

# Dexmedetomidine's Effect on Catecholamine and Inflammation in Reducing In-Hospital Adverse Events for Older Patients with STEMI Undergoing Primary PCI

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**Objective:** This study aimed to assess the effects of dexmedetomidine (DEX) on anxiety and inflammation, and its potential in reducing in-hospital adverse events in older patients with ST-elevation myocardial infarction (STEMI) undergoing primary percutaneous coronary intervention (PCI).

**Methods:** We conducted a retrospective, real-world cohort study, enrolling 160 elderly patients with STEMI admitted to the cardiac care unit (CCU) between September 2020 and December 2024. Patients were divided into two groups: DEX and non-DEX. Propensity score matching (PSM, 1:1 ratio) was applied based on demographic and clinical variables, ensuring balanced groups for comparison. We evaluated catecholamine and inflammation levels, anxiety using the Amsterdam Preoperative Anxiety and Information Scale (APAIS), and cognitive function at four time points (T0–T3). The incidence of cumulative MACE (20.00% vs 38.8%,  $P = 0.015$ ) and VT/VF (1.3% vs 10.0%,  $P = 0.034$ ) was significantly lower in the DEX group compared to the non-DEX group. Multivariable logistic regression was performed to identify risk factors for in-hospital major adverse cardiac events (MACE).

**Results:** The DEX group had significantly lower catecholamine (norepinephrine,  $P < 0.001$ ; epinephrine,  $P = 0.001$ ; dopamine,  $P < 0.001$ ) and inflammation levels (hs-CRP,  $P < 0.001$ ) post-PCI compared to the non-DEX group. Additionally, heart rate (HR) (T1,  $P < 0.001$ ; T2,  $P < 0.001$ ; T3,  $P = 0.007$ ) and respiratory rate (RR) (T1,  $P < 0.001$ ; T2,  $P < 0.001$ ) were lower, while blood oxygen saturation (SpO<sub>2</sub>) (T1,  $P = 0.045$ ; T2,  $P < 0.001$ ; T3,  $P < 0.001$ ; T4,  $P = 0.016$ ) was higher in the DEX group at various time points. In the DEX group, Ramsay Sedation Scores were higher at T1 ( $P = 0.007$ ) and T2 ( $P < 0.001$ ) than at T0, and anxiety scores decreased significantly from T1 ( $P = 0.021$ ), T1 ( $P = 0.017$ ) to T3 ( $P = 0.015$ ) compared with the preceding time point. DEX was identified as an independent predictor of reduced in-hospital MACE [odds ratio (OR) = 0.244, 95% confidence interval (CI) = 0.082–0.728,  $P = 0.011$ ].

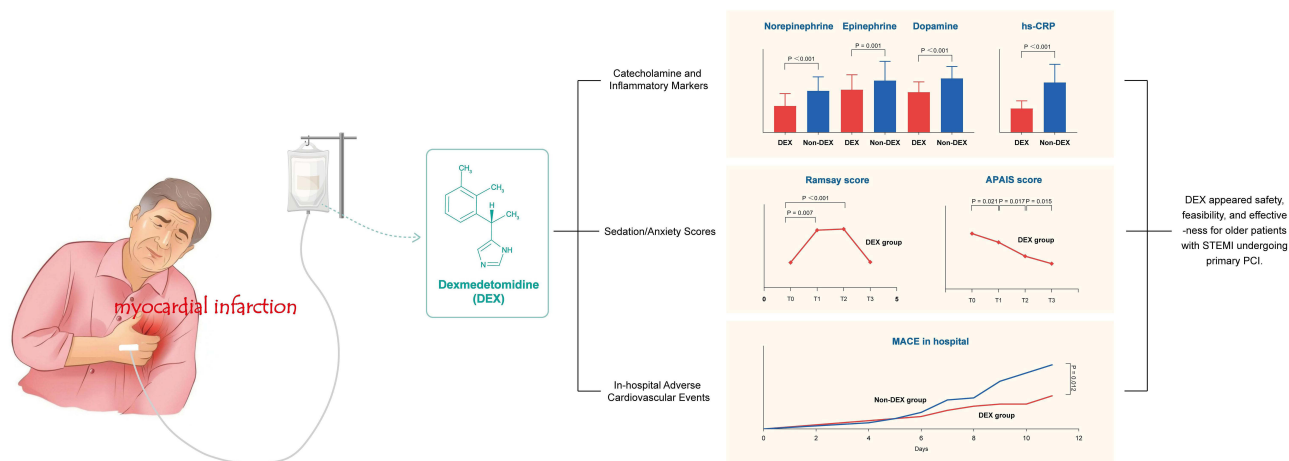
**Conclusion:** DEX was associated with lower catecholamine and inflammation levels, provided adequate sedation, and appeared safety, feasibility, and effectiveness for older patients with STEMI undergoing primary PCI.

**Keywords:** dexmedetomidine, catecholamine, hs-CRP, sedation, STEMI, primary PCI, MACE, ventricular arrhythmia

## Introduction

Convergent experimental and clinical evidence has highlighted the crucial role of pro-inflammatory pathways in the pathophysiology of coronary artery disease (CAD). Specifically, the focus on treating inflammation in patients with acute myocardial infarction (AMI) is shifting from addressing its chronic aspects to targeting the acute phase.<sup>1</sup> Myocardial infarction, a life-threatening condition, significant anxiety and psychological distress, which is characterized by symptoms such as dissociation, re-experiencing, avoidance, and hyperarousal.<sup>2</sup> Furthermore, anxiety has been identified as a risk factor for subsequent cardiovascular events and interventions.<sup>2</sup> Notably, patients with anxiety and stress-related

## Graphical Abstract



conditions also exhibit elevated circulating levels of pro-inflammatory cytokines, further linking inflammation with adverse cardiovascular outcomes.<sup>3</sup>

Primary percutaneous coronary intervention (PCI) is considered the preferred reperfusion strategy for patients with ST-elevation myocardial infarction (STEMI). However, the procedure is typically performed under local anesthesia, which may not fully block nerve transmission, leaving patients vulnerable to negative emotions such as fear, pain, and discomfort during the procedure.<sup>4</sup> In some patients, both the STEMI and the PCI procedure itself can induce significant psychological stress disorder and possible additional inflammation, leading to a range of preoperative emotional and psychological reactivity, with anxiety being one of the most common.<sup>5</sup> Therefore, a key area of interest in the field of anesthesia is the identification of reliable sedative and analgesic agents that can reduce the need for traditional anesthetics, minimize patients' stress response to pain, and decrease perioperative complications.

AMI is well known to primarily affect the elderly population.<sup>6</sup> Notably, cognitive dysfunction, depression, and anxiety have been observed in elderly patients who underwent total intravenous anesthesia (TIVA).<sup>7</sup> Therefore, the use of anesthesia and sedative drugs in this group requires careful consideration, with close monitoring to ensure safety and minimize potential complications. Dexmedetomidine is a potent and selective  $\alpha_2$  adrenergic receptor agonist that provides dose-dependent sedation, analgesia, anxiolysis, and sympathetic inhibition. It is known for its minimal side effects, making it a valuable and advantageous option in clinical settings.<sup>8</sup> Clinical research has demonstrated that dexmedetomidine not only offers neuroprotective and anti-inflammatory benefits but also helps alleviate postoperative cognitive dysfunction in elderly patients.<sup>9,10</sup> More recent studies have further highlighted the role of DEX in modulating cardiovascular stress and systemic inflammation, supporting its potential as a protective strategy in acute cardiovascular conditions.<sup>11–13</sup>

However, a critical knowledge gap remains: while DEX has shown promise in perioperative and critical care contexts, its role in elderly STEMI patients undergoing primary PCI has not been systematically evaluated. Specifically, there is limited evidence regarding its effects on anxiety, inflammatory responses, and in-hospital outcomes in this high-risk population. Therefore, we hypothesized that dexmedetomidine administration in elderly STEMI patients could be associated with attenuation of ASD, lower systemic inflammation, and improve in-hospital outcomes. This study was conducted to evaluate the effect of DEX on ASD and inflammation in reducing in-hospital adverse events for older patients with STEMI undergoing primary PCI.

## Methods

### Study Population

We retrospectively enrolled 160 patients diagnosed with STEMI who underwent primary PCI and were admitted to the cardiac care unit (CCU) between September 2020 and December 2024. STEMI was diagnosed if a patient exhibited the following: chest pain for >30 min and ST-segment elevation of 2 mm in at least two contiguous precordial electrocardiography (ECG) leads or >1 mm in at least two contiguous limb ECG leads or a newly developed left bundle branch block.<sup>14</sup> The exclusion criteria included patients with bradycardia, second-degree or higher atrioventricular (AV) block, a history of coronary artery bypass graft (CABG) surgery, cardiogenic shock, unconsciousness, a life expectancy of less than 2 years, cognitive dysfunction, or mental disorders.

Patients were divided into two groups: the DEX group and the non-DEX group. To account for variations in initial risk factors and baseline characteristics between patients who received DEX or not, we employed propensity score matching, with a 1:1 matching ratio, allowing for replacement. Patients who either received DEX or not, but could not be adequately matched, were excluded from the study population. A systematic comparison of patient information between the two groups was conducted during hospitalization.

The mean arterial pressure (MAP), heart rate (HR), respiratory rate (RR), and blood oxygen saturation (SpO<sub>2</sub>) were recorded at four time points: before drug infusion (T0), 10 minutes after drug infusion (T1), at the end of the procedure (T2), and 30 minutes after the procedure (T3). Major adverse cardiac events (MACE) included cardiovascular death, reinfarction, repeat target vessel revascularization (TVR), ventricular tachycardia (VT) and ventricular fibrillation (VF), advanced heart failure in hospital. According to the clinical protocol of our medical center, the cardiologist in the CCU is responsible for collecting and evaluating the catecholamine levels, including norepinephrine, epinephrine, and dopamine, in patients both preoperatively and postoperatively.

### Covariate Characteristics Included

To ensure data integrity, covariates included in the study were required to have no more than 25% missing values in the original dataset. The study examined a range of patient demographic characteristics, including age, sex, weight, heart beats, respiratory rate, blood pressure, blood oxygen saturation, medical history risk factors, such as alcohol drinking, hypertension, diabetes and smoking, and medications. To compare the characteristics between the DEX and non-DEX groups, absolute standardized differences were calculated.<sup>15</sup> This method was chosen given the large sample size, with an absolute standard deviation greater than 10% indicating a meaningful difference between the two groups. The majority of missing data resulted from variability in data recording practices across clinical settings, rather than systematic patient selection.

### Match Processing

To account for differences in initial risk factors and baseline characteristics between patients receiving DEX and those not receiving DEX, we employed propensity score matching. The propensity score was derived using a multivariable logistic regression model, which estimated each patient's likelihood of receiving primary PCI based on selected covariates. Patients who received DEX were then matched 1:1 with non-DEX patients, using a logit-transformed propensity score and a caliper of 0.03, allowing for replacement. Patients who could not be appropriately matched were excluded from the analysis.

### DEX Treatment

Patients in the DEX group received a loading dose of 1 µg/kg of DEX (Yangtze River Pharmaceutical (Group) Co., Ltd., Jiangsu, China), followed by a maintenance dose of 0.5 µg/kg administered intravenously over 15 minutes, after which the procedure was performed. The patients in the non-DEX cohort were treated according to the standard primary PCI protocol at our center, without receiving any sedation measures.

## Sedation Level Assessment

In our cardiology department, we have dedicated anesthesiologists who routinely evaluate sedation depth and anxiety levels for patients undergoing primary PCI with DEX treatment. The sedation depth was assessed using the Ramsay Sedation Scale,<sup>16</sup> a widely accepted tool for measuring sedation levels in clinical settings. Additionally, to quantify preoperative anxiety, we employed the Amsterdam Preoperative Anxiety and Information Scale (APAIS).<sup>17</sup> The APAIS is a validated instrument designed to measure patients' preoperative anxiety and their need for information. It was administered as part of our standard pre-procedural assessment for patients undergoing primary PCI. These assessments were also conducted at four time points: before drug infusion (T0), 10 minutes after drug infusion (T1), at the end of the procedure (T2), and 30 minutes after the procedure (T3). The routine use of these scales allows for a comprehensive evaluation of the patient's sedation status and anxiety levels throughout the perioperative period, providing valuable data for our retrospective analysis.

## Coronary Angiography and Stenting

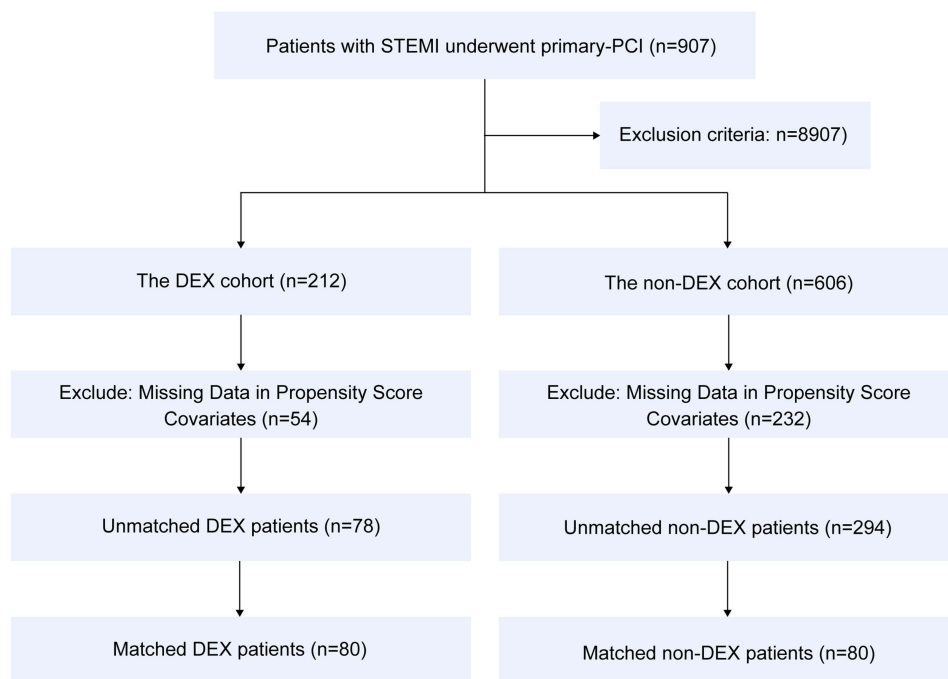
Primary PCI was typically performed via the percutaneous radial artery approach, although the femoral approach was used if an intra-aortic balloon pump was required. All angiographic data were reviewed using standard techniques from the catheterization laboratory records.<sup>18</sup> A target artery was considered clinically significant if the vessel stenosis exceeded 50%. Blood flow in the infarct-related artery (IRA) was assessed using the Thrombolysis in Myocardial Infarction (TIMI) grading system, applicable to cases receiving only primary PCI. Prior to the procedure, all patients were given 300 mg of chewable aspirin (Bayer Healthcare Co., Ltd., Beijing, China) and 180 mg of ticagrelor (AstraZeneca, plc., Shanghai, China). PCI success was defined as achieving a stenosis of less than 20% in the IRA with TIMI III flow post-procedure. Following PCI, all patients were transferred to the cardiac care unit for standardized STEMI treatment.

## Blood Sampling

Blood samples were collected from the cubital veins of all patients enrolled in the study. N-terminal pro B-type natriuretic peptide (NT-proBNP), creatine kinase-MB (CK-MB), and troponin I levels were measured daily from admission. Blood samples were taken at the same times for all patients: upon admission, and 24 and 48 hours later. Plasma NT-proBNP levels were assessed using an Elecsys<sup>®</sup> NT-proBNP analyzer, a commercially available electrochemiluminescent sandwich immunoassay (Roche Diagnostics GmbH, Mannheim, Germany). Fasting serum levels of blood glucose, triglycerides (TG), total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), and high-density lipoprotein cholesterol (HDL-C) were measured after a 12-hour fast using an Olympus AU640 Autoanalyzer (Olympus Corporation, Tokyo, Japan) with an automated spectrophotometric and enzymatic colorimetric method. Other biochemical measurements were performed using the Jaffe kinetic method on a Hitachi 7600 Autoanalyzer (Hitachi, Ltd., Tokyo, Japan). Plasma norepinephrine, epinephrine, and dopamine were measured using a commercial ELISA kit (CatCombi, IBL, Hamburg, Germany), according to the manufacturer's instructions. This method has been validated in previous studies.<sup>19</sup> All assays were performed in duplicate, with intra- and inter-assay coefficients of variation (CVs) <10%. Our hospital's central laboratory is certified and regularly participates in external quality control programs.

## Statistical Analysis

Quantitative variables were expressed as mean  $\pm$  standard deviation and qualitative variables were expressed as a percentage (%). Independent 2-sample *t*-test or 1-way analysis of variance with post hoc Student-Newman-Keuls test was used to test differences between  $\geq 2$  sets of data. Categorical variables were also compared using the  $\chi^2$  or Fisher's exact test. For the primary endpoint of in-hospital MACE, logistic regression was used as the main analytical approach, as it is most appropriate for short-term, fixed follow-up periods. Odds ratios (ORs) with 95% confidence intervals were reported. Cox proportional hazards regression was additionally performed to generate hazard ratios (HRs) and to illustrate cumulative incidence using Kaplan–Meier curves. Univariate and multivariate logistic regression analyses were used to identify predictors of in-hospital MACE. A statistically significant difference was indicated when  $P < 0.05$ . All data cleaning and preprocessing were conducted using the R software, version 4.3.2. All statistical analyses were performed using the IBM SPSS statistical software, version 26.0 (IBM SPSS Inc., Armonk, NY, USA).



**Figure 1** Study flowchart.

## Results

### Baseline Characteristics

After propensity score matching, 160 patients were included (80 in the DEX group and 80 in the non-DEX group) (Figure 1). Baseline demographic and clinical characteristics were well balanced between the two groups, with absolute standardized differences <10% for all covariates (Tables 1 and 2).

**Table 1** Baseline Characteristics of Patients Between the Two Groups

	DEX (n=80)	Non-DEX (n=80)	P-value
Age, years	73.6 ± 5.4	73.2 ± 4.8	0.433
Men, n (%)	52 (65.0)	50 (62.5)	0.869
Weigh, kg	65.1 ± 10.2	68.1 ± 12.3	0.097
Current smoker, n (%)	26 (32.5)	31 (38.8)	0.509
Alcohol drinking	26 (32.5)	32 (40.0)	0.411
Hypertension, n (%)	53 (66.3)	50 (62.5)	0.741
Diabetes, n (%)	18 (22.5)	14 (17.5)	0.554
Medical history of MI, n (%)	8 (10.0)	9 (11.3)	1.000
Previous PCI, n (%)	17 (21.3)	10 (12.5)	0.205
SBP, mmHg	124.4 ± 24.4	123.7 ± 22.2	0.847
DBP, mmHg	78.0 ± 13.4	80.0 ± 10.6	0.306
HR, bpm	87.9 ± 7.6	88.0 ± 11.6	0.949
Killip classification			
I	63 (78.8)	59 (73.8)	0.578
II	12 (15.0)	17 (21.3)	0.412
III	5 (6.3)	4 (5.0)	1.000
Culprit coronary artery, n (%)			
LAD	48 (60.0)	41 (51.3)	0.340

(Continued)

**Table 1** (Continued).

	DEX (n=80)	Non-DEX (n=80)	P-value
LCX	8 (10.0)	8 (10.0)	1.000
RCA	24 (30.0)	31 (38.3)	0.318
Reperfusion time, min	273.4 ± 198.4	276.9 ± 182.7	0.908
Stent length, mean, mm	26.1 ± 7.3	26.5 ± 7.2	0.745
Stent diameter, mean, mm	3.0 ± 0.4	3.1 ± 0.4	0.722
Medications, n (%)			
Aspirin	64 (80.0)	68 (85.0)	0.533
P <sub>2</sub> Y <sub>12</sub> inhibitors	27 (33.3)	26 (32.5)	1.000
Statins	70 (87.5)	74 (92.5)	0.430
ACEI or ARB	32 (40.0)	33 (41.3)	1.000
PPI	18 (22.5)	15 (18.3)	0.696
Length of hospital stay, days	9.0 ± 3.0	9.4 ± 3.2	0.470

**Notes:** Mean values (standard deviation) and % (n) were reported for continuous and categorical variables, respectively.

**Abbreviations:** Dex, dexmedetomidine; SBP, systolic blood pressure; DBP, diastolic blood pressure; ACEI, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blockers; MI, myocardial infarction; PCI, percutaneous coronary intervention; LAD, left anterior descending artery; LCX, left circumflex artery; RCA, right coronary artery; PPI, proton pump inhibitor.

**Table 2** Baseline Laboratory Characteristics Between the Two Groups

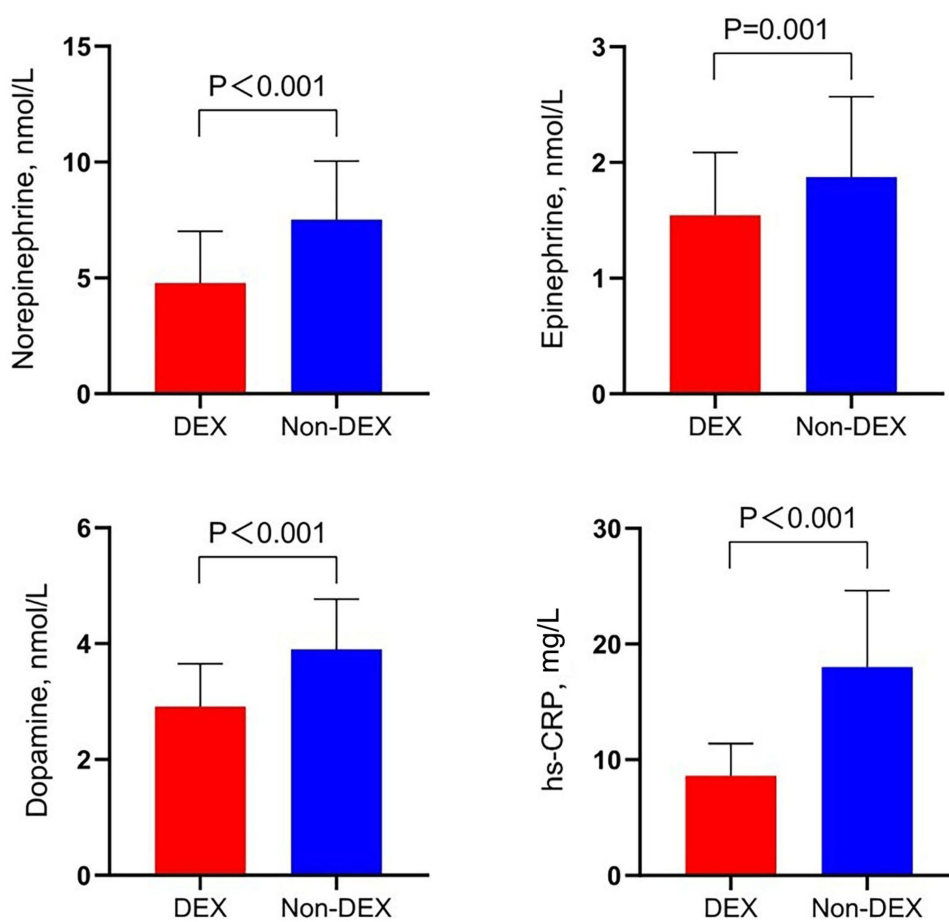
	DEX (n=80)	Non-DEX (n=80)	P-value
WBC, ×10 <sup>9</sup> /L	8.7±3.5	9.1±3.1	0.480
Platelet counts, ×10 <sup>9</sup> /L	210.0±53.2	212.2±57.0	0.804
Hemoglobin, g/L	135.0±11.1	136.6±12.2	0.413
Creatinine, μmol/L	82.5±19.6	84.5±18.3	0.502
Troponin I, μg/L	11.7±5.3	10.4±5.0	0.119
CK-MB, μg/L	8.5±2.3	8.7±3.0	0.592
Total cholesterol, mol/L	4.3±0.9	4.3±0.9	0.977
LDL, mol/L	2.5±0.9	2.6±0.7	0.903
HDL, mol/L	1.2±0.3	1.1±0.3	0.682
Triglyceride, mol/L	1.6±0.8	1.7±0.8	0.453
hs-CRP, mg/L	10.1±2.5	9.9±4.1	0.688
NT-proBNP, pg/mL	209.5±14.5	211.4±19.6	0.484
NE, nmol/L	5.5±1.3	5.5±1.2	0.870
E, nmol/L	1.6±0.4	1.6±0.4	0.692
DA, nmol/L	3.3±0.8	3.3±0.8	0.806

**Notes:** Mean values (standard deviation) and % (n) were reported for continuous and categorical variables, respectively.

**Abbreviations:** Dex, dexmedetomidine; WBC, white blood cell; CK-MB, creatine kinase-MB; HDL, high-density lipoprotein; hs-CRP, high-sensitivity C-reactive protein; LDL, low-density lipoprotein; NT-proBNP, N-terminal pro-brain natriuretic peptide; NE, norepinephrine; E, epinephrine; DA, dopamine.

## Catecholamine and Inflammatory Markers

Catecholamine and hs-CRP levels after primary PCI are shown in [Figure 2](#). In the DEX group, the levels of norepinephrine (4.7±2.2 nmol/L vs 7.6±2.5 nmol/L,  $P < 0.001$ ), epinephrine (1.5±0.5 nmol/L vs 1.9±0.7 nmol/L,  $P = 0.001$ ), dopamine (2.9±0.7 nmol/L vs 3.9±0.9 nmol/L,  $P < 0.001$ ), and hs-CRP (mmol/L vs mmol/L,  $P < 0.001$ ) were significantly lower compared to the non-DEX group. These findings suggest that patients in the DEX group were associated with significantly lower post-PCI catecholamine and hs-CRP levels.



**Figure 2** Comparison of catecholamine and inflammation levels after primary PCI.

**Abbreviations:** PCI, percutaneous coronary intervention; hs-CRP, high-sensitivity C-reactive protein.

## Comparison of Vital Signs and Sedation/Anxiety Scores

Compared to the non-DEX group, HR in the DEX group was significantly lower at T1 ( $71.2 \pm 12.5$  bpm vs  $93.5 \pm 11.1$  bpm,  $P < 0.001$ ), T2 ( $74.1 \pm 4.3$  bpm vs  $97.5 \pm 8.5$  bpm,  $P < 0.001$ ), and T3 ( $76.2 \pm 12.0$  bpm vs  $93.3 \pm 7.2$  bpm,  $P = 0.007$ ). Respiratory rate (RR) was significantly lower in the DEX group at T1 ( $16.3 \pm 1.4$  bpm vs  $17.8 \pm 0.9$  bpm,  $P < 0.001$ ) and T2 ( $16.3 \pm 1.0$  bpm vs  $18.0 \pm 1.9$  bpm,  $P < 0.001$ ). Additionally, SpO<sub>2</sub> was significantly higher in the DEX group at T1 ( $96.4 \pm 0.9\%$  vs  $96.2 \pm 0.9\%$ ,  $P = 0.045$ ), T2 ( $96.3 \pm 1.1\%$  vs  $95.3 \pm 0.9\%$ ,  $P < 0.001$ ), T3 ( $96.6 \pm 0.5\%$  vs  $95.6 \pm 0.6\%$ ,  $P < 0.001$ ), and T4 ( $96.4 \pm 0.6\%$  vs  $96.1 \pm 1.0\%$ ,  $P = 0.016$ ) (Table 3). These results indicate that DEX administration was associated with lower HR and RR, and higher SpO<sub>2</sub> at multiple time points compared with the non-DEX group.

The trends in the Ramsay and APAIS scores are shown in Figure 3. In the DEX group, Ramsay Sedation Scores were higher at T1 ( $P = 0.007$ ) and T2 ( $P < 0.001$ ) than at T0, and anxiety scores decreased significantly from T1 ( $P = 0.021$ ), T1 ( $P = 0.017$ ) to T3 ( $P = 0.015$ ) compared with the preceding time point.

## In-Hospital Adverse Cardiovascular Events

For in-hospital adverse cardiovascular events, the incidence of cumulative MACE was significantly lower in the DEX group compared to the non-DEX group (20.0% vs 38.8%,  $P = 0.015$ ) (Table 4 and Figure 4). When analyzing specific arrhythmic events, we found that the incidence of ventricular arrhythmias was significantly lower in the DEX group compared with the non-DEX group (1.3% vs 10.0%,  $P = 0.034$ ). In contrast, atrial fibrillation occurred in 1.3% of patients in the DEX group versus 7.5% in the non-DEX group, although this difference did not reach statistical significance ( $P = 0.117$ ). These findings indicate that the overall reduction in MACE observed in the DEX group was

**Table 3** Comparison of HR, RR, MAP, SpO<sub>2</sub> Between the Two Groups

	Group	T0	T1	T2	T3
HR, beats/minute	DEX	87.9±7.6	71.2±12.5 <sup>ad</sup>	74.1±4.3 <sup>b</sup>	76.2±12.0 <sup>c</sup>
	Non-DEX	88.0±11.6	93.5±11.1 <sup>ad</sup>	97.5±8.5 <sup>b</sup>	93.3±7.2 <sup>cf</sup>
	P-value	0.949	<0.001	<0.001	0.007
RR, breaths/minute	Dex	17.2±1.3	16.3±1.4 <sup>a</sup>	16.3±1.0 <sup>b</sup>	16.1±1.0 <sup>c</sup>
	Non-DEX	17.1±1.3	17.8±0.9	18.0±1.9	16.4±0.9 <sup>cef</sup>
	P-value	0.787	<0.001	<0.001	0.175
MAP, mmHg	DEX	101.4±17.9	100.6±18.7	100.7±24.7	101.9±11.9
	Non-DEX	102.1±15.2	102.6±7.9	102.7±14.4	101.3±13.9
	P-value	0.812	0.380	0.527	0.769
SpO <sub>2</sub> , %	DEX	96.4±0.9	96.3±1.1	96.7±0.5 <sup>d</sup>	96.4±0.6
	Non-DEX	96.4±0.9	95.3±0.9 <sup>a</sup>	95.6±0.6 <sup>d</sup>	96.1±1.0 <sup>ef</sup>
	P-value	0.145	<0.001	<0.001	0.016

**Notes:** Mean values (standard deviation) and % (n) were reported for continuous and categorical variables, respectively. <sup>a</sup>Significance between T0 and T1; <sup>b</sup>Significance between T0 and T2; <sup>c</sup>Significance between T0 and T3; <sup>d</sup>Significance between T1 and T2; <sup>e</sup>Significance between T1 and T3; <sup>f</sup>Significance between T2 and T3.

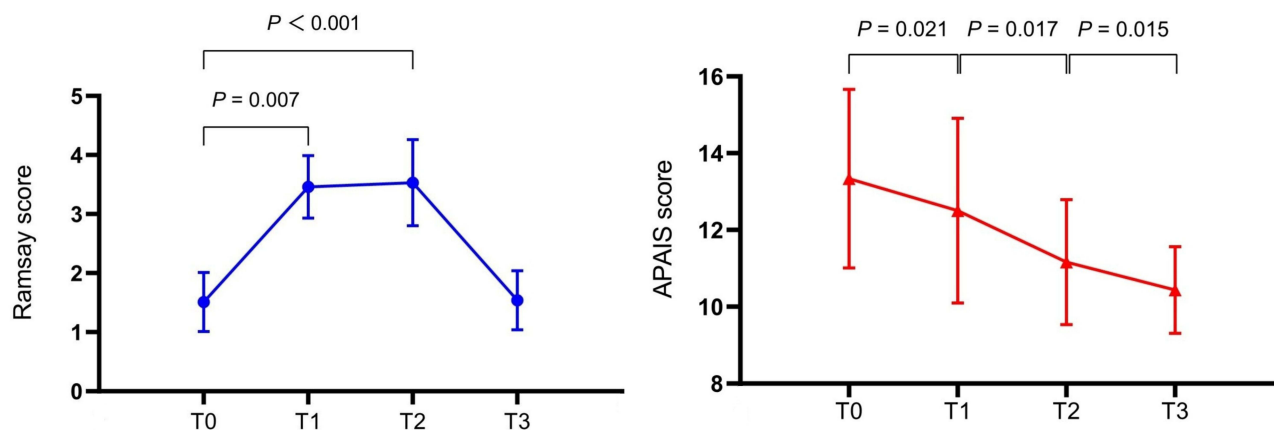
**Abbreviations:** Dex, dexmedetomidine; HR, heart rate; RR, respiratory rate; MAP, mean arterial pressure; SpO<sub>2</sub>, blood oxygen saturation.

primarily driven by a lower incidence of ventricular arrhythmias. In multivariable logistic regression, DEX treatment remained independently associated with reduced risk of in-hospital MACE (OR = 0.244, 95% CI = 0.082–0.728,  $P = 0.011$ ; Table 5).

## Discussion

Older patients with STEMI and stable hemodynamics typically undergo primary PCI under local anesthesia. However, this approach often leaves patients exposed to significant stress and anxiety, which may adversely affect perioperative stability and outcomes. Anxiety, as a subjective psychological experience, is characterized by fear, tension, and irritability.<sup>20</sup> Severe preoperative anxiety can impair cooperation during PCI, increase sedative requirements,<sup>21</sup> and elevate the risk of perioperative cardiovascular complications. Thus, it is crucial to promptly identify elderly patients with significant anxiety and provide appropriate management.

In elderly patients undergoing PCI, the administration of sedatives requires comprehensive monitoring due to their limited physiological reserve and heightened sensitivity to medications. DEX, a selective  $\alpha_2$ -adrenergic agonist, not only



**Figure 3** Ramsay and APAIS scores at different time points.

**Abbreviation:** APAIS, Amsterdam Preoperative Anxiety and Information Scale.

**Table 4** In-Hospital Adverse Cardiovascular Events

Characteristics, n (%)	DEX (n=80)	Non-DEX (n=80)	P-value
Cumulative MACE	16 (20.0)	31 (38.8)	0.015
Cardiovascular death	6 (7.5)	9 (11.3)	0.589
Reinfarction	2 (2.5)	3 (3.3)	1.000
TVR	4 (5.0)	5 (6.3)	1.000
VT/VF	1 (1.3)	8 (10.0)	0.034
Advanced heart failure	3 (3.3)	6 (7.5)	0.495
Stroke	1 (1.3)	1 (1.3)	1.000
Atrial fibrillation	1 (1.3)	6 (7.5)	0.117
AVB	2 (2.5)	2 (2.5)	1.000
Major bleeding	4 (5.0)	3 (3.8)	1.000

**Notes:** Mean values (standard deviation) and % (n) were reported for continuous and categorical variables, respectively.

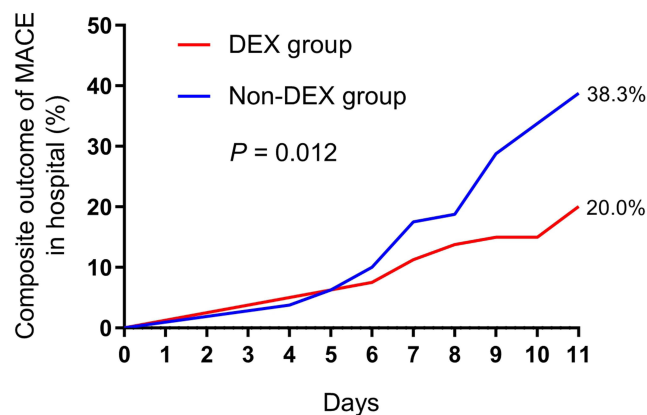
**Abbreviations:** MACE, major adverse cardiac event (cardiovascular death, reinfarction, advanced heart failure, arrhythmia); AVB, atrioventricular block; TVR, target vessel revascularization; VF, ventricular fibrillation; VT, ventricular tachycardia.

provides sedation and anxiolysis but also suppresses sympathetic activation, thereby counteracting the catecholamine surge often triggered during PCI.<sup>22–24</sup> By modulating both neuroendocrine and inflammatory pathways, DEX use was associated with lower stress responses, catecholamine release, and systemic inflammation.<sup>7</sup> These mechanisms explain why patients in the DEX group exhibited lower catecholamine and hs-CRP levels and fewer in-hospital adverse cardiovascular events.

Our study also demonstrated that patients receiving DEX had lower heart and respiratory rates, and modestly higher oxygen saturation compared with controls. Ramsay sedation scores confirmed adequate but arousable sedation, while APAIS scores showed significantly reduced perioperative anxiety. Importantly, DEX use was associated with fewer malignant arrhythmias and lower incidence of in-hospital MACE. These associations may reflect the sedative and sympatholytic properties of DEX.

## Mechanistic and Safety Considerations

Mechanistically, DEX may improve outcomes through its dual action on neuroendocrine and immune pathways: (1) suppression of sympathetic outflow and catecholamine surge, mitigating arrhythmogenic potential and hemodynamic stress; (2) downregulation of pro-inflammatory cytokines such as IL-6 and CRP, reducing systemic inflammatory burden and endothelial dysfunction. Together, these effects likely contributed to the improved hemodynamic stability and lower event rates observed in our study.



**Figure 4** Kaplan-Meier curves for cumulative MACE in hospital. Hazard Ratio: 0.472, 95% confidence interval: 0.263 to 0.848, Log-rank (Mantel-Cox) test,  $P=0.012$ .  
**Abbreviation:** MACE, major adverse cardiovascular events.

**Table 5** Univariate and Multivariable Regression Analysis for in-Hospital MACE

	Univariate			Multivariable		
	OR	95% CI	P-value	OR	95% CI	P-value
Age	0.971	0.939–1.005	0.097	–	–	–
Sex	1.146	0.561–2.340	0.708	–	–	–
DEX treatment	0.395	0.195–0.806	0.010	0.244	0.082–0.728	0.011
Post-procedure NE	1.109	0.977–1.257	0.109	–	–	–
Post-procedure E	1.229	0.724–2.088	0.445	–	–	–
Post-procedure DA	1.191	0.826–1.716	0.349	–	–	–
Post-procedure hs-CRP	1.020	0.972–1.071	0.423	–	–	–

**Abbreviations:** CI, confidence interval; OR, odds ratio; MACE, major adverse cardiovascular events; DEX, dexmedetomidine; N-terminal pro-brain natriuretic peptide; NE, norepinephrine; E, epinephrine; DA, dopamine; hs-CRP, high-sensitivity C-reactive protein.

Safety also warrants attention. Previous studies reported that high doses of DEX may lead to hypertension and exacerbate ischemic brain injury.<sup>25</sup> In addition, DEX can cause dose-dependent reductions in heart rate and blood pressure, and the initial bolus may trigger a biphasic blood pressure response.<sup>26</sup> These risks support the use of lower dosing strategies such as those employed in our study. On the other hand, DEX has been shown to provide safe sedation without significant respiratory depression, mimicking natural sleep.<sup>27,28</sup> When appropriately dosed and closely monitored, it represents a safe option for sedation during PCI.

## Arrhythmias and Adverse Outcomes

Preoperative anxiety and catecholamine surges are well known to increase arrhythmogenic risk.<sup>29</sup> Life-threatening ventricular tachyarrhythmias (VTAs), including ventricular tachycardia and ventricular fibrillation, may occur at any stage of MI.<sup>30</sup> Paroxysmal atrial fibrillation (PAF) is also frequent in the acute MI setting, occurring in 5–20% of patients,<sup>26</sup> and is associated with both heightened vagal tone and sympathetic responses.<sup>31</sup> When refractory arrhythmias occur, sedation and mechanical ventilation may be necessary.<sup>32</sup>

Our results demonstrate that the difference in in-hospital MACE between groups was mainly attributable to a lower incidence of ventricular arrhythmias in patients receiving DEX. This finding is consistent with the known sympatholytic and antiarrhythmic properties of DEX, which may help stabilize electrophysiological activity during acute myocardial infarction.<sup>33,34</sup> Although atrial fibrillation was numerically less frequent in the DEX group (1.3% vs 7.5%), the difference was not statistically significant, likely due to the limited sample size and relatively low event rates. Taken together, these findings suggest that the potential protective effect of DEX in this setting is most evident in reducing ventricular arrhythmias, which are clinically important drivers of in-hospital adverse events.

Our findings also align with evidence linking anxiety and inflammation in MI patients. AMI and hospitalization can trigger significant anxiety,<sup>35</sup> which has been associated with elevated CRP and worse cardiovascular outcomes.<sup>36–40</sup> In our study, the DEX group demonstrated lower hs-CRP levels, supporting the hypothesis that DEX use may be associated with lower anxiety-related stress and inflammation, thereby reducing in-hospital complications.

## Strengths and Limitations

A major strength of this study is its real-world, propensity-matched design, which reduces baseline imbalance between groups and enhances clinical relevance. Additionally, by combining biochemical assays, validated anxiety/sedation scales, and clinical outcomes, we provided a multidimensional evaluation of DEX effects. Nevertheless, several limitations should be noted. First, the retrospective and single-center design introduces inherent risk of bias and limits external validity. Second, the relatively small sample size reduces statistical power, particularly for less frequent outcomes. Third, although PSM minimized confounding, unmeasured factors cannot be fully excluded. Fourth, our analysis was limited to in-hospital outcomes; long-term effects of DEX remain unknown. Finally, physiological

differences (eg, small SpO<sub>2</sub> variations) may not always reflect clinically meaningful changes. These limitations warrant cautious interpretation of the findings.

Another important limitation of our study is the presence of missing data in some propensity score covariates, which led to the exclusion of 54 patients in the DEX group and 232 patients in the non-DEX group prior to matching. The missingness was primarily related to incomplete documentation of laboratory or clinical variables during the acute care setting. However, the higher exclusion rate in the non-DEX group raises concern that the missing mechanism may not be completely random. This differential missingness could potentially affect covariate balance, reduce representativeness of the matched sample, and introduce selection bias. Although propensity score matching improved comparability between groups, residual confounding related to missing data cannot be fully excluded. Therefore, our findings should be interpreted with caution and considered hypothesis-generating rather than definitive.

## Generalizability

Our cohort consisted exclusively of elderly Chinese patients with STEMI. As such, the results may not be generalizable to younger patients or to populations with different ethnic, cultural, or healthcare backgrounds. Further studies in broader, more diverse populations are required to confirm external validity.

## Future Directions

Future research should focus on large-scale, multicenter randomized controlled trials to validate our findings and clarify causal mechanisms. Longer follow-up is essential to assess whether DEX confers sustained benefits beyond hospitalization. Additionally, trials in younger and ethnically diverse cohorts would be critical to establish generalizability and explore whether the benefits observed extend across different patient subgroups.

## Conclusions

DEX use was associated with lower catecholamine and inflammation levels, and appeared to provide adequate sedation with acceptable safety, feasibility, and effectiveness in older patients with STEMI undergoing primary PCI. DEX use was associated with attenuation of sympathetic activity, stress, and inflammation reactivity, while maintaining arousable sedation. These findings support the effectiveness and safety of DEX in older patients with STEMI undergoing primary PCI.

## Data Sharing Statement

People can get a copy of study data by emailing the corresponding author, Dr Ruoxi Zhang, upon reasonable request.

## Ethics Approval and Consent to Participate

Ethical approval for this study (Ethical Committee HG-2024-010) was provided by the Research Ethics Committee of Suzhou Kowloon Hospital, Shanghai Jiao Tong University School of Medicine, 118 Wansheng Street, Suzhou Industrial Park, Suzhou, China (Chairperson Prof. Zhengguo Huang) on 21 February 2025. In our institution, written informed consent is routinely obtained from all patients at the time of hospital admission, prior to PCI and any potential administration of dexmedetomidine.

## Patient Consent for Publication

Informed consent was obtained from each patient.

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## Disclosure

The authors declare no conflicts of interest.

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