The quality of life of patients developed delirium after coronary artery bypass grafting is determined by cognitive function after discharge: a cross-sectional study

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ABSTRACT

Aims: Postoperative delirium (POD) and declined cognitive function were common in patients (especially elderly patients) underwent coronary artery bypass grafting (CABG), which may affect quality of life (QoL). The aim of this study was to determine the relationships among age, POD, declined cognitive function, and QoL in patients underwent CABG.

Methods: Consecutive patients underwent first time elective CABG and assessed for POD using Confusion Assessment Method for Intensive Care Unit for five postoperative days from

November 2013 to March 2015 were recruited. A cross-sectional study was conducted during April 2015 to assess their cognitive function and QoL, using the Telephone Interview for Cognitive Status scale and Medical Outcomes Study 36-Item Short Form Health Survey. The relationships among age, POD, declined cognitive function, and QoL was tested using path analysis.

Results: Declined cognitive function was associated with poorer QoL. POD was associated with declined cognitive function but was not associated with poorer QoL. Aging was not associated with QoL，but was associated with POD and declined cognitive function.

Conclusion: The QoL of patients developed delirium after CABG is determined by cognitive function after discharge. Necessary strategies should be implemented to prevent POD and declined cognitive function, especially in elderly patients.

SUMMARY STATEMENT

What is already known about this topic?

- Coronary artery bypass grafting is one of the most effective treatments for coronary artery disease and improving the quality of life even in elderly patients.
- Many patients especially the elderly underwent coronary artery bypass grafting may develop postoperative delirium and declined cognitive function.
- It has been proposed that postoperative delirium in patients underwent coronary artery bypass grafting may lead to a declined cognitive function and possibly a poorer quality of life.

What this paper adds?

- The present study confirmed that quality of life of patients developed delirium after coronary artery bypass grafting is determined by cognitive function after discharge.
- The elderly patients were more likely to develop postoperative delirium and declined cognitive function, which may challenge the benefits of CABG in this population.

The implications of this paper?

- The findings of this study highlight the need to develop effective strategies to identify and prevent postoperative delirium as it has long-term negative effects on cognitive function, which may lead to poorer quality of life of patients underwent coronary artery bypass grafting.
- Special attention should be paid to older patients who may be at greater risks of developing postoperative delirium and declined cognitive function.

Keywords: postoperative delirium, cognitive function, quality of life, coronary artery bypass grafting, nursing.

INTRODUCTION

Coronary artery bypass grafting (CABG) has become one of the most effective treatment methods for coronary artery disease (CAD) (Hlatky, 2015). Because it not only reduces the mortality and morbidity of CAD (Chang et al., 2016), but also improves quality of life (QoL) even in elderly patients (Peric et al., 2015), more aged people with CAD are in favor of CABG as the treatment of choice (Thorsteinsson et al., 2016). However, elderly patients predispose to develop delirium after CABG (Deiner & Silverstein, 2009; Kobayashi et al., 2002; Loponen et al., 2008; Otomo, Maekawa, Goto, Baba, & Yoshitake, 2013; Smulter, Lingehall, Gustafson, Olofsson, & Engstrom, 2013). The incidence of postoperative delirium

(POD) after CABG is 6-15% (Loponen et al., 2008; Yilmaz et al., 2016; W. Y. Zhang et al., 2015) in general and 46-73% (Khadka, McAlinden, & Pesudovs, 2012; Smith & Dimsdale, 1989) among patients aged 60 or older.

POD is associated with adverse outcomes including increased complications and mortality in the hospital and after discharge, increased healthcare costs, and the decline in physiological and cognitive function (Dong et al., 2014; Krenk & Rasmussen, 2011; Mu et al., 2013). Studies have found that POD after CABG was an independent predictor of cognitive impairment after discharge (Khadka et al., 2012; Naidech et al., 2013; Rosenthal et al., 2017), which may have a long-term effect on QoL. While several other authors indicated that elderly patients developed POD may not always have a poorer QoL after discharge (Hedeshian, Namour, Dziadik, Stewart, & Campos, 2002; Le Grande et al., 2006; Markou, van der Windt, van Swieten, & Noyez, 2008; Middel et al., 2014; Najafi, Sheikhvatan, Montazeri, & Sheikhfathollahi, 2008; Peric et al., 2015; Sen et al., 2012). These inconsistencies have been explained by that QoL is the result of the combination of multiple risk factors (Shan, Saxena, McMahon, & Newcomb, 2013) such as old age, female, duration of ICU stay, time after surgery, and the development of POD and cognitive impairment which are potentially preventable (Crocker et al., 2016; Phillips-Bute et al., 2006). It, however, remains unclear whether delirium is directly linked to poor QoL or affects QoL through declined cognitive function in elderly patients after CABG.

We therefore conducted a cross-sectional study to test the hypothesis that QoL of patients developed POD after CABG, may be determined by whether or not they developed cognitive function decline after discharge by performing a path analysis. Such analysis can specify the causal relations among age, POD, cognitive function decline, and QoL, and generate coefficients reflecting the size of the relation between two variables.

Literature review

Over the past decade, there are growing attentions on QoL of patients especially older ones who underwent CABG and developed POD or declined cognitive function (Azzopardi & Lee, 2009; Loponen et al., 2008). Aging, which is a challenge for surgery, especially high risk surgeries like CABG, could be associated with higher prevalence of postoperative complications (Khadka et al., 2012), functional decline (Blokzijl et al., 2016), and poor QoL (Blokzijl et al., 2016). However, previous studies that addressed the impact of aging on QoL of patients underwent CABG appear to be contradictory (Hedeshian et al., 2002; Markou et al., 2008; Najafi et al., 2008; Peric et al., 2015; Sen et al., 2012). Some studies showed that older patients underwent CABG exhibited higher mortality and minor improvement in QoL when compared to their younger counterparts (Markou et al., 2008). In contrast, other researchers found that older patients derived the similar benefits from having CABG as the younger counterparts did (Hedeshian et al., 2002; Peric et al., 2015; Sen et al., 2012). Interestingly, in a study of 275 patients underwent CABG, Najafi and colleagues (2008) found that elderly patients (over 70 years old) even had a higher score in the psychological dimension of QoL compared with the younger ones.

POD is defined as the onset of delirium shortly after surgery, in this study, CABG. It was characterized by a disturbance in attention which develops over a short period of time and tends to fluctuate during the course of the day (Sachdev et al., 2014). Some studies indicated that patients developed POD after cardiac surgery was associated with increased mortality, worse functional outcomes, and reduced QoL (Crocker et al., 2016; Koster, Hensens, Schuurmans, & van der Palen, 2012; Mangusan, Hooper, Denslow, & Travis, 2015). In a study of 656 patients underwent cardiac surgery, Mangusan et al. (Mangusan et al., 2015) found that patients with POD had significantly longer hospital stay, greater prevalence of falls, and greater likelihood for discharge to a nursing facility than patients without delirium. A prospective study showed that delirium after cardiac procedures was associated with increased mortality, reduced cognitive function, and reduced QoL, but the relationships among POD, declined cognitive function, and QoL after discharge was not tested (Koster et al., 2012). However, in a study of 302 patients underwent CABG, Loponen et al. (2008) found that POD was not significantly associated with a poor QoL after discharge.

Declined cognitive function is a neurocognitive disorder characterizing by a clear decline in one or more of the key cognitive domains (Sachdev et al., 2014), which is different from delirium and is common in elderly patients after cardiac surgery (Cook et al., 2007; Khadka et al., 2012). Previous studies showed that POD may have short-term (few days or weeks) and long-term (few months or years) effects on cognitive function (Khadka et al., 2012; Pandharipande, Girard, & Ely, 2014). There are also pieces of evidence showed that declined cognitive function may contribute to a delayed postoperative recovery, delayed return to work, and worsened QoL (Bak & Marcisz, 2014; Rothenhausler, Stepan, Hetterle, & Trantina-Yates, 2010; Steinmetz, Christensen, Lund, Lohse, & Rasmussen, 2009). In a multicenter study of 700 Danish patients, Steinmetz et al. (2009) found that patients with declined cognitive function had increased mortality and risk of leaving the labor market prematurely. A Polish study conducted by Szwed et al. (2012) found that declined cognitive function had a negative impact on patients' QoL and labor market attachment. However, no studies have tested the relationship among POD, declined cognitive function, and QoL after discharge of patients especially elderly patients underwent CABG.

There are other factors which have been identified as risk factors of poor QoL after discharge in patients underwent CABG, including female (Najafi et al., 2008), intensive care unit (ICU) stay (Herlitz et al., 2009), time after surgery (Lie, Arnesen, Sandvik, Hamilton, & Bunch, 2009). However, POD (Koster et al., 2012) and declined cognitive function (Rothenhausler et al., 2010) have been implicated as the most important ones and are potentially preventable. With increasing number of elderly patients undergoing CABG (Baranyi & Rothenhausler, 2012; Ida & Kawaguchi, 2014; Sophie, 2007; Strom, Rasmussen, & Sieber, 2014), a clearer understanding of the relationships among age, POD, declined cognitive function, and QoL in patients underwent CABG is warranted.

METHODS

Aims

The aim of this study was to determine the associations among age, POD, declined cognitive function, and QoL in patients underwent CABG.

Design

Participant sample

A descriptive cross-sectional study was conducted in April 2015. This study was a follow-up study of an earlier study conducted by Ding et al. (2015). Patients who were 18 years or older, underwent first time elective CABG were included in that study. In brief, POD was assessed prospectively using the Confusion Assessment Method for Intensive Care Unit (CAM-ICU) for a period of 5-days postoperatively from November 2013 to March 2015. All patients were initially screened for cognitive function using the Mini-Mental State Examination (MMSE) twenty-four hours before surgery by one investigator (X.J.T). Demographic and clinical data were also collected prospectively in that study (Ding, Tao, Feng, & Wu, 2015). All patients (One hundred and ninety-three) who were enrolled in Ding's study were invited to participate in the present study. The exclusion criteria for the present study were individuals who (1) had other types of surgery (such as valve replacement, atrial fibrillation ablation); (2) had a history of major psychiatric and neurological disorders (such as schizophrenia, Parkinson's disease); (3) had impaired bilateral hearing; (4) were unreachable by telephone; (5) had difficulty in understanding the questions, and (6) refused to participate.

Instruments and data collection

Postoperative cognitive function and QoL of the participants were assessed with the Telephone Interview for Cognitive Status (TICS-m) and Medical Outcomes Study 36-Item

Short Form Health Survey (SF-36) scales through telephone interview using a landline phone in the cardiac center of the hospital. The TICS-m is a cognitive status assessment tool specially designed for telephone screening interview which was initially developed based on the MMSE by Brandt et al. (1988). There was a good correlation between TICS-m and MMSE (r = 0.82 - 0.96，P < 0.05) (Duff, Beglinger, & Adams, 2009). The Chinese version of TICS-m has been validated in the Chinese population (Meng, Zhang, Zhou, & Sun, 2005). The sensitivity and specificity in screening and detecting dementia is 99% and 90%, respectively, and 89% and 92% in detecting mild cognitive impairment. The Chinese version of TICS-m consists of three dimensions and twelve items. The three dimensions are: (1) orientation, including four items (with a total score of 13 points); (2) memory, with two items, one is immediate recall of ten Chinese words (scored 10 points in total), and the other is delayed recall of that 10-word list (scored 10 points in total as well); (3) language and attention, including six items (scored 17 points in total). The total score of TICS-m ranges from 0 to 50 points, the higher the score, the better the cognitive status (Duff et al., 2009). Patients were defined as having cognitive impairment if the total score of TICS-m was less than 33 points.

The SF-36 is a 8-dimension tool (Brazier et al., 1992) that has been widely used in cardiac research to assess perceived health related QoL (Gandek, Sinclair, Kosinski, & Ware, 2004), and is valid and reliable in the Chinese population (Lam, Tse, Gandek, & Fong, 2005). The internal reliabilities of the 8 dimensions all greater than 0.80 (Sekse, Hufthammer, & Vika, 2015). SF-36 has been used for telephone screening interview and suggested to be as valid as self-administered mode (Garcia et al., 2005; Rollman et al., 2009). The Cronbach's alpha coefficient of the SF-36 is 0.894 in the present study. Item scores for each dimension are coded, summed, and transformed into a 0 to 100 scale (Brazier et al., 1992). Higher scores represent better QoL.

Data of TICS-m and SF-36 for each participant were collected by one investigator (Y.L.C) who was familiar with the procedure of telephone follow-up in order to reduce the variation in communication and assessment. At the time of assessment, the investigator had no information regarding the results of CAM-ICU assessment and the preoperative MMSE scores of each participant. A standardized process (Brandt, Jason, Spencer, Miriam, & Marshal, 1988; Lam et al., 2005) was strictly followed for assessing cognitive status and QoL by telephone. Briefly, the standardized process of the interview includes: (1) explain the purpose and contents of the interview; (2) tell the patient to turn off the television and radio and to remove pens, pencils, newspapers and calendars from reaching to eliminate possible distractions; (3) tell the patient not to ask others for helping while answering the questions during the interview; (4) tell the patient that all the questions can be repeated only once; and (5) read the items of the TICS-m and SF-36 in the given sequence. Notes of answers for each TICS-m and SF-36 scales item were taking one by one during the telephone interview. The whole process took 10-20 minutes for each patient.

Ethical Considerations

This study was approved by the Institutional Review Board of the University. Written informed consents were received from all participants before enrollment in the previous prospective cohort study.

Data analysis

Patients were divided into POD group and Non-POD group according to the CAM-ICU assessment results. Because the length of time after discharge might affect cognitive function and QoL, we divided patients into three different time groups (1-6 months, 7-12 months and 13-18 months). Continuous data were tested for normality using the One-Sample Kolmogorov-Smirnov test. Normally distributed data were presented as mean and standard deviation (SD), comparisons between groups were analyzed with independent student *t*-test or one-way analysis of variance (ANOVA). Non-normally distributed data were described with median and inter quartile range, comparisons between groups were analyzed with Mann-Whitney U test. Categorical data were expressed as frequency or percentage, comparison between groups were conducted with Chi-square or Fisher's exact tests as appropriate. To determine the influence of POD on the occurrence of cognitive impairment, and the effect of POD and declined cognitive function on QoL, logistic regression model and linear regression model with forward stepwise were conducted, respectively. Both the logistic and linear regression models were adjusted for confounding factors. Analysis was conducted with the use of SPSS version 21.0 software (SPSS Inc Chicago, Illinois). Mixed effects regression models with least squares means in SAS 9.4 were used to characterize the adjusted mean QoL scores. The level of statistical significance for analyses was set at a P - value of < 0.05.

To analyze the relationships among age, POD, declined cognitive function, and QoL after discharge, path analysis with maximum standard likelihood estimation was conducted using the IBM SPSS AMOS 21.0. The acceptable model fitting values (Hu L & Bentler PM, 1999) for these measures were defined as: (1) non-significant Chi-square value; (2) Comparative Fit Index (CFI) > 0.90; (3) Goodness of Fit Index (GFI) > 0.90; (4) Tucker Lewis Index > 0.90; (5) Root Mean Square Error of Approximation (RMSEA) < 0.08; and (6) Standardized Root Mean Squared Residual (SRMR) < 0.08. Effect sizes were measured using the standardized coefficients and were evaluated at the following levels: 0.1 = small; 0.3 = medium; 0.5 = large (Cohen, 1989). The model was modified until its indices fit well. Data entry was done by the first author and checked by another investigator.

RESULTS

Baseline characteristics of the participants

As shown in Figure 1, of 193 patients who were enrolled in this cross-sectional follow-up study, 136 completed the follow-up assessments (response rate: 70.5%). No significant difference was found in response rate between POD group and Non-POD group (65.6% vs. 73.0%, P = 0.287). The mean follow-up time was 9.82 (SD = 5.551) months. The comparison of baseline data between POD group and Non-POD group is presented in Table 1. Patients developed POD were more likely to be female, older, less educated, smoker, and living in rural areas (P < 0.05). These patients also tended to be hypertensive, had longer ICU stay and longer time after surgery (P < 0.05). The preoperative MMSE scores were all higher than 27 and no significant difference was found between the two groups (*P* = 0.173).

The incidence of cognitive impairment and status of QoL after discharge

Overall, forty-two of 136 patients (30.8%) meet the criteria of cognitive impairment. The incidence of cognitive impairment in the POD group was significantly higher than the Non-POD group (59.1% vs. 17.4%, $P < 0.05$). As shown in Table 2, both the total TICS-m scores and mean scores of each dimension in the POD group were significantly lower than that in the Non-POD group ($P < 0.001$).

Figure 2 A indicates the incidence of cognitive impairment in the POD group and the Non-POD group at different time points. The incidence of cognitive impairment decreased over time after discharge in Non-POD patients (from 25.7% at 1-6 months to 6.2% at 13-18 months, $P < 0.001$), whereas, no significant difference was detected in patients in POD group ($P = 0.986$). The incidence of cognitive impairment in POD patients was much higher than those in Non-POD patients at all three time points ($P < 0.05$).

The mean SF-36 scores were 67.83 (SD: 16.34) for all patients enrolled in this study. As shown in Table 2, no difference in adjusted mean QoL score was found between POD and Non-POD groups (68.36 vs. 61.97, $P = 0.071$). Figure 2 B indicates that the adjusted mean QoL scores increased over time at three different time points after CABG, the difference between 1-6 months and 13-18 months after discharge was statistically significant ($P = 0.006$).

We also compared the differences in age, incidence of POD, cognitive function, and QoL between female and male patients. As shown in Table 3, female patients were older, and had higher incidence of POD, lower TICS-m and SF-36 scores than male patients were (P < 0.001).

The relationship among age, POD, cognitive function, and QoL

The multiple logistic regression revealed that POD (OR = 4.787, 95% CI = 2.038-11.244) and age (OR = 1.076, 95% CI = 1.016-1.139) were independent risk factors of cognitive impairment after discharge of patients underwent CABG. The linear regression revealed that cognitive function (β = 0.293, 95% CI = 0.346-1.136), female (β = 0.283, 95% CI = 4.897-16.859) and time after surgery (β = 0.240, 95% CI = 0.269-1.145) were significantly associated with QoL after discharge. However, neither POD (P = 0.718) nor preoperative cognitive function (MMSE scores, P = 0.245) was associated with QoL after discharge.

The results of path analysis are shown in Figure 3. POD was negatively associated with cognitive function after discharge (β = -0.45, P < 0.001), while cognitive function was positively related to QoL (β = 0.38, P = 0.001). However, no significant association was found between POD and QoL (β = 0.02, P = 0.871). In addition, aging was not associated with QoL (β = 0.18, P = 0.053), but it was negatively associated with POD (β = 0.378, P < 0.001) and cognitive function (β = -0.27, P = 0.002). Path analysis also revealed that female was associated with poorer QoL (β = -0.30, P = 0.001), higher POD incidence (β = 0.38, P =

0.001), and older age (β = 0.34, $P < 0.001$) but was not related to cognitive function (β = -0.10, $P = 0.244$).

In addition, duration of ICU stay and time after surgery were significantly associated with QoL (β = -0.18, $P = 0.026$; β = 0.26, $P = 0.001$, respectively) and POD (β = 0.27, $P = 0.003$; β = 0.27, $P = 0.003$, respectively), but they were not associated with cognitive function. The tested model fitted well (chi-square = 204.877, df = 88, $P < 0.001$, GFI = 0.844, AGFI = 0.758, RMSEA = 0.099, CFI = 0.860, and TLI = 0.809).

DISCUSSION

In this cross-sectional follow-up study involving patients underwent first time elective CABG, we found that declined cognitive function was associated with poorer QoL after discharge. The QoL of patients developed POD was determined by cognitive function after discharge. In addition, aging itself was not related to poor QoL after CABG, but it was significantly associated with POD and declined cognitive function after discharge, which led to poorer QoL in the elderly patients underwent CABG.

Our study confirmed that patients developed POD after CABG was associated with almost fivefold increase in developing cognitive impairment even at 18 months after discharge, and cognitive function had a medium to large effect on QoL after discharge. Our findings are consistent with previous studies (Bak & Marcisz, 2014; Khadka et al., 2012; Rothenhausler et al., 2010; Steinmetz et al., 2009). However, we found POD had no direct effect on QoL after discharge, while the QoL of patients developed POD after CABG was determined by the presence of cognitive function decline. Similarly, old age was not a risk factor of poor QoL of patients after CABG, but increased age had a medium to large effect on the development of POD and medium effect on the development of cognitive decline, which had an additive effect on poor QoL after CABG. These results complement those of earlier cohort studies that patients developed POD after cardiac surgery, especially elderly patients, was independently associated with pathologic processes that drive acute cognitive function decline in a few days and subsequently chronic cognitive function decline over a few years after cardiac surgery (Davis et al., 2017; Inouye et al., 2016; Khadka et al., 2012), thereby resulting in poorer QoL (Basinski, Alfano, Katon, Syrjala, & Fann, 2010; Phillips-Bute et al., 2006; Rudolph et al., 2011). Therefore, although CABG has been identified to improve QoL of elderly patients (Peric et al., 2015), their QoL after the surgery tend to be poorer if they developed POD and declined cognitive function (Blokzijl et al., 2016). On contrary, Loponen's (2008) study showed that there was no change in QoL of patients developed delirium after CABG during 18 months compared to base level. Given that delirium mainly affected the cognition function related-QoL (Naidech et al., 2013), it was possible that POD affected QoL though cognitive function decline.

To our knowledge, our study demonstrated that, for the first time, the QoL of patients developed POD after CABG was determined by whether or not the patient developed cognitive decline. We also found that the QoL of elderly patients after CABG was determined by whether or not the patient developed POD and cognitive decline. Therefore, the implementations of multicomponent interventions directed at preventing POD, which includes pharmacological and non-pharmacological interventions (Gorski et al., 2017; O'Neal & Shaw, 2016), or strategies directed at reducing cognitive function decline when the patient developed POD, may improve the QoL of patients after CABG. Considering the elderly patients continue to form an even growing proportion of the CABG population and the advanced age is a risk factor for POD and cognitive function decline (Baranyi & Rothenhausler, 2012; Ida & Kawaguchi, 2014; Sophie, 2007; Strom et al., 2014), it is vital that clinicians need to be alert to prevent both POD and cognitive function decline. Further randomized clinical trials are needed to confirm whether prevention of POD and declined cognitive function can improve long-term QoL of patients underwent CABG, especially for the elderly patients.

This study has several limitations. First, different scales (MMSE and TICS-m) were used for assessing baseline and follow up cognitive status because a large proportion of the participants did not reside in Beijing City (all over the China). However, there is a good correlation between MMSE and TICS-m (Duff et al., 2009), and TICS-m has been validated in detecting cognitive impairment in the Chinese population (Meng et al., 2005). Moreover, all participants had a normal cognitive function at baseline and this study was not designed to test the decline in cognitive function from the preoperative period, rather to test the difference in cognitive function between POD and Non-POD patients. Secondly, to determine risk factors for cognitive impairment, some factors, such as the duration of surgery (Xu et al., 2013) and anesthetic drugs used (Xu et al., 2013) could be potential covariates. Regrettably, neither of them had been assessed in the path model. Nevertheless, the final path model has achieved a good overall fit. Thirdly, we excluded patients with impaired hearing or patients had difficulty in understanding the questions of the scales, which may limit the generalizability of our findings.

CONCLUSION

We found that the QoL of patients developed POD was determined by cognitive function after discharge. Elderly patients were more likely to develop POD and declined cognitive function, so that the benefits from CABG might be reduced. For patients underwent CABG, especially the elderly patients, strategies for preventing POD is needed. Once patients developed POD, interventions should be conducted to reduce the decline of cognitive function, thereby improving the QoL of patients after CABG.

AUTHORSHIP STATEMENT

The listed authors meet the criteria for authorship and agree with the content of the manuscript.

DISCLOSURE STATEMENT

The authors declare no conflict of interest.

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The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. All authors had full access to all the data in the study,

and the corresponding authors had responsibility for the decision to submit.

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Table 1. Comparison of baseline characteristics by POD group and Non-POD group

Variables	POD (n= 44) N (%)	Non-POD (n = 92) N (%)	*P*-value
Demographic characteristics			
Gender (Female)	20 (45.5)	12 (13.0)	< 0.001
Age (yrs)	62.0 ± 8.1	60.3 ± 7.6	< 0.001
Education level			0.004
Elementary school	18 (40.9)	14 (15.2)	
Secondary school	20 (45.6)	58 (63.1)	
College/university	6 (13.5)	20 (21.7)	
Living place			0.001
Urban (Beijing)	23 (52.3)	74 (80.4)	
Rural	21 (47.7)	18 (19.6)	
Smoking	21 (47.7)	62 (67.4)	0.048
Clinical data			
Preoperative BMI			0.170
Normal	15 (34.1)	27 (29.3)	
Overweight	19 (43.2)	49 (53.3)	
Obesity	10 (22.7)	16 (17.4)	
Myocardial infarction	19 (43.2)	25 (27.2)	0.062
Diabetes	22 (50.0)	38 (41.3)	0.339
Hypertension	37 (84.1)	50 (54.3)	0.001
Stroke	8 (18.2)	18 (19.6)	0.848
Duration of ICU stay (days)	7 (3.9-7.0)	4 (3.0-4.0)	<0.001
Preoperative LVEF%	64.0 ± 10.6	66.3 ± 8.2	0.159
Preoperative MMSE scores	29.6 ± 0.7	29.8 ± 0.6	0.173
Time after surgery (months)	13 (11.0-16.0)	11(3.0-13.0)	0.001
Time point†			0.027
1-6 months	8 (18.4)	35 (81.4)	
7-12 months	11 (30.6)	25 (69.4)	
13-18 months	25 (43.9)	32 (56.1)	

POD, indicates postoperative delirium. BMI, indicates body mass index. ICU, indicates intensive care unit. LVEF, indicates left ventricular ejection fraction. MMSE, indicates Mini-Mental State Examination.

†, patients were divided into three groups according to the length of time after surgery.

Table 2. Comparison of TICS-m scores and SF-36 scores between POD and Non-POD groups (n = 136)

Variables	POD (n = 44)	Non-POD (n = 92)	*P*
TICS-m scores			
Total scores	30.4 ± 6.9	36.8 ± 5.2	< 0.001
Orientation	10.4 ± 0.4	12.2 ± 0.1	< 0.001
Memory	6.3 ± 0.4	8.0 ± 0.2	< 0.001
Language and attention	13.3 ± 0.5	16.8 ± 0.2	< 0.001
SF-36 scores	62.0 ± 2.8	68.36 ± 2.4	0.071

POD, indicates postoperative delirium. TICS-m, Telephone Interview for Cognitive Status scale. SF-36, Medical Outcomes Study 36-Item Short Form Health Survey.

Table 3. Comparison of factors between female and male patients (n = 136)

Variables	Female (n = 32)	Male (n = 104)	*P*
Age	67.4 ± 7.1	61.0 ± 7.8	< 0.001
POD	20 (62.5%)	24 (54.5%)	< 0.001
TICS-m scores	31.2 ± 7.3	35.8 ± 5.8	< 0.001
SF-36 scores	57.2 ± 15.3	71.1 ± 15.3	< 0.001

POD, indicates postoperative delirium. TICS-m, Telephone Interview for Cognitive Status scale. SF-36, Medical Outcomes Study 36-Item Short Form Health Survey.

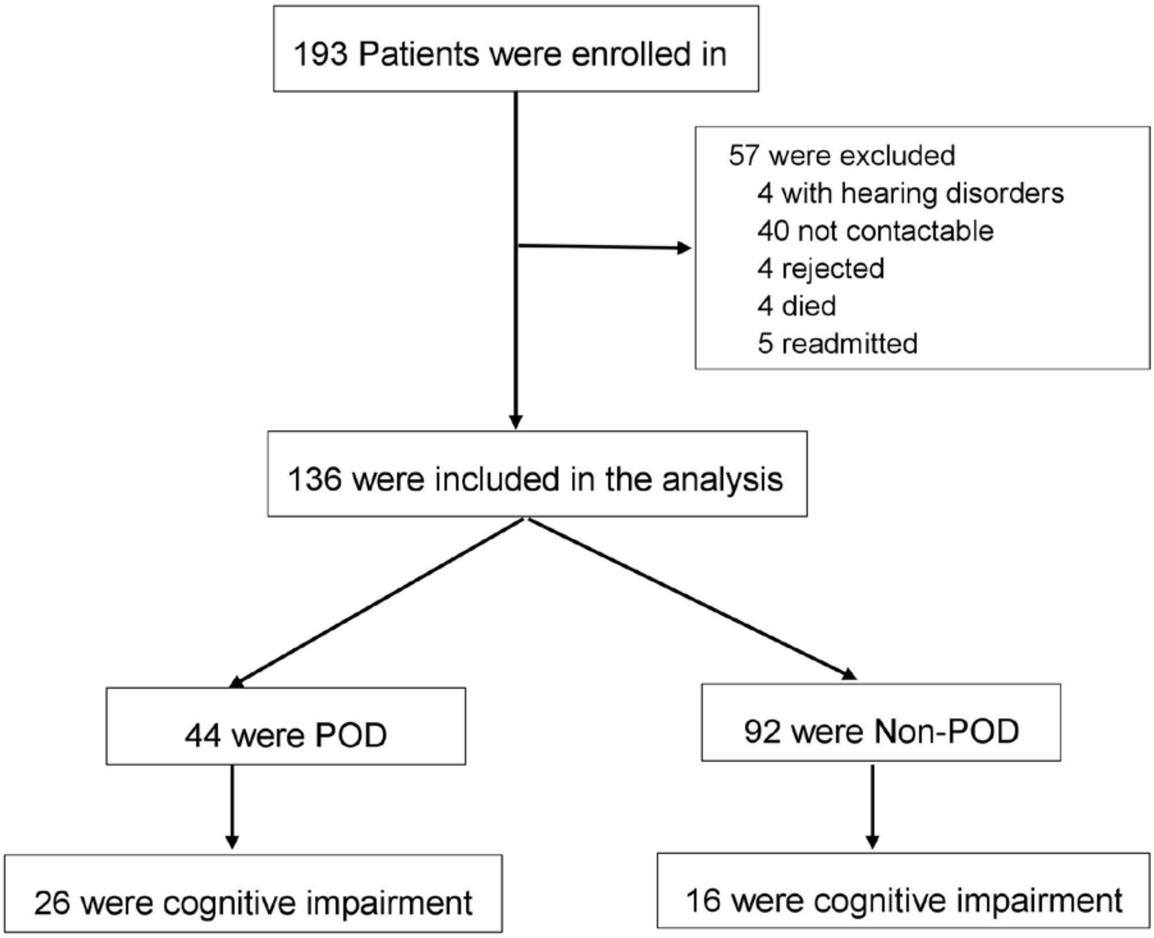
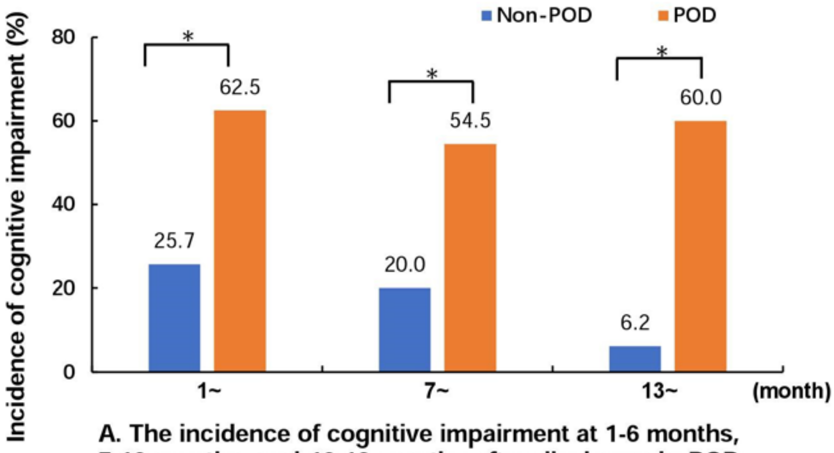
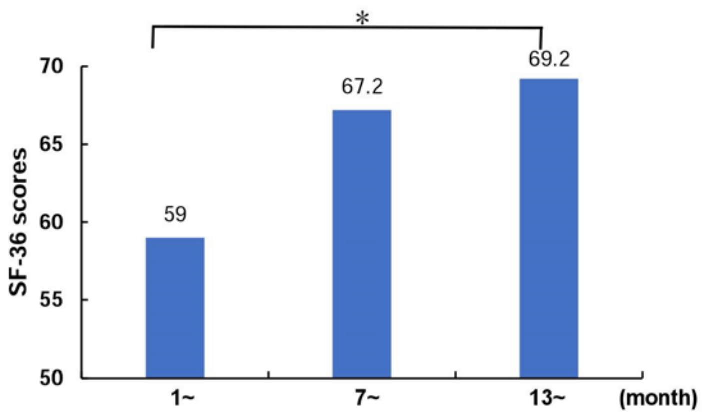


Figure 1. Flow chart of participants. POD, postoperative delirium.



A. The incidence of cognitive impairment at 1-6 months, 7-12 months, and 13-18 months after discharge in POD group and non-POD group.

∗P < 0.05. POD, indicates postoperative delirium.



B. Adjutsted mean QoL score of 136 patients at 1-6 months, 7-12 months and 13-18 months after CABG.

∗, Significant differences were found between 1-6 months and 13-18 months after discharge, P = 0.006. QoL, indicates quality of life. CABG, indicates coronary artery bypass grafting.

Figure 2. The incidence of cognitive impairment and change in QoL after discharge in different time point.

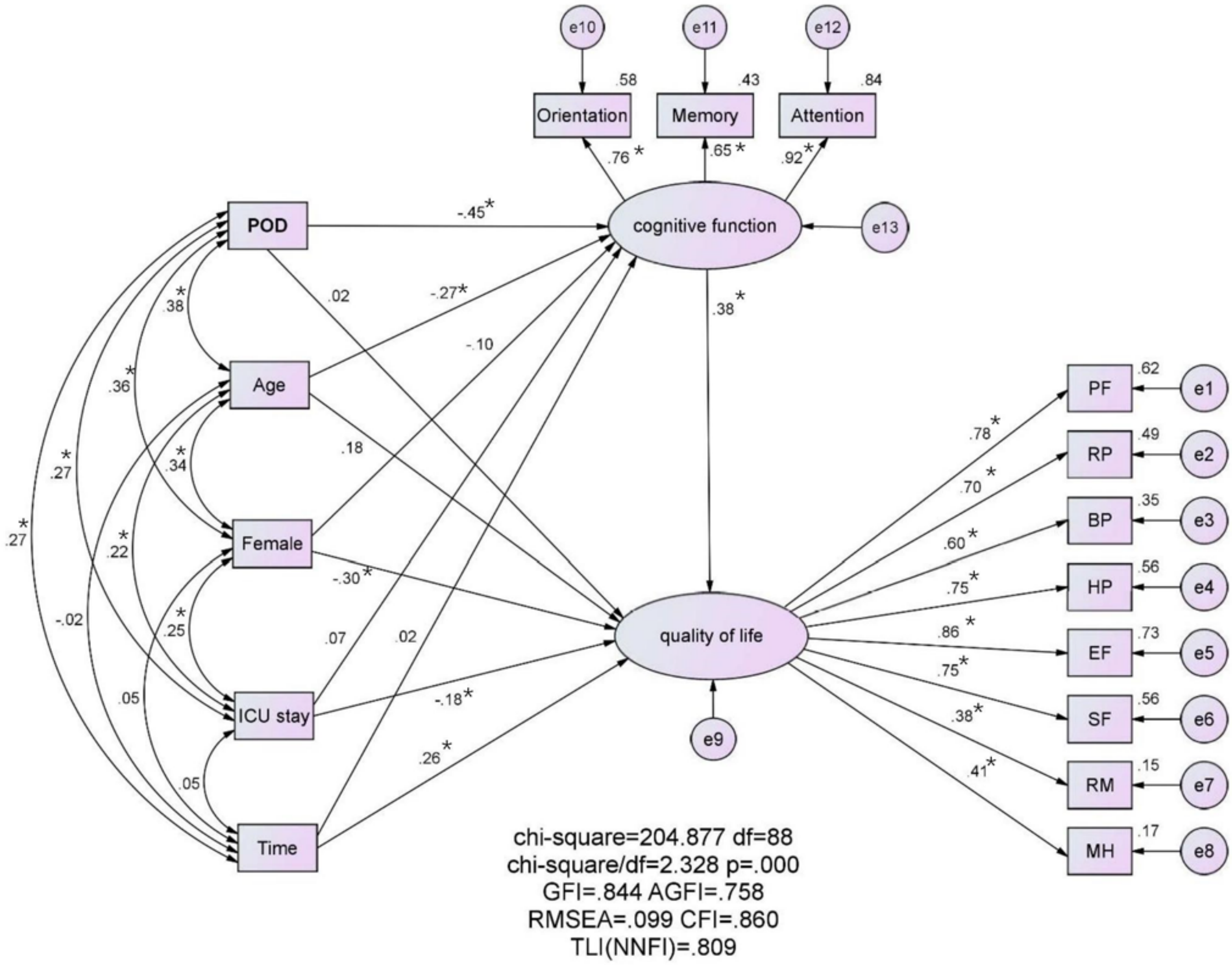


Figure 3. A path diagram of direct and indirect influence of POD, cognitive function, age, gender, duration of ICU stay (days), time after surgery (months) and quality of life. PF, physical functioning; RP, role limitation-physical; BP, bodily pain; HP, health perception; EF, energy; SF, social functioning; RM, role limitations-mental; MH, mental health. *, $P < 0.05$.