Original Article

The value of anxiety and depression in predicting physical function and major adverse cardiovascular events in patients with acute coronary syndrome

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Background: Psychological distress, including anxiety and depression, is not only prevalent in patients with coronary heart disease (CHD) but can actually predict adverse clinical events. Therefore, the necessity of addressing psychological problems among patients with CHD to improve their treatment results is increasingly acknowledged. This study's objective was to examine the prognostic impact of anxiety and depression on major adverse cardiovascular events (MACEs) and physical function among patients with acute coronary syndrome (ACS).

Methods: A total of 978 patients admitted to our hospital from September 2021 to September 2022 and diagnosed with severe vascular lesions using coronary angiography were enrolled. According to their scores on the Hospital Anxiety and Depression Scale (HADS) and the Center for Epidemiologic Studies Depression Scale at admission, they were divided into two groups and four subgroups: an anxiety group, a non-anxiety group, a depression group, and a non-depression group. The participants' baseline information, clinical characteristics, coronary angiography findings, MACEs, and changes in physical functionality were compared.

Results: There were statistically significant differences between the anxiety and depression groups in marital status, education level, history of diabetes, clinical diagnosis, cardiac troponin T (cTnI), B-type natriuretic peptide (BNP), coronary angiography, and synergy between percutaneous coronary intervention with taxus and cardiac surgery (SYNTAX) score. Logistic regression analysis showed that gender, education level, diabetes history, cTnI, and SYNTAX score were risk factors for anxiety, while education level, diabetes, and SYNTAX score were risk factors for depression. A Kaplan-Meier survival curve model was used to analyze survival rates in the anxiety and depression groups. Hierarchical regression analyses of anxiety and depression at baseline predicted significant declines in physical functionality.

Conclusions: Social support improved physical functionality and reduced the impact of psychological distress. Psychological state had the greatest long-term prognostic value in patients with CHD.

Keywords: Anxiety; depression; coronary atherosclerotic heart disease; physical functionality; SYNTAX score

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Introduction

Coronary heart disease (CHD) is the most common ischemic cardiovascular disease. It kills 8 million patients every year, accounting for about 16.6% of the global total. Acute coronary syndrome (ACS), in particular, generates the highest disability rate and the most deaths of any disease worldwide, imposing a serious burden on medical and health systems. In terms of prognoses of patients with CHD, despite the remarkable progress in early diagnosis and medical management, some people still develop psychological disorders, especially depression and anxiety. These disorders seriously affect the recovery of cardiac function, diminish quality of life, and even increase the risk of adverse cardiovascular events. Therefore, the necessity of addressing psychological problems among patients with CHD to improve their treatment results is increasingly acknowledged (1).

Psychological distress, including anxiety and depression, is not only prevalent in patients with CHD but can actually predict adverse clinical events. Recent studies have shown that about 16% of CHD patients have anxiety symptoms, while about 40% have depression symptoms, 20% of whom meet the criteria for severe depression (2,3). International studies have also shown that anxiety and depression are independent risk factors for CHD (4-6). For patients suffering from both CHD and psychological distress, some physical symptoms of the distress (such as sleepiness, fatigue, and reduced activity) may be misattributed to CHD. To avoid such erroneous diagnoses, the Center for Epidemiologic Studies Depression Scale (CES-D) has been created to determine the severity of depression while excluding physical conditions, including some emotional and cognitive issues (7).

In addition to major adverse cardiovascular events (MACEs), medical personnel also need to pay attention to a patient's physical functionality. Accordingly, the health-related quality of life scoring system has been created to extract valuable health information that can facilitate the improvement of treatment and disease management (8,9). Although a negative correlation has been established between psychological distress and the prognosis of CHD, it is not clear whether changes in psychological distress affect health outcomes over time.

Revascularization is the preferred treatment for CHD, as it can relieve symptoms and reduce the risk of death (10,11). However, in patients with severe forms of CHD, especially ACS, serious vascular lesions emerge that cannot be treated with stents or coronary artery bypass therapy, leading to incomplete revascularization. Meanwhile, psychological disorders may significantly affect patients' daily lives and long-term prognoses. Thus, we have begun to explore psychological protective factors against psychological confusion.

This study continues this project by considering whether social support improves physical function and mental health. No research has investigated the effects of anxiety and depression on long-term adverse cardiovascular events and physical function in patients with severe CHD who are unable to undergo revascularization. Therefore, this study investigated the overall impact of changes in psychological status among patients with ACS. We present this article in accordance with the STROBE reporting checklist (available at https://jtd.amegroups.com/article/view/10.21037/jtd-24-576/rc).

Highlight box

Key findings

- Psychological distress, including anxiety and depression, is not only prevalent in patients with coronary heart disease (CHD) but can actually predict adverse clinical events.

What is known and what is new?

- A negative correlation has been established between psychological distress and the prognosis of CHD.
- The health-related quality of life scoring system has been created to extract valuable health information that can facilitate the improvement of treatment and disease management.

What is the implication, and what should change now?

- Patients with negative psychological emotions such as anxiety and depression need constant attention and timely treatment when necessary. Active intervention or treatment of anxiety and depression can improve long-term adverse cardiovascular events and physical function in patients with coronary heart disease without revascularization.

Methods

Participants

A total of 11,164 patients participated in the cohort study, and 978 eligible patients were ultimately selected, including 627 males and 351 females. They were grouped according to anxiety and depression levels at admission. All participants were treated in accordance with the latest guidelines for the rapid diagnosis and treatment of

ACS (12). ACS is defined as acute ischemic syndrome caused by fresh thrombosis secondary to the rupture or erosion of unstable atherosclerotic plaque in the coronary artery; this condition includes ST-elevation myocardial infarction, non-ST-elevation myocardial infarction, and unstable angina pectoris.

The inclusion criteria specified patients 60 years of age or older who were diagnosed with ACS, underwent coronary angiography, exhibited severe vascular disease, and ultimately failed to undergo revascularization. The exclusion criteria ruled out those with primary or secondary thyroid dysfunction, severe liver or kidney dysfunction, blood diseases, malignant tumors, immune system diseases, severe infection, or incomplete or lost information.

Study design

This is a study to investigate the effects of anxiety and depression on long-term adverse cardiovascular events and physical function and mental health in patients with severe CHD who are unable to undergo revascularization. The aim is to explore the influence of negative emotions on patients with CHD and whether social support can improve patients' physical function and mental health. All procedures are overseen by trained cardiologists who test each patient during their stay in the hospital. In addition, at baseline assessment, participants first met with a research assistant who conducted a brief medical interview to gather patient information and relevant medical history. To assess anxiety symptoms, scores were divided into two groups: those with anxiety symptoms [Hospital Anxiety and Depression Scale (HADS) ≥8 points] and those without anxiety symptoms (HADS <8 points). To assess depression, scores were divided into two categories: those with depressive symptoms (CES-D ≥16 points) and those with non-depressive symptoms (CES-D <16 points). They were followed up in a number of ways and assessed for anxiety and depression at 3, 6, and 12 months after discharge, while observing the occurrence of MACE and the impact of social support (*Figure 1*).

Baseline data

The patients' general clinical data were recorded in detail, including age, sex, marriage status, education level, income, nature of work, place of work, medical history, and disease diagnosis. Laboratory indicators at admission were also recorded, including biochemical indicators, routine blood tests, B-type natriuretic peptide (BNP), and myocardial enzymes. Medications taken during hospitalization were noted, such as antiplatelet drugs, statins, β-blockers, angiotensin receptor enkephalinase inhibitors, angiotensin receptor blockers, or angiotensin converting enzyme inhibitors. Finally, coronary angiography results were recorded, and synergy between percutaneous coronary intervention with taxus and cardiac surgery (SYNTAX) scores were evaluated.

Procedures

The primary outcomes were MACEs, including angina pectoris, acute myocardial infarction, heart failure, and cardiogenic death. Patients were followed up for 1 year by telephone or through rehospitalization records, outpatient programs, and out-of-hospital visits. When one of the three MACE events occurred, the onset time of each event was recorded, and follow-up was continued. However, when cardiogenic death occurred, the time was recorded, and follow-up was terminated. If none of these events occurred, follow-up was terminated after 1 year.

Measures

Anxiety symptoms

Anxiety was measured using the anxiety subscale of the HADS. The HADS was developed specifically for medical patients and has proven effective and reliable. It contains seven common anxiety symptoms, including worry, fear, and panic (13). Participants rate the extent to which they experience each anxiety symptom on a 4-point scale. The Cronbach's α values at baseline and each follow-up were 0.80, 0.83, 0.83, and 0.82, respectively. The analysis used an overall score range from 0 to 21, with higher numbers indicating greater anxiety.

Depression symptoms

The CES-D is an effective tool for assessing depression symptoms with high sensitivity and specificity. It consists of 20 items that cover four common depression symptoms, including a depressive mood, decreased well-being, interpersonal dysfunction, and somatic symptoms (14). Seven items assess physical signs of depression, such as poor appetite and disturbed sleep.

When evaluating patients with CHD, there is a concern that these items may be confused with CHD symptoms, leading to an inaccurate assessment of depression. To

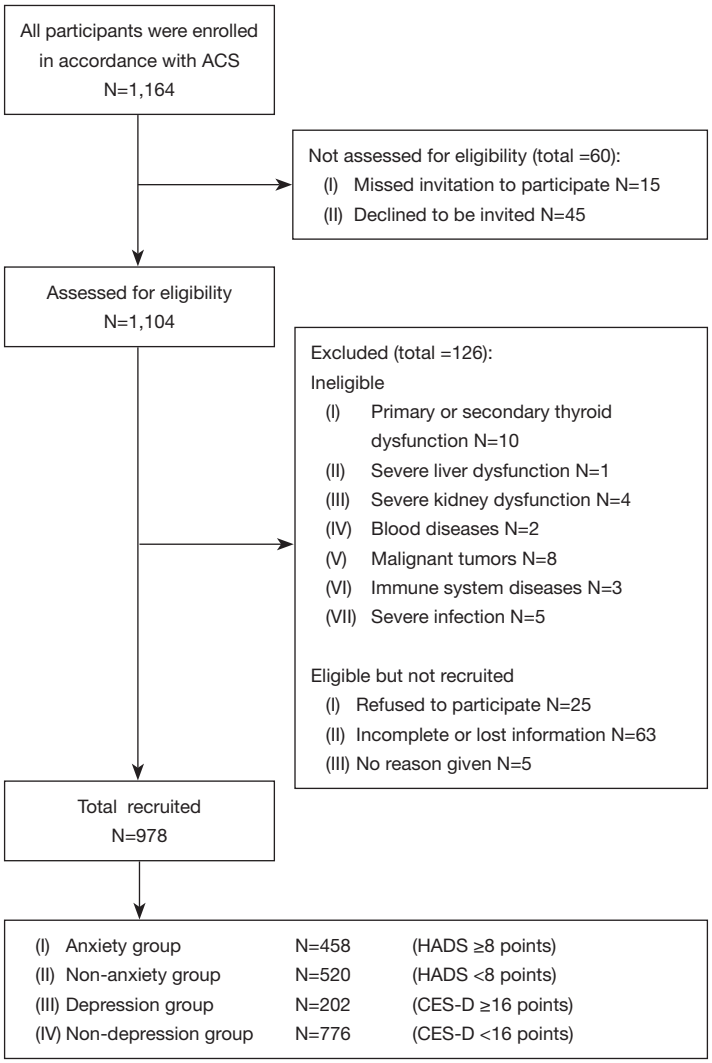

Figure 1 Flow diagram. ACS, acute coronary syndrome; HADS, Hospital Anxiety and Depression Scale; CES-D, Center for Epidemiologic Studies Depression Scale.

eliminate potential confusion, the full scale and a modified version without somatic items were tested and maintained between 0 and 60 using linear transformation. In this study, the internal consistency and reliability of both the revised scale and the complete scale were high. The Cronbach's α values of the revised scale at baseline and follow-up were 0.80, 0.85, 0.84, and 0.83, respectively, and the α values of the complete scale at each time point were 0.84, 0.89, 0.88, and 0.86, respectively.

Social support

Social support refers to objective support from one's social contacts (family, friends, colleagues, etc.) and one's subjective feelings about this support. Social support refers not only to material conditions and resources but also to emotional encouragement. Perceived social support was measured using the 14-item Medical Research Social Support Questionnaire (15). This is an effective and reliable tool that uses three dimensions of perceived available social support, including objective support, subjective support, and utilization of support. Participants rate their level of support for each statement on a 4-point scale. This scale's internal consistency and reliability are good, and the Cronbach's α in this study was 0.87. The analysis used an average score between 1 and 4 (the scores corresponding to Questions 5 and 6 in the questionnaire were determined by the number

of sources). The higher the score, the stronger the sense of social support.

Physical functionality

The MacNew Heart Disease Health-Related Quality of Life Questionnaire (MacNew) is a health-related quality of life questionnaire that measures physical function (16). MacNew is widely used to assess the health of patients with CHD. It has strong validity, reliability, and clinical utility. The physical health subscale consists of 12 items that assess physical symptoms and difficulties caused by heart disease, such as chest pain, shortness of breath, and restrictions on exercise or other activities due to heart problems. The internal consistency of the scale was high in this study, and the Cronbach's α values of the baseline and time periods were 0.82, 0.82, 0.83, and 0.83, respectively. The analysis used an average score between 1 and 7, with higher numbers indicating better physical function.

Statistical analysis

Statistical data were expressed as percentages using SPSS 20 software. Data were displayed as means and standard deviations or percentages as appropriate. The Wilcoxon rank-sum test was used for comparisons between non-normally distributed groups. A multivariate stepwise binary logistic regression model was used to analyze the factors of anxiety and depression that were related within each time period. Accumulated MACE rates were visualized using a Kaplan-Meier curve, and a comparison between the cumulative MACE rates of non-anxious/depressed patients and anxious/depressed patients was conducted using a log-rank test. A P value <0.05 was considered statistically significant.

Ethical statement

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by ethics board of The Third Central Clinical College of Tianjin Medical University (No. IRB2019-001-04) and informed consent was taken from all the patients.

Results

Participant characteristics

In the anxiety group, gender, marital status, level of education, history of hypertension, history of diabetes, history of smoking, and clinical diagnosis were statistically significant (P<0.05). In the depression group, marital status, level of education, history of diabetes, history of stroke, history of myocardial infarction, and clinical diagnosis were statistically significant (P<0.05, *Table 1*).

Laboratory biochemistry

Troponin, white blood cell count, and BNP were elevated at a statistically significant level in both the depression and anxiety groups (P<0.05, *Table 2*).

Comparison of drugs and coronary angiography

There were no statistical differences between the groups in drug use during hospitalization (P>0.05). In terms of coronary angiography, compared to the non-anxiety group, the number of left main artery cases and SYNTAX scores were significantly increased in the anxiety group, while the number of right coronary artery cases and proportion of percutaneous transluminal coronary angioplasty (PTCA) cases were lower at a statistically significant level (P<0.05). Compared to the non-depressed group, the number of left main artery and anterior descending branch cases and SYNTAX scores were significantly increased in the depression group. However, the number of right coronary artery cases and the proportion of PTCA cases were lower, and these differences were statistically significant (P<0.05, *Table 3*).

Risk factors

During the follow-up period, anxiety and depression (yes =1, no =0) were taken as dependent variables, and gender, education, hypertension, diabetes, cardiac troponin T (cTnI) level, and SYNTAX score were taken as independent variables. For anxiety, logistic regression analysis showed that gender, education, diabetes mellitus, cTnI, and SYNTAX score were independent risk factors during the follow-up period (P<0.05, *Table 4*). For depression, education level, diabetes, and SYNTAX score were independent risk factors during the follow-up period. Moreover, cTNI was an independent risk factor for depression at the 3-month follow-up, while gender was an independent risk factor for depression at the 6-month and 1-year follow-up (P<0.05, *Table 5*).

Table 1 Participant characteristics

Parameters	Anxiety (N=458)	Non-anxiety (N=520)	P	Depression (N=202)	Non-depression (N=776)	P
Male	323 (70.5)	304 (58.5)	<0.001	138 (68.3)	489 (63)	0.19
Age (years)	71.2±4.82	71.39±5.54	0.12	71.88±4.69	71.58±5.35	0.46
Marriage status						
Single	255 (55.7)	217 (41.7)	<0.001	116 (57.4)	356 (45.9)	0.004
Married	203 (44.3)	303 (58.3)		86 (42.6)	420 (54.1)	
Education <9 years	297 (64.8)	288 (55.4)	0.003	145 (71.8)	440 (56.7)	<0.001
Income (yuan)			0.53			0.40
<3,000	178 (38.9)	220 (42.3)		76 (37.6)	322 (41.5)	
3,000–8,000	163 (35.6)	171 (32.9)		77 (38.1)	257 (33.1)	
>8,000	117 (25.5)	129 (24.8)		49 (24.3)	197 (25.4)	
Occupation			0.06			0.25
Farmer	193 (42.1)	190 (36.5)		89 (44.1)	294 (37.9)	
Server	177 (38.6)	240 (46.2)		77 (38.1)	340 (43.8)	
Staff	88 (19.2)	90 (17.3)		36 (17.8)	142 (18.3)	
Workplace			0.13			0.23
Country	191 (41.7)	192 (36.9)		87 (43.1)	296 (38.1)	
City	267 (58.3)	328 (63.1)		115 (56.9)	480 (61.9)	
Previous history						
Hypertension	352 (76.9)	366 (70.4)	0.03	154 (76.2)	564 (72.7)	0.33
Diabetes	180 (39.3)	81 (15.6)	<0.001	101 (50.0)	160 (20.6)	<0.001
Stroke	43 (9.4)	43 (8.3)	0.57	28 (13.9)	58 (7.5)	0.007
Myocardial infarction	48 (10.5)	43 (8.3)	0.27	36 (17.8)	55 (7.1)	<0.001
Smoking	302 (65.9)	388 (74.6)	0.003	134 (66.3)	556 (71.6)	0.14
Diagnose			<0.001			<0.001
Angina	122 (26.6)	393 (75.6)		51 (25.2)	464 (59.8)	
Non-ST-segment elevation myocardial infarction	156 (34.1)	88 (16.9)		68 (33.7)	176 (22.7)	
ST-segment elevation myocardial infarction	180 (39.3)	39 (7.5)		83 (41.1)	136 (17.5)	
Psychological score	9.63±2.23	3.95±1.2	<0.001	19.3±3.95	8.06±3.85	<0.001

Statistics are presented as mean ± standard deviation or n (%).

Kaplan-Meier survival curve

The occurrence of MACE events during the 1-year period was predicted. We concluded that, regardless of whether the anxiety or depression events were grouped according to the baseline, the cumulative incidence of events in both groups increased at a statistically significant level (P<0.01, *Figure 2*).

Table 2 Laboratory biochemistry

Parameters	Anxiety (N=458)	Non-anxiety (N=520)	P	Depression (N=202)	Non-depression (N=776)	P
Cardiac troponin I (ng/mL)	5.36 (0.05, 22.5)	0.046 (0.038, 0.5)	<0.001	7.68 (0.05, 24.65)	0.05 (0.04, 5.06)	<0.001
Blood urea nitrogen (μmol/L)	6.50±2.67	6.34±2.35	0.32	6.58±2.81	6.37±2.41	0.30
Serum creatinine (μmol/L)	77.11±20.32	77.06±21.09	0.98	76.54±22.46	77.23±20.26	0.68
White blood cell ($\times10^9$/L)	8.73±3.12	8.23±3.85	0.03	8.79±2.91	8.38±3.68	0.14
Neutrophilic granulocyte percentage (%)	71.96±13.97	70.34±13.59	0.07	73.02±12.82	70.60±13.99	0.03
Hemoglobin (g/L)	137.01±17.28	136.04±15.83	0.36	136.78±17.48	136.42±16.27	0.78
Blood platelet ($\times10^9$/L)	226.24±63.28	228.09±61.41	0.64	223.76±60.16	228.13±62.81	0.36
Glycosylated hemoglobin (%)	6.20±0.97	6.22±0.96	0.83	6.24±0.99	6.20±0.96	0.61
Cholesterol (mmol/L)	4.51±1.10	4.47±1.12	0.63	4.54±1.09	4.48±1.12	0.48
Low density lipoprotein (mmol/L)	2.97±0.80	2.94±0.82	0.15	3.00±0.79	2.95±0.82	0.44
B-type natriuretic peptide (μg/L)	344 (231.93, 714.13)	309 (167.2, 614.5)	0.002	431 (235.38, 748.2)	313 (176.25, 665.3)	<0.001

Statistics are presented as mean ± standard deviation and median (interquartile range).

Table 3 Comparison of drugs and coronary angiography results

Parameters	Anxiety (N=458)	Non-anxiety (N=520)	P	Depression (N=202)	Non-depression (N=776)	P
Drug						
Antiplatelet	394 (86.0)	426 (81.9)	0.10	177 (87.6)	643 (82.9)	0.11
Statin	293 (64.0)	349 (67.1)	0.31	132 (65.3)	510 (65.7)	0.93
Beta-blockers	295 (64.4)	330 (63.5)	0.79	127 (62.9)	498 (64.2)	0.74
Angiotensin-converting enzyme inhibitors/angiotensin receptor inhibitor/ angiotensin receptor-enkephalin inhibitors	332 (72.5)	370 (71.2)	0.67	142 (70.3)	560 (72.2)	0.60
Coronary angiography						
Left main coronary artery	142 (31.0)	108 (20.8)	<0.001	68 (33.7)	182 (23.5)	0.004
Anterior descending branch	336 (73.4)	355 (68.3)	0.09	160 (79.2)	531 (68.4)	0.002
Left circumflex artery	316 (69.0)	375 (72.1)	0.29	149 (73.8)	542 (69.8)	0.30
Right coronary artery	361 (78.8)	437 (84.0)	0.04	148 (73.3)	650 (83.8)	0.001
Restenosis	86 (18.8)	90 (17.3)	0.56	34 (16.8)	142 (18.3)	0.68
Percutaneous transluminal coronary angioplasty	161 (35.2)	232 (44.6)	0.003	57 (28.2)	336 (43.3)	<0.001
SYNTAX score	25.9±9.46	23.76±7.3	<0.001	28.23±10.36	23.86±7.62	<0.001

Statistics are presented as mean ± standard deviation or n (%). SYNTAX, synergy between percutaneous coronary intervention with taxus and cardiac surgery.

Table 4 Risk factors for anxiety based on binary logistic regression

Risk factors	B	Wald	OR	95% CI	P
Baseline anxiety risk					
Sex	0.766	24.531	2.150	1.588–2.911	<0.001
Education	0.403	7.578	1.496	1.123–1.992	0.006
Diabetes	1.110	44.798	3.006	2.178–4.148	<0.001
CTnI	0.071	79.663	1.073	1.057–1.090	<0.001
SYNTAX score	0.020	5.701	1.021	1.004–1.038	0.02
3-month anxiety risk					
Sex	0.764	24.405	2.148	1.586–2.908	<0.001
Education	0.397	7.347	1.487	1.116–1.981	0.007
Hypertension	0.209	1.233	1.233	0.896–1.695	0.20
Diabetes	1.105	45.020	3.019	2.186–4.170	<0.001
cTnI	0.070	78.648	1.073	1.056–1.090	<0.001
SYNTAX score	0.020	5.217	1.020	1.003–1.037	0.02
6-month anxiety risk					
Sex	0.805	26.682	2.236	1.648–3.035	<0.001
Education	0.389	6.997	1.475	1.106–1.967	0.008
Hypertension	0.182	1.247	1.200	0.872–1.652	0.26
Diabetes	1.132	47.090	3.102	2.245–4.286	<0.001
cTnI	0.071	79.939	1.074	1.057–1.091	<0.001
SYNTAX score	0.020	5.309	1.020	1.003–1.037	0.02
1-year anxiety risk					
Sex	0.585	15.307	1.794	1.339–2.405	<0.001
Education	0.335	5.445	1.397	1.055–1.851	0.02
Diabetes	1.078	40.796	2.937	2.110–4.088	<0.001
cTnI	0.069	69.333	1.071	1.054–1.089	<0.001
SYNTAX score	0.017	4.258	1.018	1.001–1.035	0.04

CTnI, cardiac troponin I; SYNTAX, synergy between percutaneous coronary intervention with taxus and cardiac surgery; OR, odds ratio; CI, confidence interval.

Psychological distress and social support predict physiological function

By adjusting for covariates (gender, age, marital status, education, and baseline physiological function) when building the model, Model 1 (representing anxiety, depression, and their respective changes) predicted a deterioration in physical function at baseline and during follow-up in both groups. When psychological distress was ameliorated by increased social support in Model 2, it indicated that social support can reduce psychological distress over time (P<0.05, *Table 6*).

After adjusting for covariates, comparisons between social support at baseline and follow-up predicted improvement in physical function (baseline: β=0.409, P<0.001; β=0.486 at 3 months, P<0.001; β=0.486 at 6 months, P<0.001; β=0.505 at 12 months, P<0.001). When we used the CES-D's comprehensive assessment of depression and adjusted

Table 5 Risk factors for depression based on binary logistic regression

Risk factors	B	Wald	OR	95% CI	P
Baseline depression risk					
Education	0.647	12.754	1.910	1.339–2.724	<0.001
Diabetes	1.235	51.760	3.440	2.457–34.816	<0.001
SYNTAX score	0.051	27.886	1.052	1.033–1.072	0.001
3-month depression risk					
Education	0.671	14.180	1.957	1.380–2.775	<0.001
Diabetes	1.192	49.437	3.293	2.362–4.591	<0.001
CTnI	0.005	3.935	1.005	1.000–1.010	0.047
SYNTAX score	0.047	24.924	1.049	1.029–1.068	<0.001
6-month depression risk					
Sex	0.408	5.357	1.504	1.065–2.125	0.02
Education	0.657	13.969	1.929	1.367–2.723	<0.001
Diabetes	1.174	48.460	3.235	2.324–4.502	<0.001
SYNTAX score	0.054	32.068	1.055	1.367–2.723	<0.001
1-year depression risk					
Sex	0.499	8.990	1.647	1.189–2.282	0.003
Education	0.480	8.838	1.616	1.178–2.218	0.003
Diabetes	0.969	35.899	2.634	1.919–3.616	<0.001
SYNTAX score	0.051	32.632	1.053	1.034–1.071	<0.001

SYNTAX, synergy between percutaneous coronary intervention with taxus and cardiac surgery; CTnI, cardiac troponin I; OR, odds ratio; CI, confidence interval.

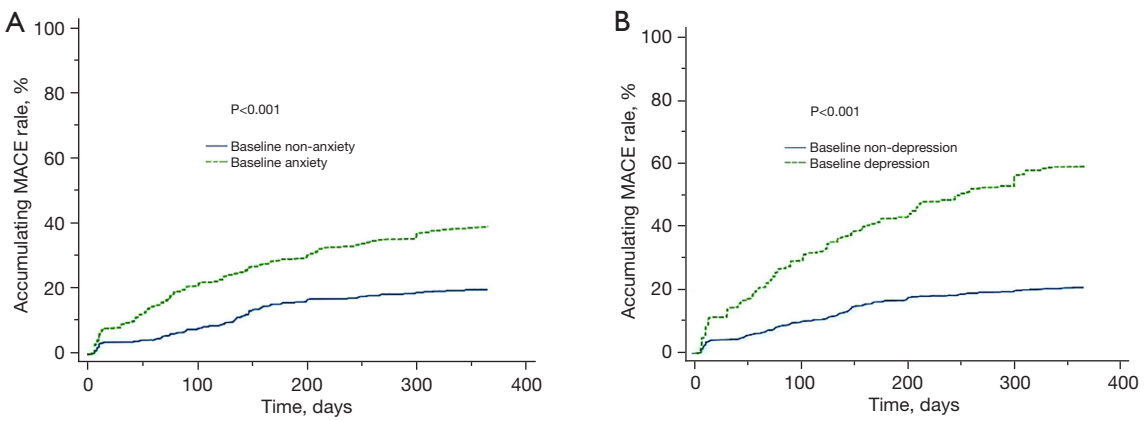

Figure 2 Kaplan-Meier survival curves. MACE, major adverse cardiovascular event.

Table 6 Psychological distress and social support to predict physiological function

Psychological predictors	Prediction of 3-month health functioning[†]				Prediction of 6-month health functioning[†]				Prediction of 1-year health functioning[†]			
	B	SE	β	P	B	SE	β	P	B	SE	β	P
Anxiety												
Model 1[‡]												
Baseline anxiety	2.613	0.440	0.746	<0.001	2.823	0.483	0.757	<0.001	1.361	0.229	0.352	<0.001
Change in anxiety	−0.844	0.401	−0.261	0.04	−0.925	0.440	−0.269	0.04	0.650	0.227	0.168	0.004
Model R^2	0.530				0.492				0.473			
Model 2[§]												
Baseline anxiety	1.790	0.456	0.511	<0.001	1.957	0.503	0.525	<0.001	0.576	0.269	0.149	0.03
Change in anxiety	−0.880	0.394	−0.273	0.03	−0.944	0.433	−0.275	0.03	0.463	0.226	0.120	0.04
Social support	0.549	0.095	0.281	<0.001	0.564	0.105	0.271	<0.001	0.607	0.113	0.281	<0.001
Model R^2	0.546				0.507				0.488			
Depression												
Model 1[‡]												
Baseline depression	2.487	0.618	1.363	<0.001	2.036	0.470	1.047	<0.001	2.015	0.427	1.000	<0.001
Change in depression	−1.475	0.600	−0.830	0.01	−0.960	0.443	−0.521	0.03	−0.850	0.391	−0.456	0.03
Model R^2	0.557				0.511				0.492			
Model 2[§]												
Baseline depression	2.232	0.621	1.224	<0.001	1.654	0.481	0.851	0.001	1.629	0.437	0.808	<0.001
Change in depression	−1.475	0.597	−2.469	0.01	−0.893	0.441	−0.485	0.04	−0.824	0.389	−0.442	0.03
Social support	0.300	0.097	0.153	0.002	0.366	0.109	0.176	0.001	0.421	0.115	0.195	0.001
Model R^2	0.561				0.516				0.499			

[†], Model: adjusted for age, sex, marital status, education, and baseline physical function; [‡], Model 1: predictors included psychological distress (anxiety or depression) and its changes and covariates; [§], Model 2: predictors increase social support. SE, standard error.

the baseline levels reported above, a second comparison of baseline depression (β=1.201 in March, P<0.001; β=1.032 at 6 months, P<0.001; β=1.010 at 12 months, P<0.001) with its changes over time (β=−0.669 at 3 months, P=0.045; at 6 months, β=−0.506, P=0.03; β=−0.466 at 12 months, P=0.03) significantly predicted a decline in physical function.

Discussion

This study examined the effects of anxiety, depression, and their changes on adverse cardiovascular events and physical function in patients with CHD. The results showed that psychological distress were sufficiently predictive of adverse cardiovascular events. Anxiety or depression at any time during the follow-up period predicted a decline in physical function, but the effect of social support improved physical function and reduced the impact of psychological distress.

Psychological distress, regardless of its source, is damaging and harmful to CHD as people struggle to regain health and maintain physical function. In addition, although each person presents differently, psychological distress, namely depression and anxiety, predicts decline in physical functioning. When individuals perceive environmental needs as a threat, different forms of psychological distress may reflect shared underlying emotional difficulties.

The possible mechanisms underlying anxiety and depression in patients with CHD, whether behavioral

(poor dietary habits and poor adherence to cardiovascular drugs) or physiological (impaired coronary blood flow reserve, inflammatory response, and endothelial injury), collectively explain the high prevalence of anxiety and depression (17). Although CHD has been recognized as a significant risk factor for anxiety and depression, few studies with large populations have examined changes in anxiety and depression among patients with severe CHD in a longitudinal manner. In addition, few studies have combined MACE, physical functioning, and social support.

To better manage anxiety and depression in patients with CHD, studies have increasingly focused on identifying risk factors associated with these mental health conditions. International research has shown that anxiety, depression, and other forms of psychological distress occur more often in female patients with CHD. One study analyzed 3,448 patients with CHD from 12 countries and showed that women and those with diabetes, lower income, and a lower education level were likelier to suffer from psychological distress (17). Elsewhere, 911 patients with CHD were followed up for cardiovascular events; here, social status (living alone) and diabetes were associated with increased risks of anxiety and depression (18). However, these studies only looked at one or two risk factors for psychological distress. Therefore, multifaceted and long-term follow-up is needed to further illuminate the potential risk factors for anxiety and depression.

In this study, multiple investigations and one year of follow-up showed that gender, education, hypertension, diabetes, cTnI, and SYNTAX score were risk factors for psychological distress. Some reasons for this finding are as follows:

(I) Women's reproductive hormones and related cycles (menopause) may make them more sensitive to CHD or lifestyle changes (19);
(II) Patients with more education may have increased knowledge and understanding of their disease and thus better understand how to control the disease and deal with the impact of negative emotions;
(III) Hypertension and diabetes are associated with worse patient outcomes, including disability and mortality. Meanwhile, patients with CHD complicated by these two diseases gradually realize that they have chronic diseases, thus increasing their psychological distress and other adverse conditions (20-22);
(IV) Elevated troponin levels indicate myocardial necrosis and even potential cardiac complications. Therefore, due to vascular occlusion or impaired cardiac function, patients will become acutely aware of their cardiac conditions and consequently suffer from anxiety, depression, or other psychological disturbances (3);
(V) The higher the SYNTAX score, the more serious the coronary vessels, and the worse the clinical manifestations, such as frequent chest pain or tightness. Such patients may face more difficulties in life and an uncertain future (23).

Individual differences in baseline psychological distress and its increase over time predicted greater decline in physical health functioning. The harmful effects of this increase in psychological distress are unimaginable beyond the baseline level. In addition, the study went beyond assessing the importance of psychological distress levels in patients with CHD at the start of treatment, tracking their mood over time, showing that increased psychological distress may contribute to additional health deterioration.

A prospective cohort study that included 853 participants with no significant evidence of cardiovascular disease and followed them for more than 10 years discovered a strong association between adverse conditions such as anxiety and a 10-year increased risk of cardiovascular disease (24). Another study of 33,156 adults' data from the 2005–2018 National Health and Nutrition Examination Survey database used Cox regression analysis to screen for covariates, finding that depression plays an intermediate role in cardiovascular disease and all-cause mortality (25).

Regarding the related biological mechanisms, studies have shown that anxiety and depression are related to disorders in the physiological stress response coordinated by the hypothalamic-pituitary-adrenal axis and the sympathetic nerve–adrenal medulla system (26-28). Psychological disorders, in turn, may trigger a range of cardiogenic processes, including chronic elevated inflammation, insulin resistance, lipid dysregulation, and endothelial dysfunction, leading to atherosclerosis and CHD. Our study found that psychological distress was associated with increased adverse cardiovascular events in patients with CHD. Meanwhile, these psychosocial disorders may lead to lifestyle changes and poor adherence to treatment, further compromising patients' quality of life and treatment outcomes.

The full version of the CES-D and the version without somatic items showed similar results, with baseline depression and its changes predicting a severe decline in physical function in patients with CHD. The results showed that the effects of depression on physical decline were not

caused by somatic symptoms mixed with cardiac symptoms. These findings suggest that, even when the depression scale includes physical factors, it can still be an effective tool for identifying patients at risk of a faster decline in health. Therefore, when using scoring criteria to identify potential cases for clinical intervention, clinicians are advised to recognize that somatic items in depression measures may exaggerate the resultant score. Therefore, studies have reached many different conclusions about social support. Thus, researchers need to further explore the different types of social support and their roles in promoting health among patients with CHD in the future.

Recent studies have shown that, although social support can improve predicted declines in physical function (at the 1-year follow-up), social support has not been found to alleviate the negative effects of psychological distress on physical function within a certain period of time (7). Therefore, we increased the sample size to further illuminate the influence of social support and concluded that such support can predict improvements in physical function and reduce psychological distress over time.

Studies have shown that social support can reduce psychological distress, promote patients' self-efficacy, and improve their level of health literacy. In turn, by increasing awareness of diseases, patients will have a strong motivation to improve their health, which will increase the demand for health-related knowledge and skills at the health level, and ultimately lead to improved health knowledge. Similarly, patients with high levels of social support show better communication and interaction skills, which effectively use the social support system to obtain both material and emotional support.

For the purposes of this study, functional social support was mainly evaluated—that is, perceived support in the forms of emotions, tools, information, and social interaction. As demonstrated in the literature, social support is a multilevel structure with multiple concepts and measurements (29). This is another reason why studies have yielded different results regarding social support. Thus, researchers need to further explore the different types of social support and their role in promoting the health of patients with CHD in the future.

There are some limitations in this study. First, the number of cases was still small, and the follow-up time was relatively short; more participants and a longer follow-up period would be ideal. Second, this was a single-center study, and local elderly patients with heart conditions were recruited, which may have created bias in terms of age and regional differences. Third, the HADS is widely used by doctors in general hospitals to assess patients with suspected anxiety disorders. However, a HADS score is not a diagnostic criterion for anxiety, and it can lead to false positive results. Fourth, most patients were followed up in the outpatient department. However, for various reasons, a small number of patients were followed up by telephone. We cannot rule out that conducting follow-up interviews over the telephone may have influenced the results. Large-scale, long-term, multicenter follow-up studies with more participants are needed to further investigate the overall impact of changes in psychological status on patients with ACS.

Conclusions

In conclusion, anxiety, depression, and their changes can predict increases in cumulative MACEs and declines in physical function among ACS patients. However, social support can improve physical function and reduce the impact of psychological distress. Therefore, given that psychological distress is prevalent and continuously developing in patients with CHD, it is helpful to look at this distress's long-term prognostic value to accurately gauge the influence of psychological states on patients with CHD.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://jtd.amegroups.com/article/view/10.21037/jtd-24-576/rc

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://jtd.amegroups.com/article/view/10.21037/jtd-24-576/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all

aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by ethics board of The Third Central Clinical College of Tianjin Medical University (No. IRB2019-001-04) and informed consent was taken from all the patients.

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