risk assessment into personalized intervention allocation - an advancement beyond conventional static prediction models. The integration of predictive nomogram with an evidence-based rehabilitation nursing model supports a promising “predict-and-preempt” strategy for personalized post-PCI care, shifting care from uniform intervention to targeted management based on individual risk profiles.

Among the predictors, age demonstrated the highest discriminative ability, with an AUC of 0.876, which is consistent with previous studies [36, 37]. This may be attributed to poorer surgical tolerance and delayed postoperative recovery in older patients, who are more prone to cardiac adverse events after PCI, resulting in reduced QoL [38]. Advanced age exacerbates chronic inflammation through enhanced nuclear factor kappa-B (NF-κB) activation, which upregulates PSGL-1 expression, creating a prothrombotic milieu that impairs both myocardial microvascular perfusion and endothelial regeneration post-PCI. Our cardiac rehabilitation model directly targets this pathway. Progressive exercise training suppresses NF-κB signaling by shear stress-mediated mechanotransduction, while polyphenols derived from the Mediterranean diet inhibit NF-κB kinase

Table 6. Multivariate Logistic regression analysis of influencing factors for QoL in elderly CHD patients after PCI

Characteristic	*β*	*SE*	*Wald* χ^2	*P*	*OR*	95% *CI*
Age (years, mean ± SD)	0.591	0.248	5.662	0.017	1.805	1.110-2.937
Smoking history (n, %)	3.254	1.595	4.161	0.041	25.904	1.136-590.635
SDS score (points, mean ± SD)	0.373	0.181	4.238	0.040	1.453	1.018-2.073
PSGL-1 (U/mL, mean ± SD)	0.067	0.031	4.590	0.032	1.069	1.006-1.136

Note: CHD, coronary heart disease; QoL, quality of life; PCI, percutaneous coronary intervention; SDS, Self-Rating Depression Scale; PSGL-1, P-selectin Glycoprotein Ligand-1.

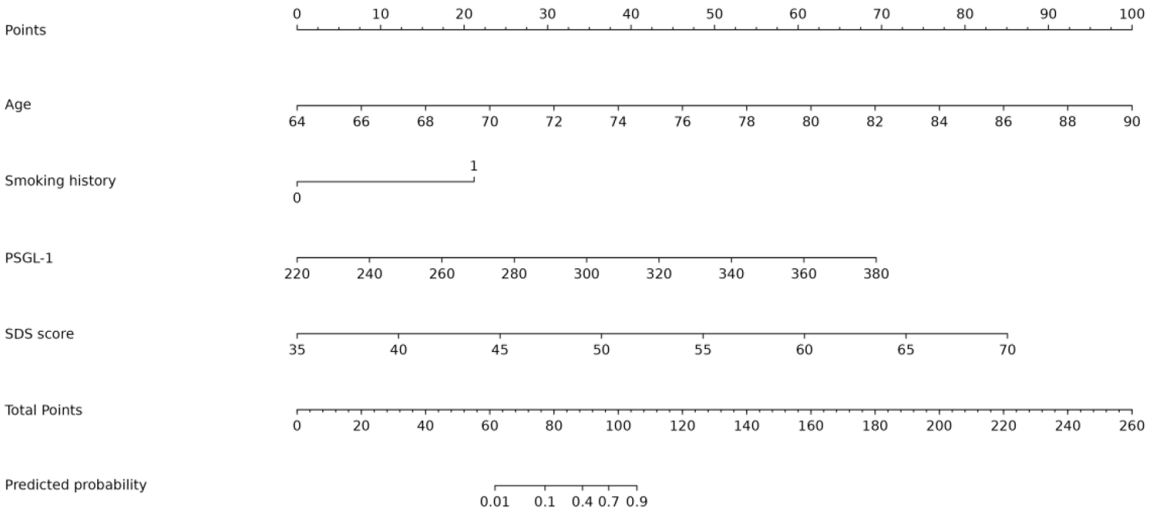

Figure 3. Nomogram for predicting the risk of poor quality of life in elderly CHD patients after PCI. Note: CHD, coronary heart disease; PCI, percutaneous coronary intervention; SDS, Self-Rating Depression Scale; PSGL-1, P-selectin Glycoprotein Ligand-1.

Table 7. Predictive performance of the nomogram and each constituent variables for poor QoL after PCI in elderly patients with CHD

Characteristic	AUC	Sensitivity	Specificity	Youden index	cut-off value	95% *CI*
Age (years, mean ± SD)	0.876	0.821	0.857	0.679	74.165	0.786-0.967
Smoking history (n, %)	0.732	0.821	0.643	0.464	0.500	0.616-0.848
SDS score (points, mean ± SD)	0.777	0.786	0.607	0.667	40.500	0.658-0.895
PSGL-1 (U/mL, mean ± SD)	0.763	0.750	0.821	0.808	276.050	0.629-0.897
Total	0.977	0.964	0.929	0.893	0.495	0.946-1.000

Note: CHD, coronary heart disease; QoL, quality of life; PCI, percutaneous coronary intervention; SDS, Self-Rating Depression Scale; PSGL-1, P-selectin Glycoprotein Ligand-1.

Inhibitor, collectively downregulating PSGL-1 and facilitating myocardial repair. Smoking history, an intervenable behavioral factor, also showed moderate predictive value (AUC = 0.732). Its associated risk is likely related to endothelial dysfunction and enhanced inflammatory responses. Studies have identified smoking as a major contributor to accelerated arteriosclerosis, adversely affecting postoperative QoL and promoting disease recurrence [39, 40], which is consistent with our findings. Smoking-induced oxidative stress triggers PSGL-1-mediated platelet aggregation, amplifying NF-κB signaling that damages endothelial integrity and elevates cardiac Troponin I (cTnI) levels, thereby accelerating arteriosclerosis and reducing exercise tolerance. Nutritional intervention in our protocol (omega-3 fatty

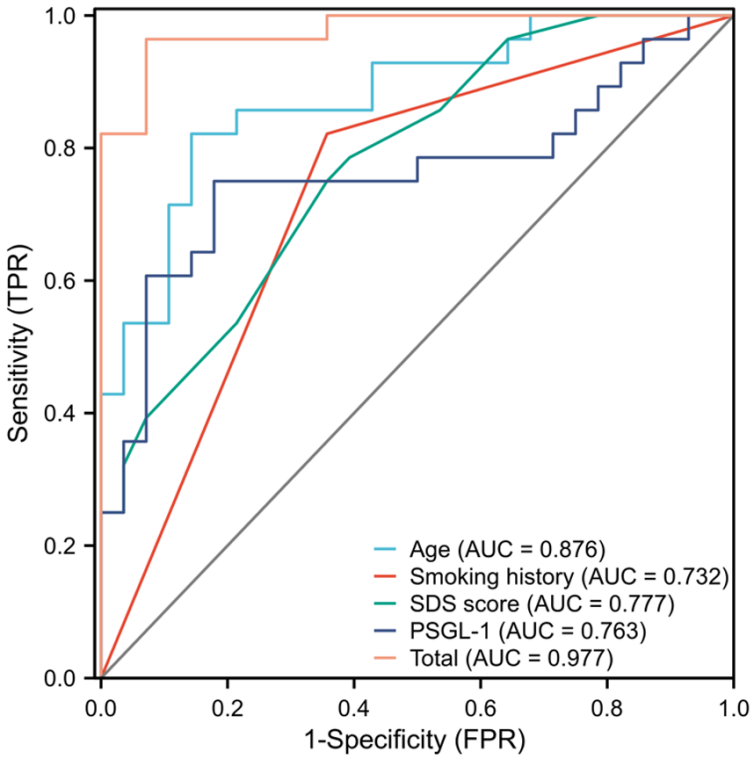

Figure 4. Receiver operating characteristic curves of the predictive model and its individual variables. Note: SDS indicates Self-Rating Depression Scale; PSGL-1 indicates P-selectin Glycoprotein Ligand-1.

acids 2 g/day) mitigates this by enhancing endothelial nitric oxide synthase-derived nitric oxide (NO) production and reducing Endothelin-1 (ET-1), directly repairing smoking-induced endothelial injury.

Higher SDS scores also showed good predictive performance (AUC = 0.777). Extensive evidence [41, 42] indicates that psychological factors such as depression and anxiety adversely affects both the incidence and prognosis of CHD, a conclusion confirmed by our study. Psychological stress elevates catecholamines, which promote PSGL-1-dependent platelet activation and impair myocardial perfusion, while NF-κB-mediated cardiomyocyte apoptosis contributes to increased creatine kinase-MB (CK-MB) leakage. Mindfulness training in our intervention reduced sympathetic overactivation, thereby attenuating catecholamine-induced PSGL-1 upregulation and interrupting the platelet-NF-κB-cardiomyocyte injury cascade.

We innovatively included inflammatory markers into the risk factor analysis and found that higher PSGL-1 was associated with reduced QoL after PCI in elderly CHD patients (AUC = 0.763), suggesting a central role of chronic inflammation in postoperative recovery. Li et al. [43] reported that elevated serum PSGL-1 levels promote inflammatory response and contribute to pulmonary infection after coronary artery bypass grafting in elderly CHD patients, possibly through NF-κB pathway-mediated inhibition of myocardial repair. As a key platelet activation marker, PSGL-1 orchestrates a cascade wherein platelet-NF-κB crosstalk suppresses endothelial nitric oxide synthase-derived NO production and elevates ET-1, impairing endothelial-dependent vasodilation and myocardial oxygen supply. Our rehabilitation model theoretically interrupts this cascade at three levels - exercise suppresses NF-κB, nutrition restores NO/ET-1 balance, and mindfulness reduces catecholamine-driven PSGL-1 expression - offering comprehensive protection beyond single-target interventions.

SAS and SDS are core tools for assessing psychological stress, and their scores objectively reflect the effectiveness of cardiac rehabilitation nursing on patients' mental health. In this study, SAS and SDS scores reduced significantly in both groups at 7 days and 6 months after PCI, with significantly lower scores observed in the observation group compared to the control group. Similarly, the QoL scores significantly improved in both groups at 7 days and 6 months after surgery, with the observation group demonstrating a more significant improvement. Anxiety, depression and other negative emotions due to worries about the prognosis of the disease, lack of confidence in rehabilitation training, and poor treatment adherence are associated with an increased risk of postoperative adverse cardiovascular events, seriously affecting the QoL of patients [44]. By comprehensively assessing patients' psychological status and implementing target-

ed psychological care, these negative emotions can be alleviated, confidence in rehabilitation enhanced, and compliance behavior improved, finally translating into improved QoL after surgery [45]. Unlike the conventional nursing approach, which focused on routine cardiac rehabilitation without standardized psychological protocols [50], our multi-component intervention integrates mindfulness training (5-10 min/session) with exercise prescription, possibly explaining the more pronounced reduction in SDS scores. Our findings extend previous findings by demonstrating that brief, nurse-led mindfulness can enhance exercise adherence, thereby improving QoL through dual pathways - directly reducing anxiety and indirectly enhancing rehabilitation compliance [46]. Mechanistically, this effect may be mediated by mindfulness-induced reduction of catecholamine-driven PSGL-1 upregulation, interrupting the neuroinflammatory cascade that impairs myocardial perfusion.

In terms of cardiac function, the 6MWT, LVEF and ST-segment regression rates in the observation group were significantly higher than those in the control group at 6 months after surgery, while the t-wave inversion rate and LVEDd were significantly lower. These findings indicate that the cardiac rehabilitation nursing model is superior to routine nursing in improving postoperative cardiac function. This may be attributed to the comprehensive intervention measures, including exercise training, psychological intervention, and nutritional guidance, which enhance myocardial oxygen supply and metabolic efficiency, promote myocardial cell repair and regeneration, thereby enhancing myocardial contractility. These results are consistent with the results reported by Xia et al. [18]. However, their study utilized supervised, gym-based training (3 times per week for 12 weeks), whereas our protocol emphasizes progressive home-based exercises supported by remote monitoring. The comparable LVEF improvement suggests that nurse-facilitated, self-management-oriented rehabilitation models may be equally effective and more sustainable for community-dwelling patients, addressing a critical gap in resource-limited settings. Our study observed a significant increase in the T-wave inversion rate at 7 days after PCI, although no significant inter-group difference was seen. Lalonde et al. [47] reported that early and deep T-wave inversion after reperfusion treatment reflects successful myocardial tissue-level reperfusion, reduced infarct size, and improved perfusion of stunned myocardium, leading to better recovery of cardiac function, which support our results. Building upon these findings, we propose that the Mediterranean diet adopted in our rehabilitation program may accelerate T-wave normalization through attenuating inflammatory responses associated with reperfusion injury. Unlike Lalonde's study, which focused solely on ECG markers, our integration of nutritional intervention provides a plausible mechanistic extension: omega-3 fatty acids likely reduce ischemia-reperfusion oxidative stress, contributing to faster recovery from myocardial stunning. At the molecular level, this may be mediated by NF-κB suppression and consequent reduction of PSGL-1-mediated platelet aggregation in the microcirculation. There was no significant difference in LVEDd between the two groups at 7 days after surgery, which may reflect the limited capacity of early rehabilitation interventions to rapidly reverse established ventricular remodeling. Early postoperative care is primarily effective in controlling inflammation and stabilizing hemodynamics, but structural abnormalities typically require longer intervention periods to improve [48]. This early-phase structural lag contrasts with clinical trials of high-intensity statin therapy, in which reductions in LVEDd are often observed within 1-4 weeks, suggesting that lifestyle-based anti-inflammatory interventions operate through distinct temporal dynamics, requiring > 1 month to manifest structural benefits. Our extended 6-month follow-up captured this delayed effect, providing evidence that comprehensive rehabilitation can achieve comparable reverse remodeling to pharmacological interventions, albeit via slower, more sustainable pathways. The delayed LVEDd improvement may reflect our PSGL-1-targeted anti-inflammatory approach, which requires sustained NF-κB suppression to reverse ventricular remodeling.

In addition, inflammatory response play a critical role in postoperative recovery following PCI. Studies have shown that inflammatory cytokines are closely related to thrombosis and vascular restenosis after PCI [49]. The lev-

els of PSGL-1, sCD14-ST and MIP-1α in the observation group were significantly lower than those in the control group at 7 days and 6 months after surgery, which may be partially due to the inhibition of NF-κB pathway activity induced by the Mediterranean diet in the rehabilitation program, leading to reduced platelet activation and attenuated monocyte chemotaxis, thereby contributing to improved cardiac function. This multi-pathway synergy - exercise reducing monocyte chemotaxis via shear stress, nutrition inhibiting NF-κB upstream, and mindfulness attenuating sympathetic drive - offers superior anti-inflammatory outcomes compared to single-target pharmacological interventions, establishing a mechanistic rationale for the superior efficacy of our comprehensive cardiac rehabilitation nursing [50].

Despite the positive results of this study, there are still some limitations. First, the sample size of the study was small and from a single center, which may limit the generalizability of PSGL-1 threshold across diverse populations. Future implementation studies should evaluate protocol feasibility in resource-limited primary hospitals and adapt cultural components (e.g., walnut oil for Xinjiang patients). Objective compliance monitoring (smart bracelets, mobile apps) and ethnic-specific cultural adaptations may further improve the broad applicability and accuracy of the results. Implementing wearable-based tracking will enable real-world effectiveness evaluation. Second, the short follow-up period (6 months) did not assess long-term durability of PSGL-1 suppression and QoL improvement. Third, this study did not include systematic recording of patient adherence metrics, such as exercise completion rates and dietary adherence. Fourth, the protocol was validated exclusively in Han Chinese patients, limiting generalizability to other ethnic groups. Future studies should extend follow-up to 1-2 years and incorporate diverse ethnic cohorts. Furthermore, future studies should include subgroup analyses and external validation to evaluate the model's utility in clinical decision-making.

Conclusion

Age, smoking history, SDS score, and PSGL-1 level are independent factors affecting QoL in elderly CHD patients after PCI. The cardiac rehabilitation nursing model can significantly improve the mental health, cardiac function, and physiologic indexes in such patient population, so as to effectively improve their quality of life after surgery. These findings provide a scientific basis for optimizing clinical nursing strategies and offer practical guidance for improving overall health level and long-term prognosis in elderly patients with coronary heart disease.

Acknowledgements

We are grateful to the medical staff of Turpan People's Hospital for their support and help. We would also like to thank all the participants in this study. This study was supported by the open research project of the State Key Laboratory for the causes and control of high incidence of diseases in Central Asia (No. SKL-HIDCA2024-TLF8) and the scientific research sailing cultivation fund.

Informed consent was obtained from all subjects involved in the study.

Disclosure of conflict of interest

None.

Address correspondence to: Yan Hou, Internal Medicine Area, Turpan People's Hospital, No. 280, Kumtag Road, Gaochang District, Turpan 838000, Xinjiang Uygur Autonomous Region, China. E-mail: 15026269919@163.com

References

[1] Roth GA, Mensah GA, Johnson CO, Addolorato G, Ammirati E, Baddour LM, Barengo NC, Beaton AZ, Benjamin EJ, Benziger CP, Bonny A, Brauer M, Brodmann M, Cahill TJ, Carapetis J, Catapano AL, Chugh SS, Cooper LT, Coresh J, Criqui M, DeCleene N, Eagle KA, Emmons-Bell S, Feigin VL, Fernandez-Sola J, Fowkes G, Gakidou E, Grundy SM, He FJ, Howard G, Hu F, Inker L, Karthikeyan G, Kassebaum N, Koroshetz W, Lavie C, Lloyd-Jones D, Lu HS, Mirijello A, Temesgen AM, Mokdad A, Moran AE, Muntner P, Narula J, Neal B, Ntsekhe M, Moraes de Oliveira G, Otto C, Owolabi M, Pratt M, Rajagopalan S, Reitsma M, Ribeiro ALP, Rigotti N, Rodgers A, Sable C, Shakil S, Sliwa-Hahnle K, Stark B, Sundstrom J, Timpel P, Tleyjeh IM, Valgimigli M, Vos T, Whelton PK, Yacoub M, Zuhlke L, Murray C and Fuster V; GBD-NHLBI-JACC

Global Burden of Cardiovascular Diseases Writing Group. Global burden of cardiovascular diseases and risk factors, 1990-2019: update from the GBD 2019 study. J Am Coll Cardiol 2020; 76: 2982-3021.
[2] Guo J, Wang H, Li Y, Zhu S, Hu H and Gu Z. Nanotechnology in coronary heart disease. Acta Biomater 2023; 171: 37-67.
[3] Tang YP, Li JQ, Zhang M, Liu X, Liu Ying Y, Gao Y, You N and Liu T. Relationship between exercise fear and exercise compliance in patients with coronary heart disease after percutaneous coronary intervention. J Nurses Train 2024; 39: 225-229.
[4] Wang L, Li X, Li T, Liu L, Wang H and Wang C. Novel application of drug-coated balloons in coronary heart disease: a narrative review. Front Cardiovasc Med 2023; 10: 1055274.
[5] Diseases NCfC, Health TWCotRoC and China Di. China cardiovascular health and disease report 2024: summary. Chin Circ J 2025; 40: 521-559.
[6] Lawton JS, Tamis-Holland JE, Bangalore S, Bates ER, Beckie TM, Bischoff JM, Bittl JA, Cohen MG, DiMaio JM, Don CW, Fremes SE, Gaudino MF, Goldberger ZD, Grant MC, Jaswal JB, Kurlansky PA, Mehran R, Metkus TS Jr, Nnacheta LC, Rao SV, Sellke FW, Sharma G, Yong CM and Zwischenberger BA. 2021 ACC/AHA/SCAI Guideline for coronary artery revascularization: executive summary: a report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. Circulation 2022; 145: e4-e17.
[7] Yi XM. Quality of life and its influencing factors in patients with coronary artery disease after PCI in a first-class hospital in Xi'an [D]. Xi'an Medical College 2023.
[8] Moreno PR, Stone GW, Gonzalez-Lengua CA and Puskas JD. The hybrid coronary approach for optimal revascularization: JACC review topic of the week. J Am Coll Cardiol 2020; 76: 321-333.
[9] Al-Duhoun AH, Hjazeen AA, Atout M and Bani Salameh AWF. Impact of percutaneous coronary interventions (PCIs) on health outcomes from a jordanian patient's perspective. Healthcare (Basel) 2025; 13: 1491.
[10] Chen SL, Chen WL, Ding WW, Li XH, Deng HM and Huang QB. Remote health management via WeChat to improve the quality of life of patients after PCI. Qual Manag Health Care 2024; 33: 160-165.
[11] Luo XB and Li YH. The efficacy of traditional Chinese Medicine emotional care combined with Ba Duan Jin in the rehabilitation care of patients after PCI for coronary artery disease. J Cardiovasc Rehabil Med 2025; 34: 553-558.
[12] Xia K, Wang LF, Yang XC, Jiang HY, Zhang LJ, Yao DK, Hu DY and Ding RJ. Comparing the effects of depression, anxiety, and comorbidity on quality-of-life, adverse outcomes, and medical expenditure in Chinese patients with acute coronary syndrome. Chin Med J (Engl) 2019; 132: 1045-1052.
[13] Liu YF, Ding RJ, Meng XP, Wang LM, Shen XJ, Shen L, Cai XJ, Yue RH, Shen YQ, Xu DY and Hu DY. Self-reported quality of life and its influencing factors in patients with coronary heart disease. Chin J Intern Med 2023; 62: 384-392.
[14] Du R, Wang P, Ma L, Larcher LM, Wang T and Chen C. Health-related quality of life and associated factors in patients with myocardial infarction after returning to work: a cross-sectional study. Health Qual Life Outcomes 2020; 18: 190.
[15] Shu QH, Liang FF and Tang XR. Effect of routine nursing and high-quality nursing mode on the condition and prognosis of patients with acute myocardial infarction undergoing PCI. Chin J Clin Nurs 2024; 3.
[16] Li Q, Li H, Ma H and Peng H. Application of medical and nursing integrated health education of new media in patients with coronary heart disease after PCI. Chin J Cardiovasc Dis Prev Treat 2020; 20: 226-229.
[17] Chen XN, Luo XJ, Jian XY and Ye XL. Effect of cardiac rehabilitation guidance combined with comfort nursing on patients with acute myocardial infarction after PCI. Qilu Nurs 2020; 26: 84-87.
[18] Xia MJ and Liu WJ. Effect of cardiac rehabilitation nursing on patients with coronary heart disease after PCI and its influence on pulmonary function [c]//China Tuberculosis Association. Proceedings of the founding conference of Ultrasound branch of China Tuberculosis Association and the first national tuberculosis ultrasound medical academic conference. Wuxue first People's Hospital 2025; 184-188.
[19] Hamad M, Smadi SA and Arabiat D. A multivariate analysis of reported quality of life among medical students in Jordan using the WHOQOL-BREF. J Educ Health Promot 2025; 14: 194.
[20] Wang XM and Sun N. Effect of early cardiac rehabilitation nursing on quality of life and incidence of adverse cardiovascular events in patients with coronary heart disease after percutaneous coronary intervention. Chin Pract Med 2021; 16: 197-199.
[21] Writing Group of Chinese Guidelines for the Management of Hypertension CHL, Chinese Society of Cardiology, Chinese Medical Doctor Association Hypertension Committee, Hypertension Branch of China International Exchange, Medical PAf and Health Care HBoCG-

MA. Chinese guidelines for the prevention and treatment of hypertension (2018 revised edition). Chin J Cardiovasc Dis 2019; 24: 24-56.
[22] Society CD. Chinese guidelines for the prevention and treatment of type 2 diabetes (2020 edition). Chin J Pract Intern Med 2021; 41: 668-695.
[23] Zhu JR, Gao RL, Zhao P, Lu GP, Zhao D and Li JJ. Chinese guidelines for the prevention and treatment of dyslipidemia in adults (2016 revised edition). Chin Circ J 2016; 31: 937-953.
[24] World Health Organisation. Guidelines for controlling and monitoring the tobacco epidemic. World Health Organisation; 1997.
[25] Guide to diagnosis and treatment of nonalcoholic fatty liver disease in traditional Chinese medicine (primary doctors edition). Chin Integr Tradit West Med Liver Dis 2019; 29: 483-486.
[26] Shen L, Meng XP, Chen XM, Zhu LY, Wang M and Cao YJ. Expert consensus on cardiac rehabilitation nursing. Chin Nurs 2022; 57: 1937-1941.
[27] Gao RL. Guidelines for the diagnosis and treatment of acute myocardial infarction. Chin J Cardiovasc Dis 2001; 9-24.
[28] Tung VS, Thong NV, Mai NP, Linh LT, Son DC, Ha TT, Hoa NT, Long NT and Tuan NV. Diagnostic value in screening severe depression of the hamilton depression rating scale, hamilton anxiety rating scale, beck depression inventory scale, and Zung's self-rating anxiety scale among patients with recurrent depression disorder. Acta Inform Med 2023; 31: 249-253.
[29] Zhao Y, Niu H and Liu S. Effects of aerobics training on anxiety, depression and sleep quality in perimenopausal women. Front Psychiatry 2022; 13: 1025682.
[30] Chinese Society of Cardiology, Chinese Medical Association; Professional Committee of Cardiopulmonary Prevention and Rehabilitation of Chinese Rehabilitation Medical Association; Editorial Board of Chinese Journal of Cardiology. Chinese expert consensus on standardized clinical application of 6-minute walk test. Zhonghua Xin Xue Guan Bing Za Zhi 2022; 50: 432-442.
[31] Ponce-Regalado MD, Becerril-Villanueva E, Maldonado-Garcia JL, Moreno-Lafont MC, Martinez-Ramirez G, Jacinto-Gutierrez S, Arreola R, Sanchez-Huerta K, Contis-Montes de Oca A, Lopez-Martinez KM, Bautista-Rodriguez E, Chin-Chan JM, Pavon L and Perez-Sanchez G. Comprehensive view of suicide: a neuro-immune-endocrine approach. World J Psychiatry 2025; 15: 98484.
[32] Chen Y, Ji M, Wu Y, Deng Y, Wu F and Lu Y. Individualized mobile health interventions for cardiovascular event prevention in patients with coronary heart disease: study protocol for the iCARE randomized controlled trial. BMC Cardiovasc Disord 2021; 21: 340.
[33] Jiao HX, He YF and Lin WH. Effect of cardiac rehabilitation exercise on the condition and prognosis of patients after PCI. Chongqing Med 2022; 51: 834-837+841.
[34] Zheng S, Lyu J, Han D, Xu F, Li C, Yang R, Yao L, Wu Y and Tian G. Establishment of a prognostic model based on the sequential organ failure assessment score for patients with first-time acute myocardial infarction. J Int Med Res 2021; 49: 3000605211011976.
[35] Ren L, Wang H, Su X, Yang Y, Zhang Y, Yin X, Zhang D, Hu G and Ning B. Construction of a predictive model for depressive symptoms following acute myocardial infarction and its impact on prognosis. Front Psychiatry 2025; 16: 1431182.
[36] Zou Y, Chen YF, Huang N, Kuang XY. Quality of life in patients with coronary heart disease after percutaneous coronary intervention. Nurs Pract Res 2019; 16: 39-40.
[37] Xu H and Tao J. Influencing factors of quality of life in patients with coronary heart disease after PCI and its continuous nursing strategy. Nurs Pract Res 2020; 17: 13-15.
[38] Yi ZH, Mai AH, Xu SL, Li L and Yang F. Effect of cognitive behavior combined with psychological intervention on compliance behavior, self-care ability and quality of life after PCI in patients with cerebral infarction and coronary heart disease. Nurs Pract Res 2019; 16: 10-13.
[39] Tian YZ and Zhu JP. Analysis of influencing factors on quality of life of patients after intracoronary stent implantation and nursing countermeasures. Health Res 2015; 35: 586-587.
[40] Mi DH, Zhao XH, Gong XP, Dong KH, Zhao XQ, Wang CX, Wang YL, Wang YJ and Liu LP. Analysis of risk factors affecting the symmetrical distribution of arteriosclerosis vulnerable plaques. Chin Stroke J 2017; 12: 609-613.
[41] Albus C, Waller C, Fritzsche K, Gunold H, Haass M, Hamann B, Kindermann I, Kollner V, Leithauser B, Marx N, Meesmann M, Michal M, Ronel J, Scherer M, Schrader V, Schwaab B, Weber CS and Herrmann-Lingen C. Significance of psychosocial factors in cardiology: update 2018: position paper of the German Cardiac Society. Clin Res Cardiol 2019; 108: 1175-1196.
[42] Kupper N, van den Houdt S, Kuijpers P and Widdershoven J. The importance, consequences and treatment of psychosocial risk factors in heart disease: less conversation, more action! Neth Heart J 2024; 32: 6-13.
[43] Li R, Li L, Yang J and Guo HP. Diagnostic value of Serum Psgl-1, presepsin and mip-1α in pulmonary infection after coronary artery bypass

grafting in elderly patients with coronary heart disease. Lab Med Clin 2025; 22: 1311-1316.
[44] Zhang XH. Study on the relationship between social support and hope, negative emotion, compliance behavior in patients with coronary heart disease after PCI. J Bengbu Med Coll 2021; 46: 1141-1145.
[45] Li DY, Li FL, Pan MD and Zhao LL. Effect of IMB combined with comprehensive nursing on self-management, negative emotion management and prognosis of patients with coronary heart disease undergoing PCI. J Cardiovasc Rehabil Med 2020; 29: 703-707.
[46] Huang C. Effect of new cardiac rehabilitation mode on cardiac function, mental state and quality of life of postoperative patients with acute myocardial infarction treated with atorvastatin calcium tablet. Eur Rev Med Pharmacol Sci 2023; 27: 3406-3419.
[47] Lalonde A, Daviss BA, Acosta A and Herschderfer K. Postpartum hemorrhage today: ICM/FIGO initiative 2004-2006. Int J Gynaecol Obstet 2006; 94: 243-253.
[48] He W, Li YM, Zhou X, Peng P, Qin YS and Bo H. Changes of ventricular remodeling and mitochondria in rats with myocardial infarction after short-term high-intensity interval training. Chin J Tissue Eng Res 2016; 20: 5986-5993.
[49] Khodayari S, Khodayari H, Amiri AZ, Eslami M, Farhud D, Hescheler J and Nayernia K. Inflammatory microenvironment of acute myocardial infarction prevents regeneration of heart with stem cells therapy. Cell Physiol Biochem 2019; 53: 887-909.
[50] Ling K, Zhou W, Guo Y, Hu G, Chu J, Xie F, Li Y and Wang W. H(2)S attenuates oxidative stress via Nrf2/NF-kappaB signaling to regulate restenosis after percutaneous transluminal angioplasty. Exp Biol Med (Maywood) 2021; 246: 226-239.