Original Article

Modeling of cardiac function of patients with acute myocardial infarction based on Type-D personality: Mediating role of negative emotions

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Abstract

Context: Cardiac function of patients with acute myocardial infarction (MI) plays a central role in their prognosis.

Aims: The purpose of this study was to model the cardiac function of these patients based on Type-D personality and the mediating role of negative emotions (anger, depression, and anxiety) in this relationship.

Setting and Design: This correlational study was performed using the structural equation modeling method, and specifically the regression equations (combination of path analysis and second-order factor analysis).

Material and Methods: The study population was the patients with acute ST-segment elevation MI (STEMI) who were hospitalized at Mazandaran Cardiovascular Hospital and underwent under primary percutaneous coronary intervention treatment in 2017 and 2018. Using Mueller's formula modeling formula (1996) based on a sample size-to-free parameter ratio, the sample size was calculated to 220 patients were chosen by the purposive method. Data were collected using Denollet'sType-DScale-14, the Spielberger's state-trait anxiety inventory, short-form of the beck depression inventory-13, and Spielberger's state-trait anger expression inventory-2.

Statistical Analysis Used: Data analysis was performed using SPSS-18 and AMOS 23.

Results: Type-D personality can directly predict of the cardiac function of patients with acute STEMI. This variable also predicts the the cardiac function of these patients via the mediation of negative emotions (anger, depression, and anxiety).

Conclusion: Type-D personality affects the incidence and prognosis of myocardial infarction via negative emotions. It is, therefore, recommended to screen the susceptible populations for this personality type.

Keywords: Heart function test, Myocardial infarction, Negative emotions, Type-D personality

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INTRODUCTION

Cardiovascular diseases (CVDs) are the leading cause of death in most countries, including Iran.[1] According to the estimates of the World Health Organization, this group of diseases will be the main cause of mortality worldwide in 2020.[1,2] Myocardial infarction (MI) is one of the major causes of hospitalization, disability, and death that 17.9 million people die each year from CVD, an estimated 31%

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of all deaths worldwide. >75% of CVD deaths occur in low-income and middle-income countries. Nearly 85% of all CVD deaths are due to heart attacks and strokes. Furthermore, 50% of all deaths per year and 79% of deaths related to chronic diseases are attributed to CVD.[3,4] Acute MI is universally considered an emergency condition. An ischemic injury in a significant portion of the myocardium that impairs left ventricular pumping is the single most important predictor of mortality following ST-segment elevation MI (STEMI).[5,6] The typical emergency medical procedures for limiting the impacts of MI and preventing damage to the myocardium include thrombolytic treatment and balloon angioplasty and stenting.[7]

The incidence of CVDs cannot be fully explained by known biological factors,[8] as psychological and personality factors also play direct and indirect roles in the development and exacerbation of these diseases.[7,9]

Given the possible relationships between personality traits and diseases, the role of personality in health has been the subject of many scientific studies. Some of these studies have managed to identify personality traits that make a person more susceptible to certain diseases.[10] Scientific evidence suggests that in the general population, there is a high correlation between well-being and depression, mental disorders, life stress, and introversion,[11] which make people, especially more susceptible to CVDs.[7]

Personality is a set of relatively stable and unique characteristics that distinguish one person from another.[12] In the late 1950s, some theoreticians (Friedman and Rosen man, 1959) hypothesized the role of Type-A personality in the development of coronary heart disease.[13] But subsequent studies showed that the characteristics of Type A personality cannot successfully predict the incidence of this condition. In the late 1990s and early 2000s, Denollet theorized a new personality type called Type-D personality, which revealed a stronger relationship between heart disease and personality traits.[14] It is reported that people with Type-D personality have four times higher risk of ischemic heart disease and consequent mortality than people with lower levels of negative affectivity and social inhibition and that this is independent of the traditional biomedical risk factors.[15-17]

Type-D personality is defined as the combination and interaction of two broad personality traits: negative affectivity and social inhibition.[18-20] People with negative affectivity and social inhibition often suffer from depression, chronic stress, anger, pessimism, low social support, and generally poor health level.[10,14,21-23] In general, this discussion is closely related to emotion, which refers to a mental feeling that affects and is affected by our thoughts, behaviors, and physiology.[7] By strengthening negative emotions, Type-D personality leads to elevated stress and cortisol levels, which when combined together, impact the heart negatively. The invoked emotion also increases the activity of the autonomic system and affects the severity of coronary artery stenosis.[24,25]

For MI patients, the negative affectivity dimension of Type-D personality predicts disability and low quality of life,[16] the latter of which predicts mortality in these patients.[15] However, since not all studies have found a relationship between the Type-D personality and the risk of CVDs, there is a need for more research in this area.[22] Although many studies in Western countries have confirmed the relationship between Type-D personality and the occurrence of cardiac problems, this relationship must be further examined in other countries.[14]

Anger, anxiety, and depression in MI patients can exacerbate cardiac complications such as heart function impairment, increased blood pressure and heart rate, dysrhythmia, ischemia and heart failure, recurrence of heart attacks, and even high mortality rate.[26-29]

Anger is associated with more than twice higher rate of acute MI and 1.25 times higher rate of mortality due to this condition, especially in the first 3 years after the incident.[29] Depression and anxiety are generally associated with MI, especially at the ages of over 50, and increased morbidity and mortality resulting from this condition.[8,11] The prevalence of depression and anxiety among coronary heart disease patients generally ranges from 10% to 50%.[30] In a meta-analysis of 12 studies and 5750 MI patients, it was reported that anxiety was associated with a 36% increase in the risk of CVD and mortality.[31] In another study, Murphy *et al*. reported that mild depression in the hospital and a moderate to severe 2-month depression predict mortality of patients with acute MI in the next 12 years.[32]

Although the role of psychological factors in coronary heart disease has recently received more attention, the major factors that influence the prognosis of heart disease are still not well known.[33] For example, while some researchers have found that anger increases the risk of coronary heart disease, others have reported that anger is a protective factor.[33-34] Nevertheless, it is believed that negative emotions (such as anger) are not risk factors by themselves and coping and adaptation strategies are also important in this respect.[25] It should also be noted that the prognosis of MI is also influenced by the extent

of heart attack and the number of vessels involved.[5] It can, therefore, be concluded that more research is still needed to ascertain the role of emotions on the cardiac function of patients in the acute MI phase. Although the association of psychological factors and coronary heart disease has been extensively researched using correlational, causality-comparative and other approaches, the present study tried to use the method known as structural equation modeling (SEM) for this purpose. Given its objective, this study falls in the category of fundamental research and may contribute to the formation of a basis for a broader theory regarding the psychological consequences of MI and better prevention and treatment strategies for limiting the health implications of this relationship.

Procedure

In this fundamental research, data collection was performed by the use of a cross-sectional method and data analysis was carried out using a descriptive method of correlational type based on SEM, and specifically the regression equations (combination of path analysis and second-order factor analysis).The analysis was performed using the covariance-based variant of SEM (CB-SEM) in the software AMOS 23. This method can estimate the path coefficients and factor loadings by minimizing the difference between the sample-based and model-based covariance matrices. Furthermore, Baron and Kenny's method was used to investigate the inter-variable correlations, the effect of exogenous variables on mediating variables, he effect of mediating variables on endogenous variables, and finally, the mediation relationship between exogenous and endogenous variables.[35]

The population of this study was the patients with acute STEMI who were admitted to the emergency department of Sari Fatemeh-Zahra Hospital (Sari, Iran) and Mazandaran Cardiovascular Hospital (Sari, Iran) in 2017–2018 and underwent primary percutaneous coronary intervention (PCI) treatment.

Inclusion criteria were as follows:

a. Patients aged 30–65 years who were diagnosed with acute STEMI and had undergone primary PCI. STEMI diagnosis criteria were: high ST-segment elevation, elevated level of cardiac enzymes, and clinical presentation of angina pectoris and angiography determined coronary artery stenosis >50%[5]
b. Having at least a minimum level of literacy (reading and writing) to fill out questionnaires.

Exclusion criteria were:

a. Failure to complete the questionnaire
b. Patient's withdrawal from the research
c. Presence of physical disorders
d. Presence of psychological and mood disorders.

The sample size was determined using Mueller's modeling equation modeling method (1996) based on a sample size-to-free parameter ratio of 10.[36] In this method, in terms of the number of path coefficients and factor loads, a factor of at least 10 is considered. In this research, taking into account the number of 7 path coefficients, 14-factor factors, 21 parameters were multiplied by 10, and the number of 220 samples was estimated. The ethics committee at Islamic Azad University provided ethics approval for the study with the code IR.IAU.SARI.REC.1397.027.

The study was performed through the following procedure. First, the case files of patients hospitalized in the coronary care unit (CCU) were reviewed to identify patients aged 30–65 years who were diagnosed with STEMI and had undergone primary PCI. Data collection instruments chosen for this study were the Type-DScale-14 (DS14), Spielberger's state-trait anxiety inventory (STAI), short-form beck depression inventory (BDI-13), and Spielberger's state-trait anger expression inventory-2 (STAXI-2). Before administering the questionnaires to the eligible patients, inclusion and exclusion criteria were checked by extracting demographic information from patients' records and also by direct examination. The extent of coronary artery involvement was determined from the angiographic report. The participants were explained how to fill out the questionnaire and asked to respond to all questions. The ejection fraction recorded in the echocardiographic report was considered as the measure of cardiac function. Data analysis was performed in SPSS 18 and AMOS (IBM, california, America).

Type-Dscale-14

DS14 is a 14-item scale developed in 2005 by Denollet. This scale consists of two subscales: negative affectivity and social inhibition.[37] This scale enjoys high reliability. Specifically, this scale is shown to have a test re-test reliability of 0.81 and a Cronbach Alpha of 0.86 (in Belgium).[38] In terms of validity, it is reported that the negative affectivity subscale has a 0.75 correlation with neuroticism, the social inhibition subscale has a −0.61 correlation with extraversion, a −0.40 correlation with conscientiousness and a 0.50 correlation with neuroticism, all at 0.001 significance level.[37]

According to the studies conducted in Iran, the internal consistency of the negative affectivity and social inhibition

subscales in this country is, respectively, 0.77 and 0.90[39] and their Cronbach's alpha is, respectively, 0.79 and 0.56. The overall Cronbach's alpha of DS14 in Iran is reported to be 0.83.[40]

This scale has been developed based on a five-point Likert scale with responses: False, Rather False, Neutral, Rather true, and true, which have a score of 0, 1, 2, 3, and 4, respectively. The total score of DS14 ranges from 0 to 56, with scores closer to 56 showing that the respondent as a Type-D personality.

Short-form beck depression inventory-13

The initial BDI was first introduced by Beck *et al*. in 1961. The short-form BDI-13 consists of 13 self-report statements expressing the specific symptoms of depression that measure the severity of this condition (from no depression to severe depression) in the respondent. In a study conducted by Rajabi in Iran, the Cronbach's alpha and the split-half reliability of this inventory were, respectively, 0.89 and 0.87, and the coefficient of correlation between the short form and the 21-item form of the inventory was 0.67.[41]

In BDI-13, responses are arranged based on a 4-point Liker' scale ranging from zero to 4, and the overall score is the sum of all scores given to every statement. The total score of BDI-13 ranges from 0 to 39 and is interpreted as follows:[42]

- 0– 04 : No depression
- 7– 05 : Mild depression
- 8– 15 : Moderate depression
- 16– 39 : Severe depression.

Spielberger's state-trait anger expression inventory-2

Developed by Spielberger in 1985, STAXI is a 57-item inventory consisting of six scales and five sub-scales with questions organized in three sections. Their liability assessments of STAXI-2 have reported an alpha of over 0.84 for state anger and trait anger scales and subscales and an alpha of over 0.73 for anger-in, anger-out, anger control, and the general anger expression index.[43] The first section of the inventory, titled "how I currently feel," measures the degree of anger felt by subjects on a four-point scale with responses ranging from "not at all = 1" to "Extremely = 4". This section contains 15 items and includes the state anger scale (S-Ang) with three sub-scales: 1-Feeling Angry (S-Ang/F), 2-feeling expressing anger verbally (S-Ang/V), and 3-feel like expressing anger physically (S-Ang/P).

The second section, titled "how I generally feel," has 10 items devoted to measuring anger trait, which are scored as in the first section. The anger trait scale (T-ang) has two sub-scales: 1-angry temperament (T-Ang-T) and 2-angry reaction, (T-Ang-R).

The third section, titled "how I generally behave or react when I am angry" measures the respondent's control over anger and consists of 32 items in four subscales: 1-anger expression-out (AX-O), 2-Anger Expression-in (AX-I), 3-anger control-out (AC-O), and 4-anger control-In (AC-I). The responses of this section are arranged based on a 4-point scale ranging from "almost never = 1" to "almost always = 4."

Among Iranian researchers, Khodayari Fard *et al*. have confirmed the validity and reliability of STAXI-2, reporting an internal consistency of 0.60–0.93, a split-half coefficient of 0.57–0.89, and a re-test coefficient of 0.72–0.93 for its scales and sub-scales.

In a study by Navidi, (2006) where they investigated the validity of STAXI-2 and general health and adjustment questionnaire on 170 male high school students, they reported a Cronbach's alpha of 0.88 for state anger and 0.85 for trait anger and average alpha of 0.71 for anger control, anger expression, and general anger expression index. All of these coefficients were statistically significant, demonstrating the satisfactory internal consistency of the scales and subscales in the studied population.[44]

Spielberger's state-trait anxiety inventory

Developed by Spielbergerin 1970, STAI consists of 40 questions, half of which measure state anxiety and the other half measure trait anxiety. For the state anxiety questions, the responses are designed based on a 4-point scale and include: Not at all, somewhat, moderately, and very much so. The responses of the trait anxiety questions, which are also based on a 4-point scale, include: almost never, sometimes, often, and almost always.[45] This inventory provides two scores, each ranging from 20 to 80, which quantify the respondent's condition in terms of state anxiety and trait anxiety.[42]

Spielberger *et al*. (1970) have reported a Cronbach's alpha of 0.92 and 0.90 and a test–retest reliability of 0.62 and 0.68 for state anxiety and trait anxiety subscales, respectively. In a study on 219 patients with generalized anxiety disorder and major depressive disorder and normal people, Cronbach's alpha of state anxiety and trait anxiety subscales were reported to be 0.92 and 0.90, respectively.[46]

In STAI, all items are scored from 1 to 4, but those items that measure the absence of anxiety are scored inversely. The total score of STAI is interpreted as follows:[42]

- 20– 29 : No or low anxiety
- 30– 49 : Moderate anxiety
- 50– 69 : Relatively high anxiety
- 70– 80 : High anxiety.

RESULTS

After checking the statistical assumptions using the skewness, kurtosis test, Box, and Kolmogorov–Smirnov tests and removing the outlier data using the Mahalanobis test, 201 samples were cleared for final analysis. After establishing the normality of data, the validity of the measurement model for the research variables was also checked and verified. For all subscales of Type-D personality in negative affectivity (anger, depression, and anxiety), the average variance extracted (AVE) were >0.5, indicating the presence of convergent validity. In the investigation of construct validity, the obtained values were found to be greater than the standard value (0.07), thus confirming the AVE and construct reliability of the questionnaire.

As the results presented in Table 1 show, a significant positive correlation at (0.01 significance level) was found between Type-D personality, negative affectivity (anger, depression, and anxiety) and cardiac function [Table 1].

As shown in Table 2, RMSEA was calculated to 0.048 (<0.1), indicating that the model is acceptably accurate. Furthermore, the ratio of the Chi-square to the degree of freedom was 2.911 (within 1–3 range), and goodness-of-fit index, comparative fit index, and normalized fit index values were almost equal and all >0.9, which signified the fitness of the measurement model for the research variables [Table 2].

According to Table 3, Type-D personality, negative affectivity (anger, depression, and anxiety) have a direct effect on cardiac function [Table 3].

As shown in Table 4, the standardized β, nonstandardized b, and R2 values obtained for the considered indirect paths using the bootstrap method indicate that Type-D personality has a significant indirect effect on cardiac function via negative affectivity (anger, depression, and anxiety) [Table 4].

Note: To incorporate the latent variables into the final model, there should be multiple indicators for each variable. It is common to use subscales of the measures as independent indicators of the construct, but in cases where there are no multiple subscales for a particular construct, one can use the item parceling method introduced by Russell, Kahn, Spoth, and Altmaier (1998). In this study, this method was used to analyze the variables of depression, personality type D and cardiac function with respect to single variability in order to improve the overall variance of the model according to the Russell method in the hidden variable [Figure 1].

DISCUSSION

The purpose of this research was to estimate the SEM of the relationship between Type-D personality and cardiac function of patients with acute MI as mediated by negative affectivity (anger, depression, and anxiety). According to the final model, Type-D personality predicts of changes in the cardiac function of patients with acute MI. After investigating the role of Type-D personality and negative affectivity (anger, depression, and anxiety) in the prediction of cardiac function in the patients, coefficient of determination for their role in the variance of cardiac function was calculated to 0.03, 0.06, 0.09, and 0.17, respectively. For the indirect path of Type-D personality toward cardiac function through negative emotions of anger, depression, and anxiety, the coefficient of determination (R2) was calculated to 0.15, 0.12, and

Table 1: Mean, standard deviation, and correlation of Type-D personality, negative affectivity (anger, depression, and anxiety) with cardiac function

Variable	M	SD	1	2	3	4	5	6	7	8	9	10	11	12
Trait Anxiety	41.57	7.75	1											
State Anxiety	38.36	9.96	**.77	1										
Depression	18.67	6.69	**.30	**.65	1									
Feeling Angry	9.64	1.24	**.41	**.29	**.29	1								
Feel Like Expressing Anger Verbally	8.04	1.67	**.42	**.61	**.37	**.43	1							
Feel Like Expressing Anger Physically	8.47	1.97	**.31	**.34	**.34	**.72	**.31	1						
Angry Temperament	7.97	3.37	**.24	**.18	**.23	**.24	**.22	**.23	1					
Angry Reaction	14.50	2.92	**.29	**.24	**.24	**.28	**.22	**.22	**.31	1				
Anger Expression-Out	15.60	4.04	**.31	**.23	**.24	**.29	**.21	**.22	**.42	**.94	1			
Anger Expression-In	14.64	3.94	**.26	**.22	**.23	**.25	**.19	**.20	**.40	**.41	**.93	1		
Anger Control-Out	14.23	4.24	**.14	**.08	**.12	**.13	**.12	**.13	**.63	**.24	**.45	**.45	1	
Anger Control-In	16.97	2.61	**.31	**.29	**.25	**.31	**.33	**.30	**.23	**.18	**.21	**.18	**.13	1
Type-D personality	24.67	4.91	**.26	**.25	**.26	**.28	**.29	**.29	**.25	**.20	**.22	**.20	**.17	**.54
Cardiac function (EF)	42.33	8.45	**.26	**.25	**.26	**.27	**.27	**.28	**.23	**.21	**.22	**.21	**.14	**.41

**Significant level: 0.01. SD: Standard deviation, EF: Ejection fraction

Table 2: Fitness indices

Test name	Description	Threshold of Acceptability	Value obtained
DF	Degrees of Freedom	-	86
RMSEA	Root Mean Square Error Of Approximation	<0.1	0.048
GFI	Adjusted Goodness of Fit Index (AGFI)	>0.9	0.942
NFI	Normed Fit Index	>0.9	0.911
CFI	Comparative Fit Index	>0.9	0.918

Table 3: Estimation of direct effects (paths) using the maximum likelihood method

Variable	b	B	R^2	Significance
Type-D personality→Cardiac function	0.21	0.19	0.039	0.034
Anger→Cardiac function	0.27	0.24	0.064	0.018
Depression→Cardiac function	0.32	0.30	0.096	0.007
Anxiety→Cardiac function	0.46	0.38	0.174	0.001

Table 4: Estimation of indirect effects (paths) using the bootstrap method

Variable	B	Lower bound	Upper bound	Significance
Type-D personality→Anger→Cardiac function	0.312	0.152	0.389	0.001
Type-D personality→Depression→Cardiac function	0.284	0.124	0.350	0.004
Type-D personality→Anxiety→Cardiac function	0.368	0.245	0.429	0.001

0.24, showing that cardiac function of the patients is also influenced indirectly via these emotions. These results are consistent with the other findings.[11,21,25,29-32,47-49]

Personality can be considered as distinct patterns of thinking, emotion, and behavior that characterize each individual's interaction with the physical and social environment.[24] There are only a few aspects of human activity that does not reflect personality[42] and everything that a person has or will attain, including its general health, is influenced by his own personality and the personality of others with whom he has interaction.[12] Personality types provide a model for assessing how a person behaves and thinks. Each personality type has certain features and attributes that can help the person overcome problems and cope with the environment.[50] The personality type of interest to this study is Type-D personality, the theoretical basis of which originates from a study of heart patients in Belgium, where the role of personality traits on the outcomes was investigated.[37]

The results of the present study in regard to the effect of Type-D personality on cardiac function can be explained as follows. Regarding the mechanism of the effect of Type-D personality factors (social inhibition and negative affectivity) on cardiac function, it can be argued that the effects of these components on the cardiac system are involved. Experiencing a negative emotion stimulates the sympathetic nervous system, and this state of arousal lingers as long as the emotion is unexpressed, which if persistent can undermine cardiac output and hence cardiac function.[5,16,24]

Type-D personality is a good predictor of physical-psychological outcomes. This personality type is also known to be associated, via lifestyle, with the biological causes of coronary heart disease (blood pressure, blood lipid level, and tobacco use) and therefore the severity of coronary artery stenosis.[51-53] It is also shown that MI patients who have a Type-D personality have a lower quality of life.[15,16]

The results of this study showed that Type-D personality affects cardiac function via the mediation of negative affectivity (anger, anxiety, and depression). In the explanation of this result, it can be argued that emotions can negatively affect the cardiac function by affecting the hypothalamic-pituitary-adrenal axis and increasing catecholamines, heart rate, vasoconstriction, and blood pressure.[7,23,54,55] A study by Faramarzinnia and Beshatat has shown that anxiety and anger have a significant positive relationship with chronic hypertension.[56] In a study by Merswolken *et al*. on patients with MI, anxiety was reported to be a predictor of cortisol secretion,[47] which is known to damage the vessel wall by activating the immune system and triggering inflammatory responses.[7] Depression is also shown to be a predictor of 12-year mortality in patients with MI.[32] It is believed that negative emotions affect the prognosis of coronary heart disease via psychological factors such as quality of life and coping styles.[48,57] The study of Merswolken *et al*. on the effect of anxiety in the elevation of cortisol secretion in patients with MI, the study of Rost *et al*. (2012) on the effect of anxiety on the mortality of these patients, the study of Murphy *et al*. on the effect of depression on the mortality in stroke patients, the study of Wrenn *et al*. (2013) on the effect of anger and anxiety on the mortality and survival rate of patients with acute MI, and the study of Vanbeec *et al*. (2016) on the effect of anxiety on the prognosis of cardiac arrest, new cardiac events, and mortality due to MI all have confirmed the existence of associations investigated. There are some differences between these studies and the present work. In the study of Murphy *et al*. for example, only the women with MI who had undergone coronary artery bypass graft surgery were investigated, so there ported mortality figures can be influenced by gender and surgery implications. Furthermore, while the above studies have investigated the

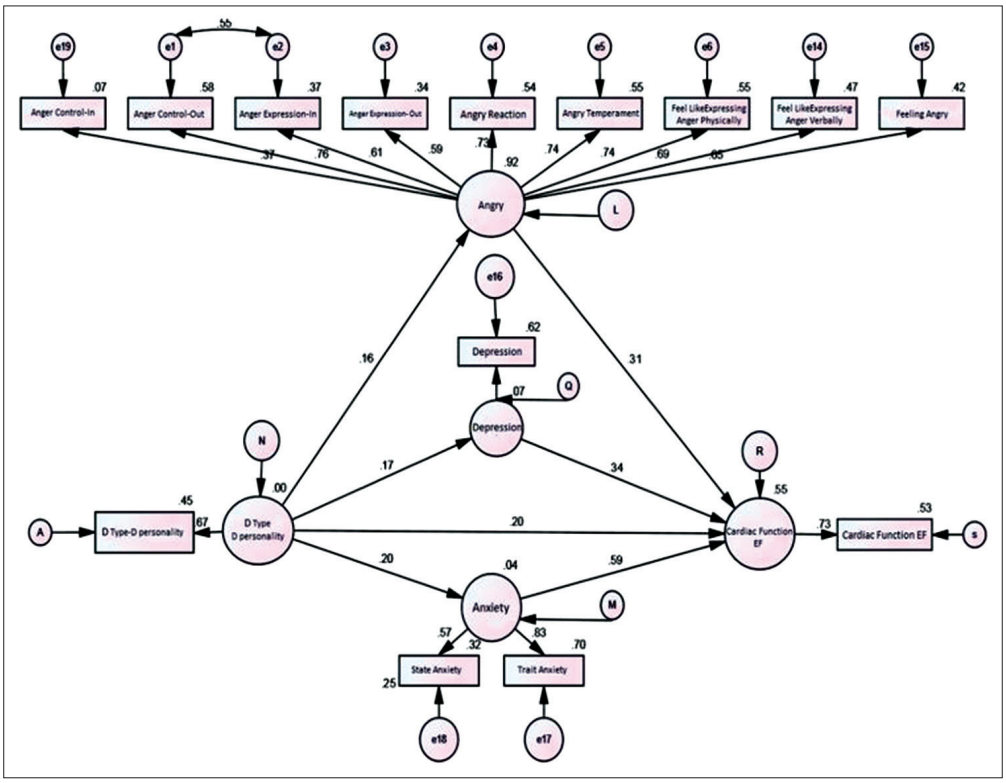

Figure 1: The final model of the tested paths and standardized statistics for the prediction of cardiac function by Type-D personality with the mediation of negative affectivity (anger, depression, and anxiety)

simultaneous effect of one or two emotions on the mortality of MI patients, the present study examined the effect of three emotions on cardiac function of patients with acute MI. It is also notable that most of the mentioned studies have used correlational or causal-comparative approach, but the present study used the method known as SEM.

The findings of this study could be of use to general health professionals, health psychologists, cardiologists, and CCU nurses. Identification of factors that influence coronary heart disease and cardiac function can also contribute to the development of interventions for improving the cardiac function in general and the prognosis of patients with acute MI in particular.

Limitation

The notable limitation of this research was the use of self-report instruments, which were too long and too difficult to complete given the physical condition of our patients. Hence, future studies are suggested to adopt a prospective strategy and approach the patients later during or after the recovery.

CONCLUSION

Given the physiological components of emotion and involvement of the sympathetic nervous system in this matter, cardiac function can be affected not only by the pathophysiology of MI but also indirectly by psychological factors. Since the prognosis of MI depends on cardiac function, hospitals are recommended to broaden their approach beyond a narrow focus on purely medical treatment by paying closer attention to the psychological health of the patients suffering from MI.

Conflicts of interest

There are no conflicts of interest.

Authors' contributions

Marzieh Mohammadi Pashaki Introduction author and Original researcher, Yarali Dousti Methodologist, Bahram Mirzaeiyan Discussion author.

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