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ORIGINAL ARTICLE

Self-care and related factors associated with left ventricular systolic function in patients under follow-up after myocardial infarction

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Background Recent advances in treatment have led to long-term survival after myocardial infarction (MI), but subsequent complications such as heart failure have also increased, and, therefore, the relationship between prognosis and self-care needs to be investigated.

Aims This study aimed to confirm the relationship of potential variables affecting self-care of patients after MI and to determine whether self-care predicts left ventricular systolic function.

Methods Using a descriptive study design, a hypothetical model was constructed based on previous studies, and 191 post-MI patients were recruited from three university hospital outpatient clinics in Korea. The modified model was verified by constructing a structural equation model using AMOS version 24.0. The exogenous variables were illness perception, social support, and depression symptoms. The endogenous variables were self-efficacy, self-care compliance, and changes in left ventricular ejection fraction (LVEF).

Results The average patient age and disease duration were 66.3 (±11.5) years and 62.1 (±56.6) months, respectively. Self-care compliance was directly influenced by self-efficacy and indirectly affected by social support. Self-care compliance had a direct effect on LVEF changes, which was indirectly associated with illness perception, social support, and self-efficacy.

Conclusion This study confirmed the direct effect of self-care compliance on changes in LVEF in patients under follow-up after MI. It is necessary to periodically monitor the degree of self-care in outpatients who are undergoing follow-up after MI to prevent a decrease in cardiac function. Counseling and education may be effective forms of social support to improve disease awareness and self-efficacy among patients with low self-care compliance.

Keywords Myocardial infarction • self-care • left ventricular dysfunction • self-efficacy • social support

Implications for practice

- This study firstly supported the importance of self-care in patients under follow-up after myocardial infarction by confirming that low self-care compliance has a negative direct effect on left ventricular ejection fraction.
- To improve self-care compliance in patients after myocardial infarction, illness perception and self-efficacy that indirectly affects left ventricular ejection fraction changes should be enhanced.
- Periodic counseling and evaluation of self-care compliance, including lifestyle habits, are needed for outpatients who are followedup after myocardial infarction.
- Patients should be empowered to use these resources, in order to view the world as more comprehensible, manageable, and meaningful.

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Introduction

Recent advances in treatment and drug development have resulted in a higher survival rate after myocardial infarction (MI) and improved long-term prognosis, but adverse cardiac events such as heart failure, vascular restenosis, sudden death, or stroke may still occur.[1] National cohort studies of patients with MI abroad showed that the incidence of heart failure was 21.8% five years after MI,[2] and 29.1% of patients experienced subsequent heart failure within two years after the initial MI diagnosis.[3] In a multicenter study of 13,000 Korean patients with MI, the incidence of major cardiac events was 9.6% at the one-year follow-up, and this increased to 18.8% at the two-year follow-up, with a 6.8% readmission rate owing to heart failure.[4] According to the studies on post-MI prognosis, heart failure after discharge increased all-cause and cardiovascular disease mortality 5.98 times and 7.93 times, respectively, for patients without a history of hospitalization for heart failure who underwent one year of follow-up.[5,6] These findings suggest the importance of prevention of heart failure,[1] which is the main determinant of secondary long-term complications of patients after acute-phase MI.

Heart failure has the highest mortality rate among all cardiovascular diseases,[7] and the five-year survival rate after diagnosis is 51.5%.[8] In order to prevent heart failure, once it has been diagnosed, the therapeutic effect is limited and it is important to find a high-risk group for heart failure and to focus on these patients at the stage preceding the disease.[6] Left ventricular ejection fraction (LVEF) is a physiological index that reflects the systolic function of the left ventricle measured by echocardiography and is the primary diagnostic method for heart failure.[1,7] Changes in LVEF have been reported as an important factor affecting the development of and mortality from heart failure in the long-term prognosis of patients with MI after discharge.[9] A five-year follow-up study of Korean MI patients showed that reduction in LVEF of more than 20% after one year of MI treatment predicted major cardiac events such as heart failure.[1] Accordingly, heart failure can be an early or late serious complication of MI, and it is important to identify changes in LVEF in patients who were followed-up after MI and to provide earlier intervention before progression to heart failure.

Unhealthy lifestyles such as obesity, lack of exercise, alcohol intake, and smoking reduced LVEF and increased the risk of heart failure in older adults.[10] In order to prevent recurrence and worsening of MI patients, it is important to comply with self-care, including personal lifestyle correction.[11,12] For patients with MI, compliance with self-care during treatment for long-term chronic illness after the acute phase has been shown to improve prognoses.[13] According to randomized controlled trials that tested the effectiveness of self-care education for patients with coronary artery disease, compliance with self-care improved the health-related quality of life by improving physical and emotional functions[14] and improving patients' knowledge and attitudes about the disease.[15] The relationship between self-care compliance and psychosocial variables was influenced by the patients' social support and depression symptoms, and was mediated by self-efficacy.[16] Positive illness perception increased self-efficacy[17] and increased self-care compliance.[18] Self-efficacy especially increased the patients' quality of life by promoting self-care compliance.[19] Low social support and depression symptoms were predictors of lower self-efficacy,[16] which affected health behaviors and lowered the quality of life.[20]

A number of previous nursing studies have examined the psychosocial variables impacting the effect of self-care on patients with coronary artery disease. However, no study has confirmed the relationship between self-care and cardiac systolic function in patients under follow-up after MI.

Therefore, the purpose of this study was to construct a structural equation model between latent variables based on previous studies and to identify factors that directly or indirectly affect LVEF.

Hypothetical model

The relationship between self-care-related factors and changes in LVEF consisted of three exogenous and three endogenous variables. Exogenous variables were illness perception, social support, and depression symptoms, with six observational variables. Endogenous variables were self-efficacy, self-care compliance, and changes in LVEF, with 10 observational variables. Psychosocial variables such as illness perception, social support, depression symptoms, and self-efficacy supported from previous studies were established as having a relationship with self-care compliance in MI patients,[16–20] but not with changes in LVEF. In this study, because there was no previous study on the relationship between psychosocial variables and a physiological indicator, LVEF, only the self-care compliance variable as the outcome variable of health behaviors was established and verified as having a causal relationship with LVEF changes. Choi[18] reported that the longer the duration of disease, the greater the severity and risks of disease. Duration after the first MI was thought to affect the relationship between the variables of this study; therefore, it was designated as the control variable.

Methods

Study design

This study is a descriptive correlational study of the relationship between changes in LVEF and the related variables that affect self-care compliance in patients under follow-up after MI.

Study population

The subjects were recruited from outpatient clinics of three university-affiliated hospitals in South Korea, and were adults over 20 years of age, who were able to communicate, understand the purpose of the study, and voluntarily participate in the study.

Inclusion criteria

(1) Patients who have undergone follow-up as outpatients for more than one year after MI diagnosis and percutaneous coronary intervention.
(2) Patients with LVEF values on echocardiography at the time of discharge after first MI treatment and LVEF values within the last six months.

Exclusion criteria

(1) Patients diagnosed with one of the following medical conditions: end-stage renal failure, terminal cancer, chronic obstructive pulmonary disease, valvular heart disease, dementia or psychiatric

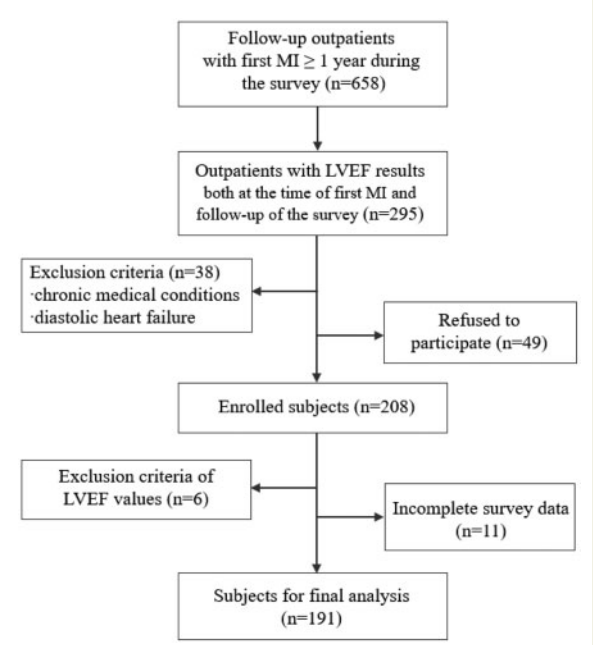

Figure 1. Flow chart.
MI: myocardial infarction; LVEF: left ventricular ejection fraction.

history, and antidepressant users. Patients taking antidepressants were excluded from the study because antidepressants may affect patients' response to the depressive mood measures.

(2) Patients with an LVEF greater than 60% above the normal range at the time of discharge after MI and an LVEF greater than 60% within the last six months (LVEF >60% was considered clinically normal). This was determined based on the recommendations of the three cardiologists that the normal range of LVEF changes conflicts with the interpretation of LVEF changes in the abnormal range.

Among the outpatients who were followed-up for more than one year with the diagnosis of MI at the three hospitals, the patients who were scheduled to visit an outpatient clinic during the survey period were recruited. Of these, we selected patients who had both echocardiographic results immediately after diagnosis of MI and within the last six months. Patients who refused to participate or had severe chronic medical conditions, and had LVEF values exceeding 60% immediately after diagnosis and within the last six months of the survey were excluded from the study. The patients were then confirmed at an outpatient visit and we explained to them the study purpose and finally selected subjects who agreed to participate in the study (*Figure 1*). The structural model analysis and maximum likelihood method were used to determine that the optimal sample was at least 100–150, with a minimum recommended level of 5–10 times the measured variable.[21] Therefore, the minimum number of samples required for this study was 160 – 10 times the 16 observational variables; however, data of 208 patients were collected to allow for dropouts. Of these, 191 were included in the analysis; 17 were excluded due to the exclusion criteria of LVEF values and incomplete data.

Study variables

Illness perception

We used the Brief Illness Perception Questionnaire, modified by Broadbent et al.[22] and tested for its reliability and validity in Koreans.[23] This instrument consists of eight items: identity, timeline, personal control, treatment control, consequences, understanding, concern, and emotional response. This tool is an 11-point scale, and among these items, the 'concern' item was removed by lowering the tool's reliability coefficient, so it was measured as 7 items (from 0 to 70). The higher the total score, the more negative the recognition of the disease. Cronbach's α was 0.73 at the time of tool development[22] and was 0.62 in this study.

Social support

The social support measurement tool was composed of family support and medical support, and it was modified by Shin et al.[16] This tool uses a four-point Likert scale and consists of 11 items, with one point being 'not at all' and four points being 'strongly agree' (range 11–44). A higher score indicated a higher level of social support. Cronbach's α values of both subscales in this study were 0.90 and 0.89, respectively.

Depression symptoms

Depression symptoms were measured by the Korean version of the Beck Depression Inventory short form developed by Beck and Beck,[24] which consists of 13 items on a four-point Likert scale ranging from 0 to 3 points. Scores range from 0 to 39; a higher score indicates more depression symptoms. The exploratory factor analysis indicated that there were no subscales in the original tool; however, in this study, we used three subscales with factor loading of 0.4 or more. Cronbach's α was 0.79 at the time of development[24] and 0.85 in this study.

Self-efficacy

Self-efficacy refers to the confidence and judgment of one's ability to perform a specific activity or task[25]; it was measured by a tool developed by Jun[26] for coronary artery disease patients. The instrument includes 12 items measured by a five-point Likert scale, comprising psychological adaptation ability, exercise, medication, diet, and daily life. Scores range from 12 to 60; a higher score reflects a higher level of self-efficacy. The exploratory factor analysis confirmed three subscales consisting of 'confidence' (six items), 'health responsibility' (four items), and 'exercise' (two items). Cronbach's α was 0.89 in the study by Jun[26] and 0.83 in this study.

Self-care compliance

Self-care compliance was measured by the tool modified by Son[27] for MI patients. This instrument comprises 23 items measured on a five-point scale ranging from 'not at all' to 'always good' (range: 23–115). It includes medical follow-up and medication, diet and weight, smoking and alcohol, exercise and rest, sex life, stress management and blood pressure, and pulse measurement. A higher total score indicates better self-care compliance. Cronbach's α was 0.80 in the study by Son[27] and 0.87 in this study.

Changes in LVEF

To examine the changes in LVEF values, we identified the results of two-dimensional echocardiography in the patients' medical records. Differences in LVEF values were calculated by comparing values that were measured within the last six months to those that were measured at the time of discharge after the first diagnosis of MI:

[LVEF (%) at follow-up – LVEF (%) at the time of first MI]

If the final measured LVEF value (within the last six months of the survey) minus the initial measured LVEF value (at the time of discharge after coronary intervention) was positive (+), then the left ventricular contraction function had improved. If it was negative (–), then the left ventricular contraction function had worsened.

Table I General characteristics of the subjects (*N*=191)

Variables	Categories	*n* (%)	M ± SD	$ü^2$ (*p*-value)
Gender	Male	154 (80.6)		
Age (years)	36–59	50 (26.2)		
	60–69	57 (29.8)	66.3 ± 11.5	
	70–94	84 (44.0)		
Marital status	Married	165 (86.4)		
Education level	≤Middle school	79 (41.5)		
	High school	59 (30.8)		
	≥College	53 (27.7)		
Type of MI	STEMI	100 (52.4)		
	NSTEMI	91 (47.6)		
Duration of MI (month)	12ã 36	86 (45.0)	62.1 ± 56.6	
	37–322	105 (55.0)		
Treatment	PCI-first time	115 (60.2)		
	PCI-recurrence	70 (36.5)		
	CABG	11 (5.8)		
Number of occluded vessels	≥2	88 (46.1)	1.6 ± 0.8	
Progression to Heart failure[a]	Yes	67 (35.1)		
LVEF at first diagnosis (%)	34.0–40.0	8 (4.2)	54.0 ± 9.1	
	40.1–49.9	62 (32.5)		
	50.0–76.0	121 (63.4)		
Recent LVEF (%)	14.3–40.0	35 (18.3)	50.9 ± 12.3	
(within the last six months)	40.1–49.9	49 (25.7)		
	50.0–75.1	107 (56.0)		
LVEF changes (%)[b]	-44.5 to -10.0	55 (28.8)	3.1 ± 12.9	
	-9.9 to -0.1	56 (29.3)		
	0.1ã 33.0	80 (41.9)		
Family history of CVD, yes		57 (29.8)		
CVD risk factors	Diabetes mellitus	64 (33.5)		
(multiple response)	Hypertension	111 (58.1)		
	Hyperlipidemia	112 (58.6)		
Medications				
ACEi or ARB, yes	At discharge after first MI	149 (78.0)		
	Negative LVEF change	86 (77.5)		0.04 (0.861)
	Positive LVEF change	63 (78.8)		
	Follow-up in recent six months	145 (75.9)		
	Negative LVEF change	87 (78.4)		0.88 (0.393)
	Positive LVEF change	58 (72.5)		
Beta blocker, yes	At discharge after first MI	184 (85.9)		
	Negative LVEF change	91 (82.0)		3.29 (0.092)
	Positive LVEF change	73 (91.3)		
	Follow-up in recent six months	154 (80.6)		
	Negative LVEF change	91 (82.0)		0.31 (0.583)
	Positive LVEF change	63 (78.8)		

M: mean; SD: standard deviation; MI: myocardial infarction; STEMI: ST elevation myocardial infarction; NSTEMI: non-ST elevation myocardial infarction; PCI: percutaneous coronary intervention; CABG: coronary artery bypass graft; LVEF: left ventricular ejection fraction; CVD: cardiovascular disease; ACEi: angiotensin-converting enzyme inhibitor; ARB: angiotensin-receptor blocker.

[a]Received a diagnosis six months before the survey.

[b]The difference measured within the last six months minus the LVEF values after the first MI treatment.

Table 2 Descriptive statistics of variables

Variables	Actual range	Mean ± SD	Skewness (N=191)	Kurtosis
Illness perception	6–59	33.0 ± 9.2	-0.19	0.17
Social support	19–44	34.4 ± 5.0	0.08	0.34
Depression symptoms	13–34	19.6 ± 5.2	0.79	-0.13
Self-efficacy	24–60	44.2 ± 7.3	-0.14	-0.23
Self-care compliance	40–103	82.9 ± 11.2	-0.80	0.84
LVEF changes	-44.5-33.0	-3.1 ± 13.0	-0.21	0.62

SD: standard deviation; LVEF: left ventricular ejection fraction.

Data collection and ethical considerations

This study complied with the Declaration of Helsinki and received approval from the institutional review boards of the two institutions (HYUH 2017-06-013-003; TMP-2017-321) at which the study was conducted. The data collection period of this study lasted from September 25, 2017 to April 27, 2018. Data were collected from three university-affiliated hospitals in Seoul and two provinces in Korea with cooperation from the cardiology department of each hospital. After MI was diagnosed and informed consent obtained from the outpatients, a self-reported questionnaire was conducted in a quiet, separate outpatient consultation room. Before data collection, the first author of the study and the research nurse of each hospital received an informed consent after explaining the purpose and protocol of the study through face-to-face interviews. It was also explained that they were free to withdraw at any time during the interview.

Data analysis

SPSS/WIN version 24.0 (SPSS Inc, Chicago, IL, USA) was used to verify the basic assumptions of the parametric statistics for the variables and to provide descriptive statistics on the study parameters. The reliability of the instrument was obtained by Cronbach's alpha. Pearson's correlation coefficient was used to confirm the correlation between the continuous variables. The exploratory factor analysis of the instrument was analyzed using principal component analysis by varimax rotation. A confirmatory factor analysis was performed to determine the model fit using AMOS version 24.0 (IBM Corp, Armonk, NY, USA). In order to estimate the parameters of the model analysis, the model was first estimated using the maximum likelihood method, then the predictive model was estimated. Structural equation modeling was performed to calculate the direct and indirect path coefficients between the factors affecting the changes in LVEF. The model's goodness of fit was determined using $\dot{u}^2$, goodness-of-fit index (GFI), comparative fit index (CFI), Tuckerã Lewis index (TLI), root-mean-square error of approximation (RMSEA), and standardized root-mean-square residual (SRMR). We used the bootstrapping method to test the standard errors and statistical significance of indirect effects and total effects of the modified model on the endogenous variables (number of bootstrap samples=1000).

Results

General characteristics of the subjects and descriptive statistics of variables

The mean age of the patients was 66.3 ± 11.5 years, and 80.6% were men. The mean duration of MI was 62.1± 56.6 months and 45.5% was the most frequent between 12 and 36 months; 35.1% had a diagnosis of heart failure, and 60.2% were undergoing management without recurrence after the first coronary intervention. The mean difference between the LVEF value at the last six months and the LVEF value at the initial diagnosis was –3.1 ± 12.9%, 33.5% of patients had diabetes, and 58.1% had hypertension. The basic assumption of the multivariate analysis for the normal distribution of all variables was verified that the absolute value of skewness was less than three, and the absolute value of kurtosis was less than 10.[21] Angiotensin-converting enzyme inhibitors (ACEi) or angiotensin-receptor blockers (ARB) was prescribed to 78% of the subjects at the time of discharge from the first MI and to 75.9% at follow-up within six months of the survey. ACEi or ARB were prescribed to 85.9% of subjects at the time of discharge after the first MI diagnosis, and to 80.6% at follow-up within six months. There was no statistically significant difference in the relationship between the prescription of ACEi/ARB or beta blocker (BB) and the reduction of LVEF at both the discharge from the first diagnosis of MI and the follow-up of the survey (*Table 1*). The descriptive statistics of variables are shown in *Table 2*.

Correlations among variables and validity of latent variables

Correlations were statistically significant between all exogenous and endogenous variables ($p<0.05$) except for depression symptoms and self-care compliance ($r=0.08$, $p=0.253$). The convergent validity was satisfied that the construct reliability was higher than 0.70 and the average variance extracted (AVE) was higher than 0.50, indicating that the observational variables were highly related to the latent variables.[21] The discriminant validity also confirmed that the AVE values of the potential variables were larger than the square of the correlation coefficient (R^2) (*Table 2*).

Test of fitness of the hypothetical model and revision of the model

The linear regression analysis showed that the tolerance ranged from 0.58 to 0.79, and that the variance inflation factor ranged from 1.26 to 1.72, which was less than 10, indicating no multi-collinearity.[21] The analysis results showed that the fitness index of the hypothetical model was $x^2=186.83$ (df=103, $p<0.05$), GFI=0.90, TLI=0.89, CFI=0.91, RMSEA=0.06 (0.05–0.09), and SRMR=0.08, thereby indicating a good level of fitness. Six of the eight paths were statistically significant ($p<0.05$). Self-care compliance was affected by illness

Table 3 Correlations among variables and validity of latent variables

Variables	Illness perception r(*p*)	Social support r(*p*)	Depression symptoms r(*p*)	Self-efficacy r(*p*)	Self-care compliance r(*p*)	LVEF changes r(*p*)	CR	AVE
Illness perception	1						–	–
Social support	-0.29 (<0.001)	1					0.83	0.73
Depression symptoms	0.42 (<0.001)	-0.35 (<0.001)	1				0.94	0.84
Self-efficacy	-0.34 (<0.001)	0.38 (<0.001)	-0.35 (<0.001)	1			0.70	0.50
Self-care compliance	-0.15 (0.034)	0.24 (0.001)	0.08 (0.253)	0.53 (<0.001)	1		0.86	0.51
LVEF changes	-0.23 (0.020)	0.21 (0.003)	-0.29 (<0.001)	0.29 (<0.001)	0.22 (0.003)	1	–	–

LVEF: left ventricular ejection fraction; CR: construct reliability; AVE: average variance extracted.

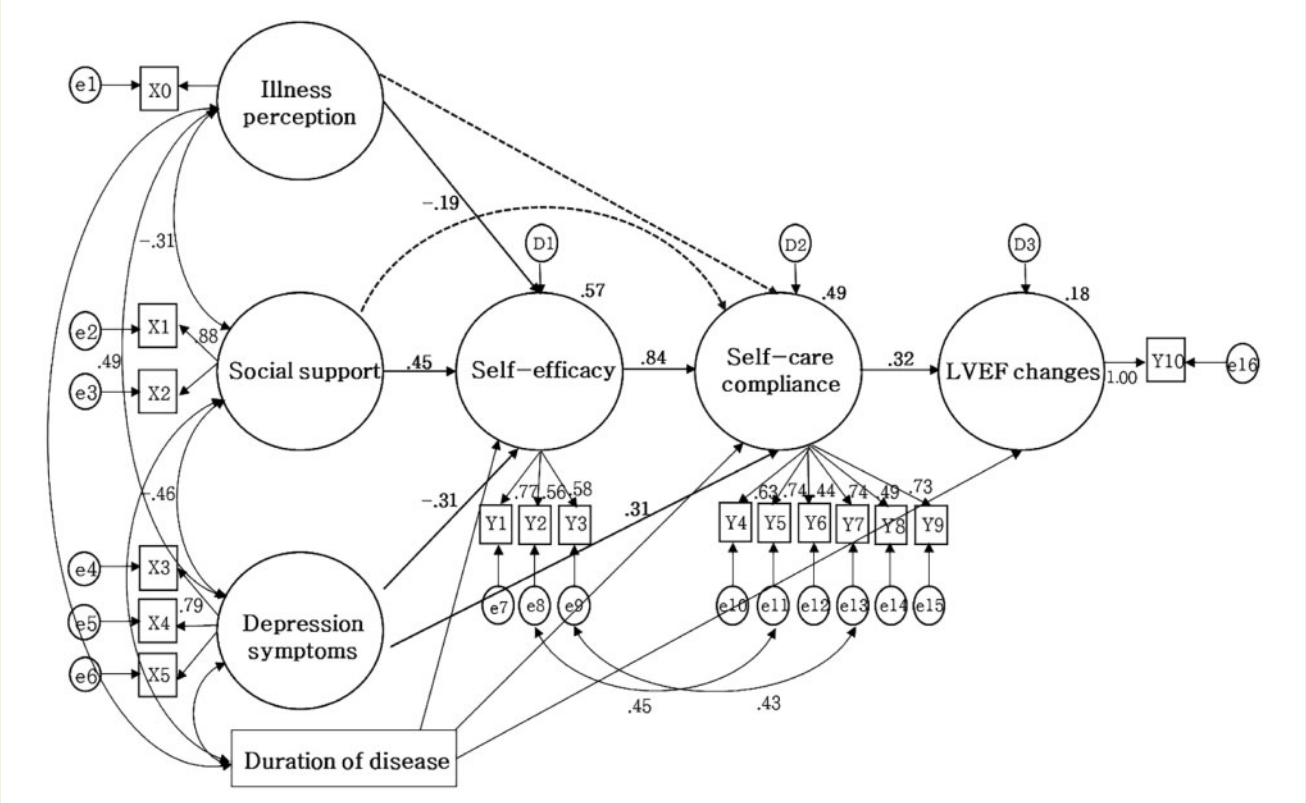

Figure 2. Final modified model.

XO: illness perception; X1: family support; X2: medical support; X3: social withdrawal and helplessness; X4: negative thinking; X5: guilty feeling and indecision; Y1: confidence; Y2: health and responsibility; Y3: exercise; Y4: medical follow-up and medication; Y5: diet and weight; Y6: smoking and alcohol; Y7: exercise and rest; Y8: sexual life; Y9: stress management; Y10: difference of LVEF value.

perception (β=0.02, t=0.19, p=0.846) and social support (β=-0.01, t=-0.05, p=0.959), and there was no significant difference between the two variables. Therefore, after eliminating that path, we compared the fitness of the hypothetical model with the modified model.

Table 4 Standardized direct, indirect, and total effects of the modified model

Endogenous variables	Exogenous variables	B	SE	CR	SMC	Standardized direct effects (*p*)	Standardized indirect effects (*p*)	Standardized total effects (*p*)
Self-efficacy	Illness perception	-0.08	0.03	-20.30	0.57	-0.19 (0.022)		-0.19 (0.022)
	Social support	1.12	0.33	30.41		0.45 (<0.001)		0.45 (<0.001)
	Depression symptoms	-0.46	0.80	-20.61		-0.31 (0.009)		-0.31 (0.009)
Self-care compliance	Illness perception				0.49		-0.16 (0.053)	-0.16 (0.053)
	Social support						0.38 (0.002)	0.38 (0.002)
	Depression symptoms	0.57	0.22	20.56		0.31 (0.011)	-0.26 (0.046)	0.05 (0.653)
	Self-efficacy	1.03	0.18	50.67		0.84 (<0.001)		0.84 (<0.001)
LVEF changes	Illness perception				0.18		-0.05 (0.029)	-0.05 (0.029)
	Social support						0.12 (0.001)	0.12 (0.001)
	Depression symptoms						0.02 (0.575)	0.02 (0.575)
	Self-efficacy						0.27 (0.001)	0.25 (0.001)
	self-care compliance	6.34	10.51	40.20		0.32 (<0.001)		0.32 (<0.001)

LVEF: left ventricular ejection fraction; SE: standard error; CR: critical ratio; SMC: squared multiple correlations; B: beta.

For the modified model, the fit index was x^2=186.87 (df=105, p<0.05), GFI=0.90, TLI=0.90, CFI=0.92, RMSEA=0.07 (0.05–0.08), and SRMR=0.07, thus indicating a good level of fitness.

Standardized path coefficients and significance of modified models

Self-efficacy was significantly affected by illness perception (p=0.022), social support (p<0.001), and depression symptoms (p=0.011); the explanatory power of self-efficacy was 57%. Self-care compliance was affected by self-efficacy (p<0.001) and depression symptoms (p=0.011), and the explanatory power was 49%. The LVEF changes were affected by self-care compliance (p<0.001), and the explanatory power was 18% (*Table 3*).

Standardized direct, indirect, and total effects of the modified model

Self-efficacy was directly related to illness perception (p=0.022), social support (p<0.001), and depression symptoms (p=0.009), and the effect was statistically significant. Regarding self-care compliance, illness perception (p=0.053) showed a borderline significance and social support showed a statistical significance (p=0.002). Self-efficacy was statistically significant for self-care compliance with direct effect (p<0.001). For LVEF changes, illness perception (p=0.029) and social support (p=0.001) mediated indirect effects and statistical effects, respectively. As a mediating effect of self-care compliance, LVEF changes were statistically significant for self-efficacy (p=0.001), indirect effects, and total effects. LVEF changes and self-care compliance (p<0.001) were statistically significant for direct effects and total effects (*Table 4*). The final modified model is shown in Figure 2.

Discussion

In this study, a hypothetical model was established to identify the predictors of LVEF in patients following-up after MI, and the final revised model was derived through validation of this hypothetical model. This section discusses the variables that directly or indirectly affect self-care compliance and LVEF. First, regarding the characteristics of the study subjects, 80.6% of the subjects were men, which is similar to the result of the global comparison study showing that the proportion of men was higher than that of women, averaging 70% in Korea, 60% in western Europe,[28] and 67% in the US.[29] This is also supported by the high proportion of men in the multicenter registry study in Korea.[1,4] In addition, in this current study the prescription rates of ACE inhibitors and BB were about 75% to 80%, respectively, both after the diagnosis of MI and over the past six months. According to the European Society of Cardiology guidelines, treatment with ACE inhibitors is recommended in MI patients with systolic LV dysfunction or heart failure, hypertension, or diabetes.[30] There was no significant difference in the rates of drug prescription between the two time points. Therefore, it is assumed that there was no drug effect on the LVEF, and, thus, this was not included in the model after consulting a statistician.

Patient's illness perception, social support, and depression symptoms had significant direct effects on self-efficacy, which explained 57% of the variance. These results supported the findings of previous studies, indicating that positive illness perception and social support corresponded with increased self-efficacy,[17] and lower levels of depression symptoms were associated with higher levels of self-efficacy[16] for patients with coronary artery disease. In addition, self-efficacy directly influenced the self-care compliance in this study. This is consistent with the results reported by previous studies that indicated that self-efficacy is the most influential factor in self-care compliance for outpatients after MI,[16,17,19] and it confirmed the importance of improving self-efficacy. In addition, in this study, the reliability of the items on illness perception was low at 0.62, which is due to the fact that some of the items are difficult to understand and the interpretation of the questions on the item is somewhat inconsistent. Further repeated studies using this tool will be needed.

Self-care compliance was directly influenced by self-efficacy and indirectly influenced by illness perception and social support, and those variables explained 49% of the variance. However, depression symptoms were found to have a direct effect on self-care compliance and an indirect effect on self-care compliance through mediation of self-efficacy, but their total effects were not statistically significant. This suggested that depression symptoms did not explain self-care compliance in this study. This finding was inconsistent with the results of a previous study of outpatient visits after coronary intervention that indicated that social support and depression symptoms were influenced by self-care through self-efficacy.[16] It was also not consistent with previous results indicating that depression symptoms decreased physical activities such as exercise[31] and that those factors directly influenced self-care compliance.[20] This difference may have occurred because depression was measured by a self-report questionnaire and because the duration of illness and depression measurement tools were different. However, illness perception and social support were omitted from the modified model because they were not statistically significant for self-care compliance. This was in contrast to the results of the study by Choi,[18] in which patients with coronary artery disease had positive illness perception and social support that directly affected their health behaviors. Therefore, further research is necessary to clarify these relationships.

In the present study, self-care compliance had a direct effect on LVEF changes and had 18% explanatory power. Illness perception and social support indirectly influenced LVEF changes through mediation of self-efficacy and self-care compliance. This finding is supported by the results of a study of the elderly in the US that indicated that improved lifestyle habits such as walking, leisure activities, smoking cessation, and weight and dietary control reduced the risk of heart failure.[10] In addition, previous studies reported that self-care compliance was directly related to the recurrence and aggravation of cardiovascular disease.[19,32] Therefore, nurses should periodically assess and guide outpatients' self-care, including medication and lifestyle habits, during the follow-up period after MI.

Few studies on the prospective outcomes of the psychosocial variables of MI patients have been performed; therefore, the direct causal relationship between psychosocial variables and LVEF has not yet been verified. Future prospective studies are required to verify the relationship between psychosocial variables and LVEF, as well as the relationship between self-care behaviors. A study by Greco et al.[33] showed that the LVEF values of coronary artery disease patients measured at discharge had a positive and direct effect on self-efficacy and illness perception and were not related to depression. Additionally, this was similar to the findings that LVEF was significantly lower in MI patients who had adverse cardiac events including heart failure than in those who had no cardiac events during the first year after successful coronary intervention. In particular, those with low LVEF less than 60% showed 1.8 times more low compliance with medication than those with LVEF greater than 60%.[34] However, in those studies, LVEF values were observed at one time point. This study examined the changes in LVEF values, (i.e. the difference between initial and recent values); therefore, direct comparisons with the results of other studies are limited. Follow-up studies using LVEF as a physiological indicator of the effectiveness of counseling interventions and education need to be conducted.

This study had some limitations. First, when examining the LVEF values, we could not consider the disease-related condition or the cardiac pathophysiological differences in patients with heart failure progression after MI. We focused on cardiac systolic function and compared the difference between the LVEF at the first MI and the LVEF after one year or more. Future studies will need to compare clinical outcomes from prospective studies by distinguishing between reduced LVEF levels and preserved LVEF levels at the time of first MI. Second, the disease duration varied from one to 26 years after acute MI. Although disease duration was included in the model validation process as a control variable, the study should be repeated using a shorter disease duration and larger number of study subjects. Lastly, the study subjects were recruited from three hospitals with convenient sampling, and the results of the self-report questionnaire are limited in order to generalize for all other MI patients.

Conclusion

The results of the structural equation model test showed that better self-care compliance in follow-up patients after MI directly affected the positive changes in LVEF, which was indirectly affected by positive illness perception, social support, and self-efficacy. It is necessary to periodically evaluate the extent of self-care and lifestyle habits to detect early systolic heart failure in outpatients with follow-up after MI. In particular, counseling and education are needed to provide social support to improve their illness perception and self-efficacy, especially for patients with low self-care compliance. Further research is needed to compare the sociodemographic and disease-related characteristics of maintaining or reducing cardiac contractility during the post-MI period and to compare the perceptions and barriers to self-care using a mixed method.

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