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Original article

Factors predicting physical and mental health-related quality of life among post-myocardial infarction patients: Bayesian model averaging analysis

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Abstract: Coronary artery disease was the cause of half of morbidity and mortality due to cardiovascular diseases in 2013. Myocardial infarction (MI) has been a common medical emergency with high mortality rate and complications unless it is early and appropriately treated. Health-related quality of life (HRQoL) has been popularly used in assessment of health state among coronary artery disease patients undergone both medical and surgical therapies. Bayesian model averaging approach statistically facilitated for identifying potential predictors of HRQoL among post-MI patients following up at University Medical Center, Ho Chi Minh City. The cross-sectional descriptive study was conducted on 146 participants diagnosed and treated with acute myocardial infarction from April 1st 2017 to June 30th 2017. The better HRQoL in physical component summary was associated with higher educational levels (coefficient = 1.2) and weekly moderate - intensity physical activity (coefficient = 0.002) but the contrast status for the female (coefficient = -3.7) in the fit model with R^2 = 0.24, BIC = -25.7 and posterior probability = 11.7%. The good economic household (coefficient = 9.8), more daily sitting time (coefficient = 1.4) and weekly moderate - intensity physical activity (coefficient = 0.004) predicted the increase of mental component summary score in the given model with R^2 = 0.08, BIC = -20.3 and posterior probability = 25%. The post - MI patients experienced low physical health much more than mental health. The female and suitable physical activity should be concerned in the rehabilitation program as well as follow-up care during the discharge process.

Keywords: HRQoL, predictor, post-MI patients.

1. INTRODUCTION

Cardiovascular diseases (CVDs) have been contributing to nearly half of all global deaths and coronary artery disease (CAD) has become a major public health problem in low and middle-income countries including Vietnam [1], [2]. Myocardial infarction (MI) is defined in pathology as myocardial cell death due to prolonged ischemia [3]. This medical condition might lead to dangerous complications causing a high risk of mortality if not soon detected and treated. Heart failure is one of the severe complications of MI in the acute episode and the early post-hospital period [4]. The socioeconomic effects from disability and cost have an influence on both patients and healthcare delivery system [5]. Both stressful burden of morbidity and finance have a direct impact on quality of life among coronary heart disease patients including MI ones [6]. Health-related quality of life (HRQoL) is popularly considered as an indicator of health status among CAD patients and also the basic assessment of treatment outcome [7]. HRQoL serves vital information to evaluate the rehabilitation and disease management because it refers to the clients'ability to enjoy normal life activities, mental and social well-being. Multiple factors were found to influence patients' HRQoL over the post-discharge period and their greater attention in order to improve QoL and daily functioning. Bayesian model averaging approach was

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employed for identifying potential predictors of HRQoL to reduce overconfident inferences. Thus, this study was carried out to answer the research question: what factors predict HRQoL among post-MI patients?

2. METHODS

The cross-sectional study was conducted.

Setting and subjects: The eligible patients who aged 18 years and older were diagnosed with acute MI for at least 4 weeks according to the diagnostic standard for acute myocardial infarction of The Joint ESC/ACCF/AHA/WHF Task Force for the Universal Definition of Myocardial Infarction [8]. The included subjects had good cognitive abilities and were healthy enough to answer questions and agreed to participate in the research. Those with heart failure, peripheral artery disease, chronic obstructive pulmonary disease, cancer, stroke and severe chronic anemia (Hb < 9 gram%) were excluded. A sample size of 90 post MI patients was determined as adequate to estimate the population parameter, based on the mean score (SF-36) in the field of general health that was 55.8 (standard deviation: 19.1) with a 95% confidence interval (Shibayama Kenzo's similar study in Japan, 2012). To allow for a 7% absolute error, all eligible post-MI patients who followed up from April 2017 to June 2017 at Cardiac examination room, University Medical Center, Ho Chi Minh City, Vietnam were conveniently invited to direct interviews. 146 subjects who met inclusion criteria were provided with written consents and recruited into our study.

Data collection procedure: Post - MI patients meeting the inclusion criteria were invited to participate in the face–to–face interviews. All demographic and socioeconomic information consisting of age, gender, occupational status, educational level, marital status, economic status was directly identified through interviews. Clinical variables including body mass index (BMI), chronic comorbidities (hypertension/diabetes), time of onset since acute myocardial infarction, treatment (percutaneous coronary intervention/ coronary artery bypass grafting/thrombolytic therapy) and ejection fraction (EF - left ventricular ejection fraction) were noted from patients' medical records on computer system and directly verified again. Variables of behavioral lifestyle associated with disease were collected by interviews based on the global physical activity questionnaire about moderate-intensity physical activities (MIPA) and sitting time. MIPA was measured by counting weekly amount of time that subjects spent in a typical week. A number of hours for both daily sitting and activities regarding sitting were also noted through patients' recall. Dependent variables regarding two aspects in health-related quality of life were collected by interviews based on SF-36^{v2} (36 item Short form health survey version 2).

Instrument: The structured questionnaire was about socioeconomic, demographic, clinical characteristics including: Patients' age, gender, occupational status, education level, marital status, economic status, chronic comorbidities, time of onset since AMI, and treatment (PCI/ CABG/thrombolytic therapy). Moderate-intensity physical activities and sedentary behaviors which were collected by using questions from Vietnamese Global Physical Activity questionnaire (GPAQ). 36-item short form health survey version 2 is a self-assessment questionnaire commonly used for investigating health-related quality of life. The 36 questions in the SF-36 survey (Ware & Sherbourne, 1992) capture the subject's perception of generic health by sorting the queries into two subscales. They are physical component summary (PCS) and mental component summary (MCS). This tool was translated into Vietnamese version that had been used in the study on Vietnamese American population with acceptable reliability (Cronbach's alpha coefficient) about 0.67 to 0.89 (Quyen Ngo-Metzger, 2008) [9].

Data analysis: The complete collected data was entered in Epidata 3.1 software and analyzed with R-software version 3.4.0. The frequency, percentage (%), mean and standard deviation (SD) were used to describe the demographic, socioeconomic, clinical characteristics and QoL scores. Bayesian model average (BMA) was employed to determine predictors of HRQoL chosen from the multivariable regression model. BMA is a more appropriate alternative to conventional techniques because it is extensively applied in combining multiple models for predictive purposes and selecting models, particularly covariable sets in regression models. Bayesian model averaging gives a coherent approach in accounting for model uncertainty to improve predictive performance and to avoid the problem of overstatement of the strength of evidence when p-values are only computed after traditional variable selection. BMA also facilitated our study in selection of a subset of predictor remains that would be a fundamental issue in linear regression modeling for situations involving a large number of predictors and small sample size. All independent variables in our observational study were simultaneously included in a BMA regression analysis by using the *bicreg ()* function contained in the BMA package of R software. The BMA procedure gave all possible models made up of the independent variables evaluated according to specific criteria. The models with the lowest BIC (Bayesian information criterion) and largest posterior probability were considered the appropriate ones [10]. The BIC approximation accounted for model uncertainty in multiple regression models. The posterior distribution of the outcome variable is a weighted average of the posterior distributions of the outcome for each likely model thus it is used as a suitable method for analysing a large number of predictors [11, 12]. In this study, we used the unique model with the most likely posterior probability. Another indicator for model choice was the coefficient of determination (R^2) calculating how the variable explained and showing the relative importance of factors as well.

3. RESULTS AND DISCUSSION

3.1. The result

The demographic, socioeconomic and clinical characteristics among post MI patients

The mean age among MI patients was 65.8 years (SD:10.7) and males accounted for 63.7%. The patients' occupational status was retirement at 61.6% and 32.2% of those was employment and the remaining (6.2%) was unemployment. The rate of MI patients living with wives or husbands was

77.4% compared with the single ones (6.2%) and to the divorced /widowed people (16.4%). 50 percent of those got the educational level of secondary and high school; 9.6 percent of them attended in vocational school and university education while the lower educational levels were an elementary school (22%) and illiteracy (11.2%). It showed that a fewer number of patients with poorly economic household (6.2%) but 93.8% of them with a good economic household. The prevalence of comorbidities including hypertension and diabetes in post-MI patients was 85.7% and 24.7%, respectively. The normal body mass index (BMI) among participants (18.5 - 22.9) was about 44.5% and the abnormal BMI accounted for 19.2% (23 - 24.9) and 28.8% (≥ 25). The larger proportion of AMI patients treated with PCI was 72.6% compared with those undergone with CABG (19.2%) and thrombolytic therapy (22.8%). 43.2% of patients diagnosed with AMI less than 1 year, 43.8% of those experiencing from 1 year to 5 years and the remaining having more than 5 years since the onset of AMI (13%) were reported. Whose EF over 50% were conserved with the largest percentage (80.8%) compared with the limited EF (from 40 to 49%) and reduced EF (under 40%), respectively 15% and 13%. The patients performed weekly moderate-intensity physical activities for 1352.4 (SD: 1069) minutes and spent an average of 8.1 (SD: 2.8) hours per day sitting. (Table 1)

The scores of HRQoL among post MI patients

Table 2 showed HRQoL scores of post-MI patients throughout two components of mental and physical health (MCS and PCS). The mean score of physical component summary (PCS) was 39.3 (7.7) and the mean score of the mental component summary (MCS) was 54.1 (8.2).

Table 1. Background and clinical characteristics among the subjects (n = 146)

Characteristics	Mean (SD) /Frequency	Percentage (%)
Age	65.8 (10.7)	N/A
Gender *(Male)*	93	63.7%
Occupational status		
Unemployment/ Housewife	9	6.2%
Employment	47	32.2%
Retirement	90	61.6%
Marital status		
Single	9	6.2%
Married	113	77.4%
Divorced/widowed	24	16.4%
Educational level		
Illiteracy	17	11.6%
Elementary school	32	22.0%
Secondary school	42	28.7%
High school	41	28.1%
Vocational/College/University	14	9.6%
Economic household		
Good	137	93.8%
Poor/Very poor	9	6.2%
Hypertension	125	85.7%
Diabetes	36	24.7%
BMI		
< 18.5	11	7.5%
18.5 - 22.9	65	44.5%
23 - 24.9	28	19.2%
≥ 25	42	28.8%
Treatment		
PCI	106	72.6%
CABG	7	4.8%
Thrombolytic therapy	33	22.6%
EF		
≥ 50%	118	80.8%
41% - 49%	15	10.3%
≤ 40%	13	8.9%
Time since AMI onset		
< 1 year	63	43.2%
1 year – 5 years	64	43.8%
> 5 years	19	13.0%
Weekly MIPA *(minutes)*	1352.4 (1069)	N/A
Daily sitting time *(hours)*	8.1 (2.8)	N/A

BMI: Body Mass Index. *MIPA: Moderate Intensity Physical Activity.* *EF: Ejection Fraction.* *N/A: no account*
AMI: Acute myocardial infarction *PCI: percutaneous coronary intervention* *CABG: Coronary artery bypass grafting*

Table 2. The mean scores of subscales in HRQoL among post MI patients

Subscale	Mean	Standard deviation (SD)	Min	Max
PCS	39.3	7.7	12.3	58.0
MCS	54.1	8.2	24.1	68.7

PCS: Physical component summary *MCS: Mental component summary*

Table 3. The multivariable regression models of predictive factors of PCS score among post-MI patients

Variables	PCS				
	Model 1	Model 2	Model 3	Model 4	Model 5
Gender *(Female)*	-3.7	-4.7	-4.2	-3.2	-4.0
Age	-	-	-	-	-
Occupational status	-	-	-	-	-
Marital status	-	-	-2.7	-2.5	-
Educational status	1.2	-	-	1.1	1.3
Economic household	-	-	-	-	-
BMI	-	-	-	-	-0.3
Ef	-	-	-	-	-
Time since AMI onset	-	-	-	-	-
Hypertension	-	-	-	-	-
Diabetes	-	-	-	-	-
Treatment	-	-	-	-	-
Sitting time *(hours)*	-	-	-	-	-
MIPA *(minutes)*	0.002	0.002	0.002	0.002	0.002
Variables	3	2	3	4	4
R^2	0.24	0.22	0.24	0.26	0.25
BIC	-25.7	-25.5	-24.9	-24.6	-23.8
Posterior probability	11.7%	10.5%	8%	6.7%	4.5%
Intercept *(α)*	37.6	42.4	47.7	42.9	45.1
Cumulative posterior probability			0.41		

BIC: Bayesian information criterion. *R^2: Coefficient of determination.* *EF: Ejection fraction* *BMI: Body mass index*
AMI: Acute myocardial infarction. *MIPA: Moderate-intensity physical activity.* *PCS: Physical component summary*

Table 4. The multivariable regression models of predictive factors of MCS score among post-MI patients

Variables	PCS				
	Model 1	Model 2	Model 3	Model 4	Model 5
Gender *(Female)*	-	-	-	-	-
Age	-	-	0.07	0.07	-
Occupational status	-	-	-	-	-
Marital status	-	-	-	-	-
Educational status	-	-	-	-	-
Economic household	9.8	10.1	9.7	10.0	9.7
BMI	-	-	-		-
Ef	-	2.0	-	2.1	-
Time since AMI onset	-	-	-	-	-
Hypertension	-	-	-	-	-2.1
Diabetes	-	-	-	-	-
Treatment	-	-	-	-	-
Sitting time *(hours)*	1.4	1.5	1.4	1.5	1.5
MIPA *(minutes)*	0.004	0.004	0.003	0.003	0.003
Variables	3	4	3	5	4
R^2	0.21	0.24	0.23	0.25	0.22
BIC	-20.3	-19.7	-17.3	-17.1	-16.7
Posterior probability	25%	19%	5.6%	5.2%	4.2%
Intercept *(α)*	10.9	15.3	16.2	12.3	20
Cumulative posterior probability			0.59		

BIC: Bayesian information criterion. *R^2: Coefficient of determination.* *EF: Ejection fraction* *BMI: Body mass index*
AMI: Acute myocardial infarction. *MIPA: Moderate-intensity physical activity.* *MCS: Mental component summary*

The factors predicting HRQoL from multivariable regression models

The five best models predicting subscales of HRQoL, defined by lowest BIC and largest posterior probability, are displayed in Table 3&4. The two predictive models for PCS and MCS have cumulative posterior probabilities of 0.41 and 0.59 respectively. The number of predictors and R^2 estimation were also provided in each model. The first model (Model 1) was chosen as the one fitting data because it served the lowest BIC (-25.7) and the largest posterior probability (11.7%). This model was also selected as our final predictive model of PCS because the largest coefficient of determination (R^2 = 0.24) meant that 24% of the PCS score was explained. It indicated that gender, educational level, and MIPA were the strongest factors related to physical aspect in HRQoL (Table 3). Similarly, the selected model that was considered fit to MCS with the smallest BIC (-20.3) and the highest posterior probability (25%) for the appearance of first model. There was 21% (R2 = 0.21) of the MCS score explained by this model. It gave that economic household, sitting time and MIPA were factors strongly predicted mental aspect in HRQoL (Table 4).

3.2. Discussion

HRQoL scores among post-MI patients

PCS scores among post-MI patients more reduced compared with MCS scores (Table 2). Despite various time to survey patients after AMI, the results in our study were similar to others as J. Fogel et al. [13], Doris S.F. Yu et al. (2009), Kenzo Shibayama (2012). The reduction in MCS scores was similar to other results of Doris S.F. Yu et al. [14], Kenzo Shibayama [15]. According to Tone M. Norekvål [16], patients suffered from acute MI tended to be less satisfied with general health, and both physical and environmental QoL. They were limited much in daily activities, working ability, travelling, fatigue and usually dependent on health care services. Some prior findings demonstrated that MI survivors experienced worse HRQoL compared with the general population in daily activity, both physical health and mental health [17], had more cardiovascular symptoms, and were more likely to be re-hospitalized [18]. The largely impacted physical and mental health status after acute MI was identical among studies including our work.

The predictors of HRQoL among post MI-patients

The demographic predictors of HRQoL in physical and mental health were gender, educational level and economic household. The clinical characteristics predicting physical and mental QoL were not determined in the fit model. The behavioral lifestyles were predictors of both QoL's PCS and MCS including moderate-intensity physical activities and sitting time.

The better HRQoL in PCS was predicted by higher educational levels (coefficient = 1.2), the increased time of physical activities per week (coefficient = 0.002) and male patients (coefficient = -3.7 as female was true) with R^2 = 0.24, posterior probability = 11.7%. The oversea prospective studies showed the association between male and PCS improvement after one-year onset [19]. This result was also found in AMI patients assessed at the time of admission in Malaysia with EuroQol -5D questionnaire (EQ - 5D) ($p< 0.05$) [20]. Gender was known independent determinant to HRQoL with the generic questionnaire, ED - 5D (β = -0.1, 95%CI : -0.16;-0.004, $p< 0.05$) and females reported low HRQoL scores compared with males [21], [22].

Educational level was statistically associated with PCS among post MI patients in the regression model (Table 3). Mohsen Taghadosi et al. (2013) [23] reported that HRQoL statistically related to educational levels (illiteracy and literacy) with SF-36, but not with SAQ (Seattle Angina Questionnaire). This result was nearly similar to ours regarding statistical differences of PCS scores among patients with vocational/ college/university education, high school, secondary school, elementary school and illiteracy. The educational attainment is able to affect general health, disease, and other aspects of living because it changes personal attitude and view[23]. The report of De Smedt D. (2012) [24] demonstrated the lower educational level (elementary school, secondary school and high school) related to the reduced HRQoL in both PCS and MCS ($p<0.001$). The association between educational attainment and physical and mental health was varied among studies, in addition, some did not show the significant difference of mental health among post MI patients distributed by educational level [25], [26].

According to Hawkes et al. [27], there was 33 percent of post-MI patients (294) meeting the recommendation of weekly moderate-intensity physical activities (≥150 minutes per week) after 6 months. Joanna M. Morys [28] reported 46.6% of 112 post MI patients did exercises at least 3 times per week compared to the recommendation of minimal exercise time for 30 minutes/day and 3 times/week. Post-MI patients in our study had greater time for physical activities than previous results. To analyze multivariable data with independent factors, the increased MIPA was a predictor of improvement in PCS scores (coefficient = 0.002). The low HRQoL (SF-36) in post MI patients who did not intend to do physical activities in 6 months ($p< 0.001$) and lacked of activity confidence ($p< 0.001$) was observed [27]. The people without exercises were found lower QoL scores through a specific tool (MacNew) compared with those getting more active to exercise ($p< 0.001$) [25]. Ejection fraction might be also gradually improved by physical activities among post AMI patients [29]. The physical limitation was responsible for the worsening of QoL among post MI patients [30] and the physical activity was associated with QoL improvement [31]. Lovlien et al. found that a low level of physical activity was associated with the reduction of self-reported QoL[32]. However, the hypothesis of low QoL inducing limitation of someone's daily activities was clarified. HRQoL was able to impact the recovery process, to decrease the adherence with treatments and to perform activities of daily living [33], [34].

In HRQoL regarding MCS, patients with good economic household (coefficient = 9.8), more time spent on sitting daily (coefficient = 1.4) and MIPA weekly (coefficient = 0.004) predicted MCS scores increase in model with R^2 = 0.08, BIC = -20.3 and posterior probability =25%. The increase in MCS scores was associated with more time (minutes) on MIPA (coefficient = 0.004) among observed subjects. The post-MI patients who acted much more physical activities with moderate intensity including professional works would be better in

physical health and get more chances to involve in social function [25]. According to Tan BV. et al.[35], it showed that time for sitting and watching television among the Vietnamese population was 4.0 hours per day for both male and female. In our study, post-MI patients got the high mean age (65.8 years) and suffered from lots of various chronic conditions compared with Tan B.V.'s research subjects. The sitting time as well as sedentary lifestyles in post-MI patients correlated to HRQoL scores (MCS). Patients with much sedentary sit related to the increased MCS score in multivariable regression analysis (coefficient = 1.4) (Table 4). This result was partially contrasted to those of Anna L Hawkes (SF-36) [27], HRQoL was low in MCS scores among patients with more sedentary lifestyles including watching and sitting time per week with p = 0.001. The elder tended to enjoy much time sitting and site-related activities and that contributed to explaining their better mental health status. Several studies showed that sedentary lifestyles relating to factors like older (p = 0.001) and obese (p = 0.001) were able to induce high mortality risk [36]. Therefore, the high QoL in MCS of post-MI ones who spent more time sitting might have an association with older's health status and living condition. Yet some prior results showed that higher physical activity volume was associated with higher mental health scores and fewer symptoms of anxiety and depression [37]. The following cohort studies should clarify if the limited function of physical activities causes AMI patients sit more on day.

The participants with good economic status were the highest proportion with 93.8% of total and just the least one for the poor and very poor economic status about 6.2% was reported by patients (Table 2). The QoL regarding mental health (MCS) among patients with good economic status was much more improved (coefficient=9.52) compared with the poor patients after AMI. The expensive cost of medical therapy might impact patients' decision on engaging in treatment. However, the relation between HRQoL in mental health and the economic status in this study might be contributed by economic anxiety as well as psychological stress. Sachin J. Shah et al. (2012) [18] assessed HRQoL among acute MI subjects through both SF-12 (short-form health survey with 12 questions) and SAQ after one year. They reported that the patients with high economic stress had the low scores in MCS (SF-12) and the differences were statistically significant (p< 0.05). The financial stress in developed countries related to low growth development product (GDP) and high rate of unemployment. According to these authors, the economic stress was a factor associated with low outcomes, reduced independence and a barrier to get healthcare services. Similarly, Ha Mi Kim et al.[38] showed that post-MI patients with poor condition of finance had low HRQoL.

Clinical factors were not seen in selected predictive models although several studies indicated hypertension, diabetes, obesity, reduced EF and new time from onset associating low HRQoL scores in physical and mental aspects through other QoL instruments [15], [20, 21], [39], [40], [41], [42], [61]. It was noted that patients undergone with PCI experienced higher mean scores of HRQoL through EuroQol-5D questionnaire than who involved in thrombolytic therapy with medication (p<0,001) [43]. In addition, the reduced chest pain induced the increased HRQoL scores in patients undergone PCI after one month. Yet, previous studies showed that the association between HRQoL and disease-related factors including comorbidities, EF, treatment and even time from onset was not seen [19], [27, 44]. The strategies of medical treatment well managed comorbidities in healthcare services and as the result of that was the weak effect of these conditions on HRQoL in our study. According to several studies, the most important factors impacting HRQoL after PCI were demographic, clinical characteristics and medication adherence to control CVD risk contributors. Thus our results showed the similarity in no relation between medical treatment and HRQoL among post MI patients.

Our research subjects almost in Ho Chi Minh City reported good financial condition and were treated in the University Medical Center as a tertiary hospital. Therefore, the results were difficult to implicate to population nearby local areas. The effects of anxiety, stress and depression were not observed in this study. The time of onset from acute myocardial infarction in subjects was largely various due to the cross-sectional study with limited period of survey time. The generic instrument of HRQoL (SF-36) exactly described the bodily functions as well as the reduced physical health, but it was less sensitive to perceptions about mental health and clinical symptoms compared with specific tools as SAQ, MacNew and EQ-VAS.

4. CONCLUSION

The scores of PCS reduced much more than MCS among post MI patients. The female patients percepted low QoL in physical aspect compared with the male. The higher educational level and more moderate intensity activities related to the improvement of QoL in physical health. The economic household and time on weekly physical activities and sitting per day strongly predicted good mental health. The healthcare providers should be concerned more female individuals and suitable physical activities as well as follow-up care after the discharge.

Medical ethics: The study was approved by the Ethics Council of University of Medicine and Pharmacy at Ho Chi Minh City. Approval number was 456-ĐHYD-HĐ.

Conflict of interest: We declare that we have no conflict of interest.

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