



Using path analysis to investigate the relationships between depression, anxiety, and health-related quality of life among patients with coronary artery disease

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Abstract

Purpose Demographic and clinical indicators usually influence depression, anxiety, and health-related quality of life (HRQoL) in patients with coronary artery disease (CAD). The aim of this study was to assess the direct and indirect association that existed among the identified variables, psychosocial status, and HRQoL in CAD patients.

Methods CAD patients with at least one of the main coronary artery and/or branch stenosis over 50% were eligible for inclusion. HRQoL, depression, and anxiety were tested by questionnaires within 3 days after angiography. Mono-factor and multiple linear regression models were used to examine the independent associations of depression, anxiety, and HRQoL. A path analysis was conducted to examine the association among demographic/clinical indicators, depression, anxiety, and HRQoL.

Results The sample consisted of 414 subject, patients with depression accounted for 40.82%, and patients with anxiety accounted for 25.12%. The direct effects of SAS scores on HRQoL ($B = -0.26$, $\beta = -0.16$), of SDS scores on HRQoL ($B = -0.70$, $\beta = -0.47$), of gender on HRQoL ($B = 4.05$, $\beta = 0.17$), and of NYHA classification on HRQoL ($B = -3.46$, $\beta = -0.18$) were significant ($p < 0.001$). The indirect effects of gender on HRQoL ($B = 2.16$, $\beta = 0.09$) and of Gensini scores on HRQoL ($B = -0.06$, $\beta = -0.08$) were also statistically significant ($p < 0.001$).

Conclusions Depression and anxiety were common CAD patients and played an important role in HRQoL. Gender differences were found in determinants of HRQoL and the state of depression and anxiety directly, and women's anxiety, depression, and quality of life were worse than men's. NYHA classification and Gensini scores also played direct and indirect role in HRQoL, respectively.

Keywords Coronary artery disease · Health-related quality of life · Depression · Anxiety · Path analysis

Introduction

Coronary artery disease (CAD) is a common chronic disease of high morbidity and mortality [1, 2]. It has long been ranked the main cause of death globally [3]. Mortality

and morbidity have traditionally been the outcome in studies of CAD. As medicine and interventional therapy have evolved, health-related quality of life (HRQoL) has become another important indicator of CAD outcome to evaluate the severity of the disease and the effectiveness of its therapy [4–6]. HRQoL is a measure of the general well-being of individuals and societies, which can reflect how a disease and its symptoms influence physical, mental, emotional, and social functioning [7]. CAD is associated with both physical and mental disorders. Patients experience these symptoms including angina, fatigue, decline in activity, or edema, which would further influence the physical and psychological states [8]. Previous research shows that CAD patients reported impaired HRQoL and more psychological distress (symptoms of anxiety and depression, and relative absence of positive affect) compared with the control group

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[9]. Thus, identifying the patients' HRQoL and psychosocial status and clarifying the contributing factors is of great importance.

Over the past decade, several studies have focused on detecting the factors related to HRQoL or psychosocial status in CAD patients. Some studies explored risk factors associated with impaired HRQoL [4, 10, 11]. Other studies focused on the factors associated with psychosocial status [9, 12]; for example, it was reported that gender difference was one of the risk factors affecting psychosocial distress [9]. In another study, psychosocial factors (anxiety, depression) seemed to be more important predictors of change in HRQoL compared with some objective medical indicators (ejection fraction) among patients with coronary disease [13]. However, each of these studies examined only the factors related to HRQoL, or the factors associated with psychological status, or the relationship between emotional distress and HRQoL at a time. Previous studies have focused on finding factors that directly affect HRQoL, which may lead to the neglect of some indirect associations. In this study, we concentrated on exploring the direct and indirect relationships that exist among the demographic/clinical variables, psychosocial states, and HRQoL in patients with CAD. The aim of this study was to assess the status of depression, anxiety, and HRQoL, and conduct a path analysis to examine the relationship among demographic/clinical indicators, depression, anxiety, and HRQoL in patients with a definite CAD diagnosis by the gold standard of coronary angiogram.

Materials and methods

Study sample

This study was approved by the ethics committee of Nantong University. The CAD patients were recruited from September 2015 to December 2017 in Nantong Rich Hospital. Patients with acute ST-elevation myocardial infarction, previous stenting, liver and kidney dysfunction, unstable cerebral lesions, malignant tumor, serious complications, such as pericarditis, pleuritis, atrial fibrillation, atrial flutter, atrioventricular block, bundle branch block and other arterial embolism, and patients with cognitive impairment or severe mental illness who weren't able to complete the questionnaire survey were excluded. According to the result of angiography, a value of at least one of the main coronary artery and/or branch stenosis over 50% was considered a significant stenosis [14, 15]. A total of 414 patients meeting the criteria were enrolled in this study.

Clinical data collection

The following clinical data were collected: (1) demographic data such as age, gender, education, family income, and traditional risk factors, including hypertension, hyperlipidemia, type 2 diabetes, smoking; (2) clinical measurements including blood pressure, New York Heart Association (NYHA) Functional Classification, body mass index (BMI), echocardiography, blood biochemical variables, such as fasting blood glucose (FBG), total cholesterol (TC), triglycerides (TG), low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), serum creatinine (SCr), creatinine clearance rate (CCR), the serum urea nitrogen (BUN), aspartate aminotransferase (AST), alanine aminotransferase (ALT), total bilirubin (TBil), Direct bilirubin (DBil). (3) Information about lesion location, the number of vascular stenosis, and the severity of stenosis were recorded in the coronary angiography. According to coronary angiography with Judkins catheters, angiographic Gensini scores were calculated to evaluate the severity of coronary artery damage [16].

NYHA functional classification was regularly assessed in clinical. NYHA class I: patients with cardiac disease but without resulting limitation of physical activity; NYHA class II: patients with cardiac disease resulting in slight limitation of physical activity who are comfortable at rest. Ordinary physical activity results in fatigue, palpitation, dyspnea, or angina pain; NYHA class III: patients with cardiac disease resulting in marked limitation of physical activity; NYHA class IV: patients with cardiac disease resulting in inability to carry on any physical activity without discomfort. Blood samples were obtained after an overnight fast and tested immediately to measure fasting glucose, lipid profiles, and other biochemical parameters via routine laboratory methods. Hypertension was defined as a baseline systolic blood pressure of ≥ 140 mmHg or diastolic blood pressure of ≥ 90 mmHg or using antihypertensive drugs. Hyperlipidemia was diagnosed based on a total cholesterol concentration ≥ 5.72 mmol/L, a triglyceride concentration ≥ 1.70 mmol/L, or a history of having taken hyperlipidemic drug. Type 2 diabetes mellitus was defined by fasting glucose levels ≥ 7.0 mmol/L with symptoms of hyperglycemia or a 2-h glucose level ≥ 11.1 mmol/L during an oral glucose tolerance test without symptoms of hyperglycemia. BMI was calculated by dividing the weight in kilograms by the square of the height in meters.

Health-related quality of life and psychological tests

HRQoL and psychological interviews were performed by a trained physician within 3 days after coronary

angiography. HRQoL was tested using the short form (36) health survey (SF-36), which consists of eight subscale scores, including physical functioning (PF), physical role functioning (RP), bodily pain (BP), general health perceptions (GH), vitality (VT), social role functioning (SF), emotional role functioning (RE), and mental health (MH), which are the weighted sums of the questions in their section. Each scale is directly transformed into a 0–100 scale on the assumption that each question carries equal weight. The lower the score the more the disability. The higher the score the less the disability. The eight subscale scores were normalized with z-score transformation, calculated as (observed scores – mean scores)/standard deviation (SD), respectively; then, the physical health summary (PCS) and mental health summary (MCS) of SF-36 were calculated according to specific scoring algorithms in the Asian population [17]. If one half or fewer of the items in a scale were missing, the average of the non-missing items was used to represent the scale. And if more than one half of the items in a scale were missing, the scale score was declared missing.

Depression and anxiety were tested by the Chinese version of the Zung Self-Rating Depression Scale (SDS) and the Zung Self-Rating Anxiety Scale (SAS) separately [18]. The SDS and the SAS are commonly used in general medical practice to screen for depression and anxiety and to measure the severity of depression and anxiety in a number of settings [19–21]. They have been also used to assess depression and anxiety in clinical studies on cardiovascular diseases [22–25]. Each questionnaire included 20 items relating to the patient's psychological situation in a recent week, and each item is scored on a Likert scale ranging from 1 to 4. The total raw scores range from 20 to 80. According to SDS scores, the subjects were divided into 2 groups: depression group ($SDS > 44$) and non-depression group ($SDS \leq 44$). Similarly, the subjects were divided into an anxiety group ($SAS > 44$) and a non-anxiety group ($SAS \leq 44$) according to the SAS scores.

Data analysis

Continuous variables were described as mean \pm SD, and categorical variables were described as number and %. Pearson correlation of depression and anxiety with HRQoL was investigated. The demographic/clinical factors associated with psychological situation and HRQoL were analyzed by mono-factor regression firstly, and the variables with a p value of < 0.1 in mono-factor regression were included in the multiple linear regression models. Statistical analyses were performed using SPSS version 17.0 software (SPSS Inc. USA).

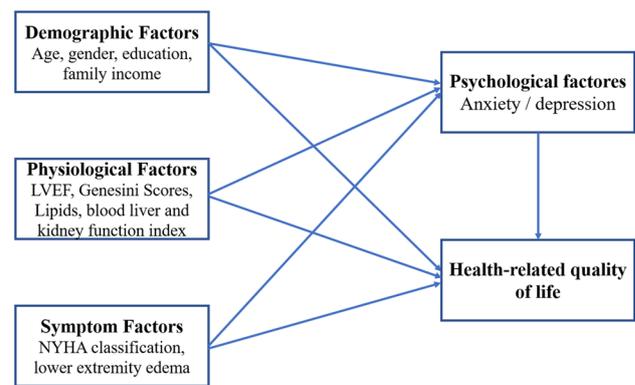


Fig. 1 Theoretical model of the relationships among demographic/clinical indicators, depression, anxiety, and HRQoL

Figure 1 shows a model to investigate the relationships among demographic/clinical indicators, depression, anxiety, and HRQoL in CAD patients using path analysis. The variables included in the path model and the direction of the relationship were based on general logic and previous studies. Associations of variables were analyzed before performing path analysis. In order to evaluate the model fit, Chi-square (χ^2) and the root mean square error of approximation (RMSEA) were used as absolute fit indices; the comparative fit index (CFI) and the normed fit index (NFI) were used as incremental fit indices in this study. A value of 0.90 or above for CFI and NFI, and the value of 0.05 or below for RMSEA were regarded as a “good fit”. The χ^2 values closer to zero indicate a better fit. χ^2 was not recommended as a judgment of model fit because it is sensitive to the sample size used in the analysis of model fit [26]. Therefore, it was only reported but not used as a fit statistic in this study. Then, direct, indirect, and total effects were examined using the bootstrap method. The AMOS 21.0 statistical program was used to analyze the path model, obtain goodness-of-fit indices and maximum-likelihood estimates of model parameters. p values reported were two tailed, and p value < 0.05 was considered significant.

Results

The mean age ($n = 414$) was 62.88 ± 10.40 years. 274 (66.18%) were male and 140 (33.82%) female. There were 165 (39.86%) cases of diabetes and 299 (72.22%) patients with hypertension. The mean score of SDS was 48.64 ± 7.55 , and the mean score of SAS was 41.14 ± 6.97 . The average score of SF-36 was 61.01 ± 11.93 . Table 1 shows the demographic and biochemical characteristics of all patients. There were 169 (40.82%) patients in the depression group and

Table 1 Descriptive statistics of clinical characteristics (*n* = 414)

| Variables | <i>N</i> (%) | Mean ± SD |
|-------------------------------------|--------------|------------------|
| Gender | | |
| Male | 274 (66.18%) | |
| Female | 140 (33.82%) | |
| Age (years) | | 62.88 ± 10.40 |
| < 65 | 221(53.38%) | |
| ≥ 65 | 193 (46.62%) | |
| Education | | |
| Primary education or below | 102 (24.64%) | |
| Secondary school education | 170 (41.06%) | |
| Higher education or above | 142 (34.30%) | |
| Family income (RMB/month) | | 4865.36 ± 578.45 |
| < 5000 | 265 (64.01%) | |
| ≥ 5000 | 149 (35.99%) | |
| NYHA classification | | |
| I | 323 (78.02%) | |
| II–IV | 91 (21.98%) | |
| Diabetes mellitus | 165 (39.86%) | |
| Hypertension | 299 (72.22%) | |
| Hyperlipidemia | 133 (32.13%) | |
| Smoking | 160 (38.65%) | |
| BMI (kg/m ²) | | 25.36 ± 3.27 |
| TC (mmol/L) | | 4.43 ± 1.00 |
| LDL-C (mmol/L) | | 2.67 ± 0.89 |
| HDL-C (mmol/L) | | 1.07 ± 0.27 |
| TG (mmol/L) | | 1.59 ± 0.88 |
| SCr (μmol/L) | | 101.59 ± 56.82 |
| CCR (mL/min × 1.73 m ²) | | 69.84 ± 23.70 |
| BUN (mmol/L) | | 6.14 ± 3.75 |
| AST (μmol/L) | | 46.57 ± 80.54 |
| ALT (μmol/L) | | 29.23 ± 36.64 |
| TBil (μmol/L) | | 12.34 ± 5.65 |
| DBil (μmol/L) | | 3.90 ± 1.80 |
| LVEF (%) | | 64.04 ± 10.51 |
| Gensini scores | | 23.43 ± 13.98 |
| SAS scores | | 41.14 ± 6.97 |
| SDS scores | | 48.64 ± 7.55 |
| SF-36 total scores | | 61.01 ± 11.93 |
| Physical functioning | | 69.71 ± 24.44 |
| Physical role functioning | | 30.92 ± 42.16 |
| Bodily pain | | 64.59 ± 20.04 |
| General health perceptions | | 48.09 ± 13.72 |
| Vitality | | 62.84 ± 16.28 |
| Social role functioning | | 79.29 ± 19.85 |
| Emotional role functioning | | 44.53 ± 35.95 |
| Mental health | | 62.43 ± 15.01 |

BMI body mass index, TC total cholesterol, LDL-C low-density lipoprotein cholesterol, HDL-C high-density lipoprotein cholesterol, TG triglycerides, SCr serum creatinine, CCR creatinine clearance rate, BUN the serum urea nitrogen, AST aspartate aminotransferase, ALT alanine aminotransferase, TBil total bilirubin, DBil Direct bilirubin, LVEF left ventricular ejection fraction

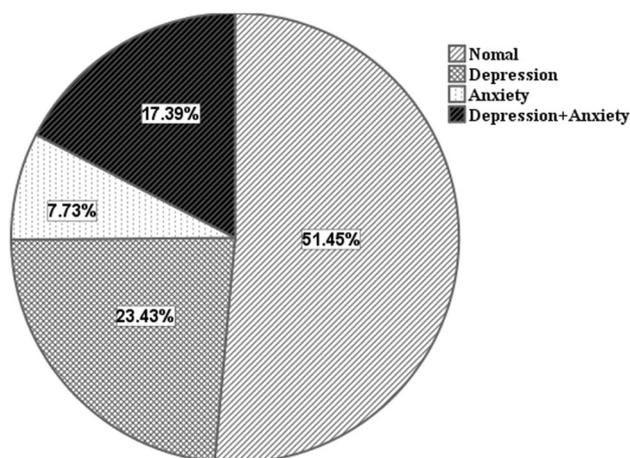


Fig. 2 The distribution of depression and anxiety

104 (25.12%) patients in the anxiety group. As is shown in Fig. 2, 72 (17.39%) patients met the criteria for both depression and anxiety according to SDS and SAS. 97 (23.43%) patients experienced depression without anxiety, and 32 (7.73%) patients suffered from anxiety without depression.

Correlation analysis revealed that total SF-36 scores were significantly negatively correlated with SAS scores (Coefficient of Pearson Correlation $r = -0.46, p < 0.001$) and SDS scores ($r = 0.57, p < 0.001$) (Fig. 3). Besides, the eight subscale scores of SF-36, including vitality, physical functioning, bodily pain, general health perceptions, physical role functioning, emotional role functioning, social role functioning, and mental health, were all significantly negatively correlated with depression and anxiety (all $p < 0.001$). Among the eight subscale scores, vitality had a relatively strong negative correlation with anxiety ($r = -0.40$) and depression ($r = -0.50$). The correlations between MCS/PCS and SAS/SDS were consistent with the results of SF-36 and its eight subscale scores (Table 2).

Table 3 provides details of the association between patients’ characteristics and HRQoL. Male had a higher SF-36 scores than the female (Unstandardized Coefficient $B = 3.28, 95\%$ confidence interval (CI) = 0.73, 5.84, $p = 0.01$). Each increase by one level of NYHA classification was associated with a 3.74-point decrease in the SF-36 score ($B = -3.74, 95\%$ CI = -5.69, -1.79, $p < 0.001$). Each increase by one score of SAS was associated with a -0.21-point decrease in the SF-36 score ($B = -0.21, 95\%$ CI = -0.41, -0.02, $p = 0.03$), and each increase by one score of SDS was associated with a -0.70-point decrease in the SF-36 score ($B = -0.70, 95\%$ CI = -0.89, -0.52, $p < 0.001$).

Univariate regression and multiple linear regression analysis was used in the factors associated with SAS scores and SDS scores (Table 4). It was found that patients with lower extremity edema had higher SAS scores ($B = 2.23,$

Fig. 3 The correlation between SAS/SDS scores and SF-36 scores

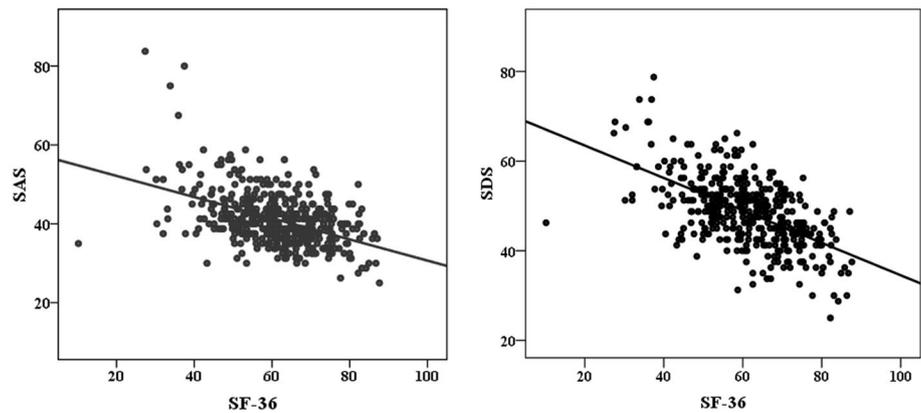


Table 2 The correlation of anxiety/depression and quality of life

| | SAS scores | | SDS scores | |
|----------------------------|------------|----------------|------------|----------------|
| | <i>r</i> | <i>p</i> value | <i>r</i> | <i>p</i> value |
| SF-36 total scores | -0.46 | <0.001 | -0.57 | <0.001 |
| Physical functioning | -0.31 | <0.001 | -0.33 | <0.001 |
| Physical role functioning | -0.25 | <0.001 | -0.21 | <0.001 |
| Bodily pain | -0.28 | <0.001 | -0.30 | <0.001 |
| General health perceptions | -0.22 | <0.001 | -0.35 | <0.001 |
| Vitality | -0.40 | <0.001 | -0.50 | <0.001 |
| Social role functioning | -0.26 | <0.001 | -0.29 | <0.001 |
| Emotional role functioning | -0.20 | <0.001 | -0.23 | <0.001 |
| Mental health | -0.27 | <0.001 | -0.45 | <0.001 |

95% CI=0.05, 4.51, $p=0.04$), and male had a lower SAS scores than the female ($B = -1.87$, 95% CI = -3.44, -0.30, $p=0.02$). Each increase of one Gensini score was associated with a 0.08-point increase in SDS score ($B = 0.08$, 95% CI = 0.03, 0.14, $p=0.002$). Male had a lower SDS scores than the female ($B = -1.62$, 95% CI = -3.12, -0.04, $p=0.04$).

The path coefficient of lower extremity edema to HRQoL was not significant ($p=0.054$); therefore, the model was adjusted by eliminating the variable of lower extremity edema. Multiple criteria were used for the evaluation of model fit. The result showed that $\chi^2 = 1.13$, RMSEA = 0.02, CFI = 0.935 and NFI = 0.908, indicating that all the fit indices were in an appropriate range, and the modified model had a good fit. Figure 4 shows the path model. The direct and indirect effects are shown in Table 5. The direct effects of gender on SAS scores ($B = -2.24$, standardized Coefficient $\beta = -0.15$, $p=0.002$), of gender on SDS scores ($B = -2.27$, $\beta = -0.14$, $p=0.003$), and of Gensini scores on SDS scores ($B = 0.09$, $\beta = 0.16$, $p < 0.001$) were statistically significant. The direct effects of SAS scores on HRQoL ($B = -0.26$, $\beta = -0.16$, $p < 0.001$), of SDS scores on HRQoL ($B = -0.70$, $\beta = -0.47$, $p < 0.001$), of gender on HRQoL ($B = 4.05$, $\beta = 0.17$, $p < 0.001$), and of NYHA classification on HRQoL

($B = -3.46$, $\beta = -0.18$, $p < 0.001$) were statistically significant. The indirect effects of gender on HRQoL ($B = 2.16$, $\beta = 0.09$) and of Gensini scores on HRQoL ($B = -0.06$, $\beta = -0.08$) were also statistically significant ($p < 0.001$).

Discussion

The aim of the present study was to assess the status of depression, anxiety, and HRQoL, and to explore the direct and indirect relationships of HRQoL, psychological health (anxiety and depression), and demographic/clinical indicators among CAD patients according to the theoretical model of dependence. In general, the variables related to depression, anxiety or HRQoL were supported by regression analysis. As expected, depression and anxiety played an important role in HRQoL, and gender and NYHA classification associated with HRQoL directly. Furthermore, gender and Gensini scores also played an indirect role in HRQoL.

The SF-36 is a commonly used measure of HRQoL and a useful tool for clinical management and has been used in many clinical studies [27–29]. In our study, the average score of SF-36 was only 61.01, which meant HRQoL of CAD patients was not high. This was mainly due to the low scores in physical role functioning, emotional role functioning and general health perceptions. It was found that total SF-36 scores, as well as all eight subscale scores, including vitality, physical functioning, bodily pain, general health perceptions, physical role functioning, emotional role functioning, social role functioning and mental health, were all significantly negatively correlated with depression and anxiety. Two-factor structures of physical and mental component summary were demonstrated in SF-36, thus reflecting an overall assessment of quality of life related to physical and mental health, respectively [17].

Previous studies reported that the prevalence of depression in patients with CAD was more than 2 times higher [30]. A meta-analysis included twenty-seven studies in China showing that the overall prevalence of depression

Table 3 Multiple linear regression analysis of the factors associated with SF-36 score

| | Univariate regression | | | Multiple regression | | |
|-------------------------------------|-----------------------|--------------|----------------|---------------------|--------------|----------------|
| | <i>B</i> | 95% CI | <i>p</i> value | <i>B</i> | 95% CI | <i>p</i> value |
| Age (years) | −0.15 | −0.26, −0.04 | 0.01 | −0.03 | −0.17, 0.11 | 0.68 |
| Gender | 6.29 | 3.93, 8.65 | <0.001 | 3.28 | 0.73, 5.84 | 0.01 |
| Education | 0.48 | −1.42, 1.57 | 0.32 | | | |
| Family income | −0.39 | −1.64, 2.02 | 0.29 | | | |
| SAS scores | −0.79 | −0.93, −0.63 | <0.001 | −0.21 | −0.41, −0.02 | 0.03 |
| SDS scores | −0.90 | −1.03, −0.78 | <0.001 | −0.70 | −0.89, −0.52 | <0.001 |
| NYHA classification | −4.69 | −6.55, −2.82 | <0.001 | −3.74 | −5.69, −1.79 | <0.001 |
| Diabetes mellitus | −0.70 | −3.05, 1.66 | 0.56 | | | |
| Hypertension | −1.60 | −4.17, 0.97 | 0.22 | | | |
| Hyperlipidemia | 0.35 | −2.13, 2.82 | 0.78 | | | |
| Smoking | 1.88 | −0.48, 4.24 | 0.12 | | | |
| Lower extremity edema | −2.88 | −6.68, 0.92 | 0.14 | | | |
| BMI (kg/m ²) | 0.24 | −0.13, 0.61 | 0.20 | | | |
| Gensini scores | −0.11 | −0.19, −0.23 | 0.01 | −0.04 | −0.12, 0.04 | 0.32 |
| LVEF (%) | 0.14 | 0.01, 0.26 | 0.03 | 0.03 | −0.11, 0.12 | 0.95 |
| SCr (μmol/L) | −0.01 | −0.03, 0.01 | 0.36 | | | |
| CCR (mL/min × 1.73 m ²) | 0.09 | 0.04, 0.14 | 0.001 | −0.01 | −0.08, 0.05 | 0.73 |
| BUN (mmol/L) | −0.29 | −0.60, 0.02 | 0.06 | | | |
| AST (μmol/L) | 0.01 | −0.01, 0.03 | 0.46 | | | |
| ALT (μmol/L) | 0.001 | −0.03, 0.03 | 0.97 | | | |
| TBil (μmol/L) | 0.46 | 0.26, 0.66 | <0.001 | 0.11 | −0.22, 0.44 | 0.51 |
| DBil (μmol/L) | 1.21 | 0.57, 1.85 | <0.001 | 0.21 | −0.79, 1.21 | 0.68 |

BMI body mass index, *LVEF* left ventricular ejection fraction, *SCr* serum creatinine, *CCR* creatinine clearance rate, *BUN* the serum urea nitrogen, *AST* aspartate aminotransferase, *ALT* alanine aminotransferase, *TBil* total bilirubin, *DBil* direct bilirubin

in hospitalized CAD patients was 51% and the prevalence of depression in CAD within the community ranged from 34.6% to 45.8% [31]. Another study in Australia showed that the symptoms of anxiety were common in CAD patients [32]. In our study, patients with depression accounted for 40.82%, and patients with anxiety accounted for 25.12% during hospitalization. Overall, the proportion of depression was higher than anxiety, and our data kept with the trend of the result of previous studies and demonstrated that SDS and SAS can well identify depression and anxiety.

It was found that gender not only directly affected HRQoL but also indirectly, through depression and anxiety. This result supports the preconception that female CAD patients report significantly not only lower HRQoL but also poor psychological health compared to male patients [33–35]. The gender differences in HRQoL might be attributed to social factors and life context. There were differences between men

and women in the recognition of disease symptoms and the illness process. Women who suffered from CAD have a more diverse symptom presentation than men, which are more often precipitated by emotional or mental stress [36, 37]. From the sociological perspective, it was hypothesized that these differences between men and women might originate from traditional gender roles and the different social position [38]. In order to explain the gender difference, some studies proposed “conceptual or unmeasured” variables named “gender roles” [35] and “gender index” [33]. It was reported that gender differences in health status outcomes might be better explained by patients’ gender-related characteristics than biological sex characteristics [34].

NYHA functional classification showed a negative impact of HRQoL directly. Patients with a higher grade of NYHA classification had poorer quality of life. The NYHA functional classification provides a simple way of classifying the extent of cardiac function. As it places patients in four

Table 4 Multiple linear regression analysis of the factors associated with SAS/SDS score

| | Univariate regression | | | Multiple regression | | |
|-------------------------------------|-----------------------|--------------|----------------|---------------------|--------------|----------------|
| | <i>B</i> | 95% CI | <i>p</i> value | <i>B</i> | 95% CI | <i>p</i> value |
| SAS | | | | | | |
| Age (years) | 0.02 | −0.04, 0.09 | 0.46 | | | |
| Gender | −2.24 | −3.65, −0.83 | 0.002 | −1.87 | −3.44, −0.30 | 0.02 |
| Education | −0.80 | −2.32, 0.73 | 0.30 | | | |
| Family income | −0.25 | −0.45, −0.04 | 0.02 | −1.12 | −2.72, 0.49 | 0.17 |
| NYHA classification | 0.83 | −0.29, 1.95 | 0.15 | | | |
| Diabetes mellitus | 0.32 | −1.06, 1.70 | 0.65 | | | |
| Hypertension | 0.27 | −1.24, 1.78 | 0.72 | | | |
| Hyperlipidemia | 0.94 | −0.51, 2.28 | 0.20 | | | |
| Smoking | −0.06 | −0.12, −0.01 | 0.03 | −0.57 | −2.13, 0.99 | 0.48 |
| Lower extremity edema | 2.64 | 0.41, 4.86 | 0.02 | 2.23 | 0.05, 4.51 | 0.04 |
| BMI (kg/m ²) | 0.01 | −0.22, 0.23 | 0.98 | | | |
| Gensini scores | 0.03 | −0.02, 0.08 | 0.28 | | | |
| LVEF (%) | 0.02 | −0.05, 0.10 | 0.58 | | | |
| SCr (μmol/L) | −0.01 | −0.02, 0.01 | 0.57 | | | |
| CCR (mL/min × 1.73 m ²) | −0.01 | −0.04, 0.02 | 0.44 | | | |
| BUN (mmol/L) | −0.13 | −0.31, 0.05 | 0.17 | | | |
| AST (μmol/L) | 0.01 | −0.01, 0.02 | 0.92 | | | |
| ALT (μmol/L) | −0.01 | −0.02, 0.02 | 0.70 | | | |
| TBil (μmol/L) | −0.26 | −0.38, −0.14 | 0.001 | 0.10 | −0.54, 0.75 | 0.76 |
| DBil (μmol/L) | −0.61 | −0.99, −0.23 | 0.002 | −0.26 | −0.47, 0.05 | 0.16 |
| SDS | | | | | | |
| Age (years) | 0.04 | −0.03, 0.11 | 0.22 | | | |
| Gender | −1.95 | −3.48, −0.42 | 0.01 | −1.62 | −3.12, −0.04 | 0.04 |
| Education | −1.30 | −2.90, 0.30 | 0.11 | | | |
| Family income | −0.14 | −0.37, 0.09 | 0.24 | | | |
| NYHA classification | 1.13 | −0.08, 2.34 | 0.07 | | | |
| Diabetes mellitus | 0.35 | −1.14, 1.84 | 0.65 | | | |
| Hypertension | 0.58 | −1.05, 2.21 | 0.48 | | | |
| Hyperlipidemia | −0.54 | −2.10, 1.02 | 0.50 | | | |
| Smoking | −0.86 | −2.36, 0.64 | 0.26 | | | |
| Lower extremity edema | 0.66 | −1.77, 3.08 | 0.60 | | | |
| BMI (kg/m ²) | −0.16 | −0.39, 0.08 | 0.18 | | | |
| Gensini scores | 0.08 | 0.03, 0.13 | 0.003 | 0.08 | 0.03, 0.14 | 0.002 |
| LVEF (%) | −0.06 | 0.14, 0.02 | 0.16 | | | |
| SCr (μmol/L) | 0.01 | −0.01, 0.02 | 0.88 | | | |
| CCR (mL/min × 1.73 m ²) | −0.03 | −0.06, 0.01 | 0.13 | | | |
| BUN (mmol/L) | −0.12 | −0.32, 0.08 | 0.22 | | | |
| AST (μmol/L) | −0.01 | −0.02, 0.01 | 0.61 | | | |
| ALT (μmol/L) | 0.01 | −0.02, 0.02 | 0.86 | | | |
| TBil (μmol/L) | −0.20 | −0.33, −0.07 | 0.03 | −0.22 | −0.92, 0.47 | 0.53 |
| DBil (μmol/L) | −0.56 | −0.96, −0.15 | 0.007 | −0.11 | −0.34, 0.11 | 0.33 |

BMI body mass index, *LVEF* left ventricular ejection fraction, *SCr* serum creatinine, *CCR* creatinine clearance rate, *BUN* the serum urea nitrogen, *AST* aspartate aminotransferase, *ALT* alanine aminotransferase, *TBil* total bilirubin, *DBil* direct bilirubin

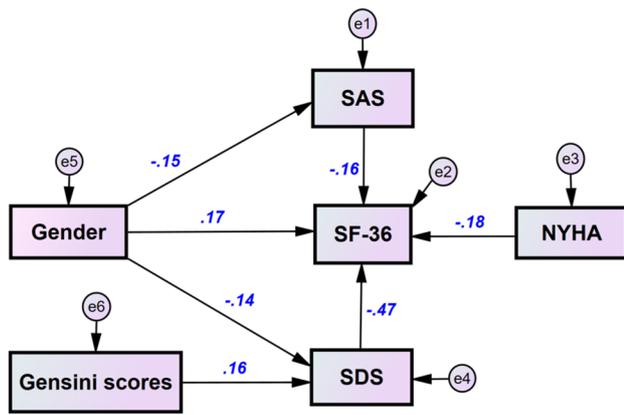


Fig. 4 Path model for demographic/clinical indicators, depression, anxiety, and HRQoL. The standardized coefficients were labeled

categories based on how much they are limited during physical activity, the limitations/symptoms were in regard to normal breathing and varying degrees in shortness of breath and/or angina. Meanwhile, physical functioning and bodily pain played an important role in the assessment of HRQoL. It was reported that the improvement of exercise capacity in CAD patients is strongly related to NYHA functional class and further improve quality of life [39].

Gensini score was calculated based on the involved artery and the extent of atherosclerosis according to coronary angiography with Judkins catheters [16]. This scoring system is one of the best indices for showing the severity of coronary artery damage and the intensity of CAD, which provides a quantitative variable for statistical analysis [40]. A recent study reported that there was no statistical correlation between Gensini scores and well-being

states [40]. However, it was found in our study that the degree of severity of cardiovascular lesion was positively associated with depression, which further influenced HRQoL. With the reference to the theoretically based model, path analysis further increased the understanding of the relationships between the clinical indicators and HRQoL when compared to the bivariate correlation analysis results.

As a hospital-based study, it had some advantages. All subjects were diagnosed by the gold standard of coronary angiography, and the complete clinical information data were available. However, the study also had several limitations that must be considered in the interpretation of our findings. Firstly, the SF-36 is a generic quality of life instrument rather than a CAD-specific questionnaire. Secondly, as a hospital-based study, selection bias might exist. As a cross-sectional study, the results could provide some clues to further validation, but the causal relationships could not be accounted for. Thirdly, SDS and SAS were commonly used in general medical practice to screen for depression and anxiety status, but they cannot be used as clinical standards to diagnose anxiety and depression. Finally, the data were collected within three days after coronary angiography, and the situation in other periods remained to be further studied.

In summary, depression and anxiety were common in hospitalized CAD patients. Depression and anxiety played an important role in HRQoL. Gender differences were found in determinants of HRQoL and the state of depression and anxiety directly, and women’s anxiety, depression, and quality of life were worse than men’s. NYHA classification and Gensini scores also played direct and indirect role in HRQoL, respectively.

Table 5 Path coefficients of direct and indirect effects among variables ($n = 414$)

| Dependent variable | Intervening variable | Independent variable | <i>B</i> | β | <i>SE</i> | <i>p</i> value |
|--------------------|----------------------|----------------------|----------|---------|-----------|----------------|
| SAS scores | ← | Gender | -2.24 | -0.15 | 0.72 | 0.002 |
| SDS scores | ← | Gender | -2.27 | -0.14 | 0.77 | 0.003 |
| SDS scores | ← | Gensini scores | 0.09 | 0.16 | 0.03 | <0.001 |
| SF-36 scores | ← | Gender | 4.05 | 0.17 | 0.98 | <0.001 |
| SF-36 scores | ← | NYHA Classification | -3.46 | -0.18 | 0.73 | <0.001 |
| SF-36 scores | ← | SAS Scores | -0.26 | -0.16 | 0.07 | <0.001 |
| SF-36 scores | ← | SDS Scores | -0.70 | -0.47 | 0.06 | <0.001 |
| SF-36 scores | ← SAS scores | ← Gender | 1.18 | 0.46 | 0.06 | <0.001 |
| SF-36 scores | ← SDS scores | ← Gender | 0.98 | 0.44 | 0.05 | <0.001 |
| SF-36 scores | ← SDS scores | ← Gensini scores | -0.06 | -0.08 | 0.02 | <0.001 |

B unstandardized coefficients, β standardized coefficients, *SE* standard error

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Compliance with ethical standards

Conflict of interest None of the authors has any conflict of interest to disclose.

Ethical approval The study was approved by the ethics committee of Nantong University.

Informed consent All subjects signed informed consent forms before participating.

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