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ORIGINAL RESEARCH

Multimorbidity Patterns and In-Hospital Outcomes in Chinese Young Women (Aged <55 Years) Presenting with ST-Segment–Elevation Myocardial Infarction

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BACKGROUND: Recent evidence highlights an increasing incidence of myocardial infarction in young women. Identifying clinical multimorbidity patterns in this population may improve therapeutic strategies and clinical care.

METHODS AND RESULTS: We identified multimorbidity patterns in 9570 young women with ST-segment–elevation myocardial infarction (median age, 50 years [range, 47.0–53.0 years]) admitted to the China Chest Pain Center Database between 2016 and 2021. Hierarchical clustering of 15 medical conditions was performed to derive multimorbidity patterns. The primary outcome was a composite of in-hospital adverse events. Associations between multimorbidity patterns and outcomes were evaluated using multivariable-adjusted logistic regression models. Among 9570 patients, 50% (n=4789) had multimorbidity. Six multimorbidity patterns were identified, including 4 specific patterns: (1) pattern 1, cerebrovascular cluster (histories of cerebrovascular disease and hypertension); (2) pattern 2, traditional cardiovascular disease risk factors cluster (histories of hyperlipidemia, obesity, and diabetes, and family history of cardiovascular disease and smoking); (3) pattern 3, coronary-heart failure cluster (histories of heart failure, coronary artery disease, peripheral arterial disease, and thyroid dysfunction); and (4) pattern 4, anemia-renal dysfunction cluster (histories of atrial fibrillation, anemia, chronic kidney disease, and peptic ulcer). Compared with patients without multimorbidity, those with pattern 1 (odds ratio [OR], 2.29 [95% CI, 1.49–3.52]), pattern 2 (OR, 1.52 [95% CI, 1.24–1.86]), and pattern 4 (OR, 2.25 [95% CI, 1.10–4.61]) exhibited higher risks for composite outcomes.

CONCLUSIONS: Specific multimorbidity patterns in young women with ST-segment–elevation myocardial infarction were associated with distinct in-hospital outcomes in a nationwide registry, providing proof-of-concept evidence to guide future therapeutic approaches.

Key Words: cardiovascular events ■ Chinese ■ female ■ multimorbidity ■ ST-segment–elevation myocardial infarction

See Editorial by Tran and Minhas.

Cardiovascular disease (CVD) remains the leading cause of death for women.[1,2] Although mortality from coronary artery disease has decreased significantly over recent decades, this favorable trend does not extend to young adults, particularly women aged <55 years.[3,4] The proportion of acute

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CLINICAL PERSPECTIVE

What Is New?

- This is the first study to assess patterns of multimorbidity among young Chinese women presenting with ST-segment–elevation myocardial infarction.
- Cluster analysis identified 4 specific multimorbidity patterns among young Chinese women presenting with ST-segment–elevation myocardial infarction.
- Specific multimorbidity patterns in young women with ST-segment–elevation myocardial infarction were associated with differential in-hospital outcomes.

What Are the Clinical Implications?

- Future research focusing on the prevention, multimorbidity, and outcomes of cardiovascular disease in young women are urgently needed to inform risk stratification and management strategies in this population.

Nonstandard Abbreviations and Acronyms

ARM	association rules mining
CCPC	China Chest Pain Center

myocardial infarction admissions attributable to patients aged 35 to 54 years significantly increased, from 27% to 32% (21%–31% among women) during 1995 to 2014.[4] A study in the United States found no significant improvement in in-hospital mortality among patients with ST-segment–elevation myocardial infarction (STEMI) aged <55 years over the past 12 years.[5] Additionally, research from Italy conducted from 2007 to 2018 reported stable acute myocardial infarction rates with higher in-hospital mortality for women aged <47 years.[6] Furthermore, among young patients with STEMI, women have worse outcomes than men.[7] A higher burden of several comorbidities in young female patients compared with male patients is one of the crucial reasons.[8]

Existing evidence has shown an increased risk of mortality with an increase in the number of comorbidities in patients with STEMI. Multimorbidity (≥2 coexisting conditions in an individual)[9] had a greater relative impact on all-cause mortality in middle-aged as opposed to older populations.[10] In addition, multimorbidity is more common in women than in men.[11] However, the single count of diseases may not reflect the impacts of disease severity or disease interaction on mortality risk.[12] The adverse effects of multimorbidity and disease interaction on young female patients with STEMI may be currently underestimated.

Most studies exploring CVD disparities have focused on comparisons by race,[1,4,7,13] and less is known about clinical characteristics, patterns of care, and outcomes for the Chinese young women. On the other hand, the mortality rate associated with acute myocardial infarction is steady or even elevated in developing countries, which accounts for >80% of global deaths attributable to ischemic heart disease.[14] Examining risk stratification of the young Chinese women with STEMI is important, as findings from western countries may not be broadly applicable. However, there are limited studies investigating the characteristics, therapeutic strategies, and in-hospital outcomes of in this population.

This study aimed to identify multimorbidity patterns and evaluate their associations with in-hospital outcomes among young female patients with STEMI using data from the China Chest Pain Center (CCPC) database.

METHODS

The study materials, data, and analytic methods will be accessible for onsite audits by third parties to replicate the procedure or reproduce the results.

Study Population

The analysis used data from CCPC, an ongoing nationwide registry program dedicated to enhancing urgent health care for patients with acute chest pain.[15] The CCPC project was launched in 2015, and all data included in this study were derived from this program. Patient information, including time of symptom onset, admission diagnosis, discharge diagnosis, demographic characteristics, history of relevant diseases, angiographic characteristics, and treatment procedures, was systematically collected. Between January 1, 2016, and December 31, 2021, data from a total of 7 869 703 cases of patients with acute chest pain or other ischemic symptoms were uploaded and incorporated into the CCPC database, including 579 919 patients who were registered with the diagnosis of STEMI in the database. We applied the version of the data included in the latest questionnaire to ensure the data integration of the data (version 2.0 and 2.1). The Chinese Cardiovascular Association Executive Committee and its subcommittee routinely performed quality control for data entry.[16]

This study encompassed 9570 female patients, all aged <55 years, who received a diagnosis of STEMI. The diagnoses of STEMI were made by cardiologists based on chest pain or other ischemic symptom, electrocardiographic evidence, and measurements of myocardial

injury biomarkers, which was based on the state-of-art practicing guidelines in China,[17,18] which was in accordance with the US guideline.[19,20] Additionally, data such as disease diagnoses, treatment history, and other relevant clinical details were directly extracted from the electronic medical records of participating hospitals by trained personnel. These data were subsequently submitted to the CCPC data platform to ensure standardization and reliability before being analyzed in this study. For patients with multiple admissions, only the data from their first admission for STEMI were retained. The study flowchart is shown in Figure 1. The study protocol was conducted in accordance with the Declaration of Helsinki (as revised in 2013) and approved by the institutional review board at the Tianjin Medical University General Hospital (IRB2022-WZ-145). Informed consent was waived because of the retrospective nature of the study.

Definition of Variables and Study Outcomes

The data elements in the Chinese Cardiovascular Association Database–Chest Pain Center include patient characteristics, prehospital treatment and presenting features, in-hospital medication and reperfusion therapy, and in-hospital outcomes and discharge.[21] Variables in this study included routes of hospitalization (walk-in, emergency medical services, transfer, or in-hospital onset), admission levels of heart rate and

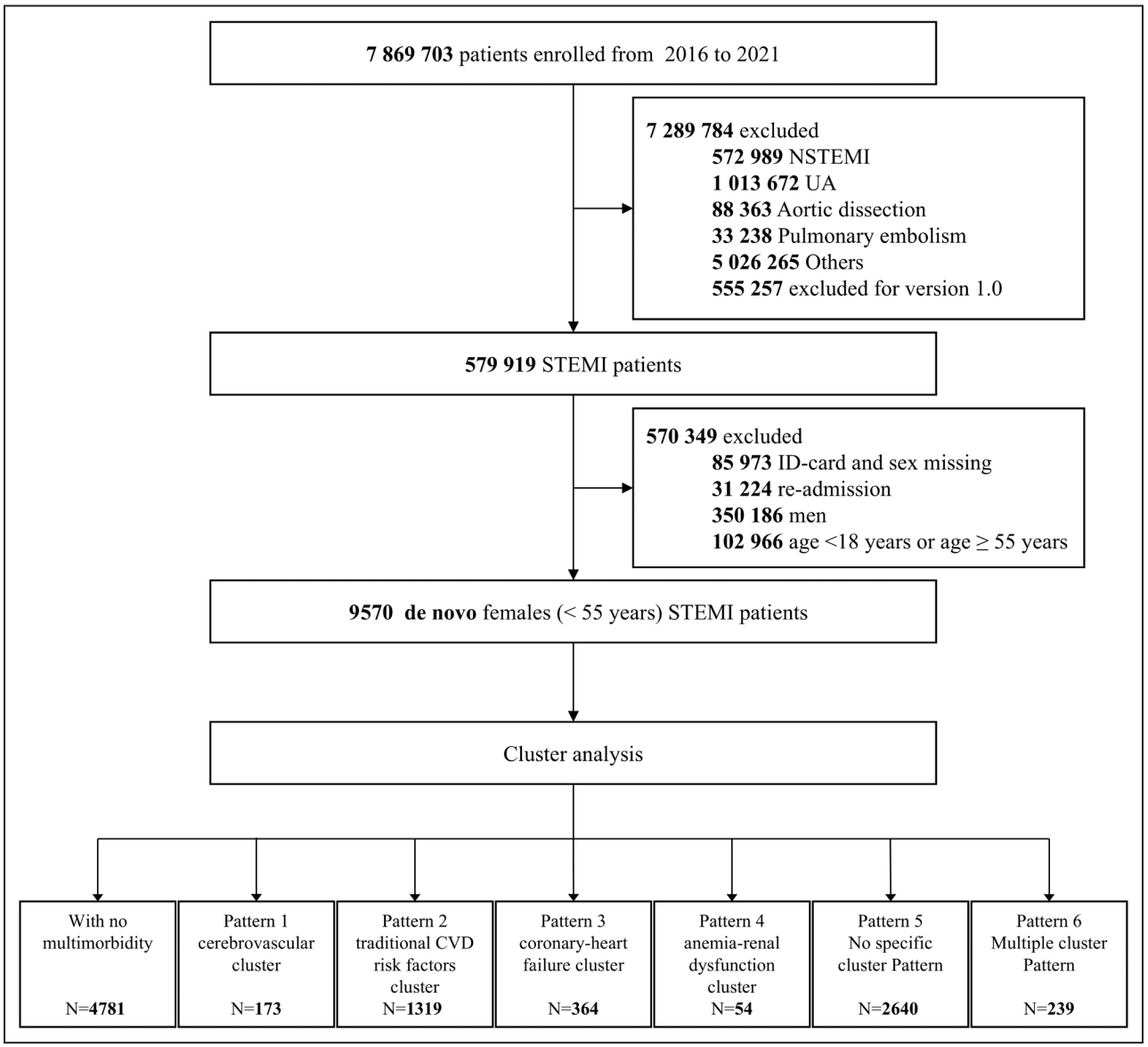

Figure 1. Study flow diagram.
CVD indicates cardiovascular disease; ID, identity document; NSTEMI, non–ST-segment–elevation myocardial infarction; STEMI, ST-segment–elevation myocardial infarction; and UA, unstable angina.

blood pressure, medical conditions/histories (obesity, family history of CVDs, histories of hypertension, cerebrovascular disease, diabetes, hyperlipemia, smoking, coronary heart disease, heart failure, atrial fibrillation, chronic kidney disease, anemia, peripheral arterial disease, and thyroid dysfunction). In-hospital medication information included dual-antiplatelet therapy, β-blockers, statins, and reperfusion therapy. Reperfusion strategies included primary percutaneous coronary intervention (PCI), thrombolysis, elective PCI, coronary artery bypass grafting, and transfer PCI. Multivessel coronary artery disease was defined as significant stenosis (≥50%) in at least 2 major coronary arteries of ≥2.5-mm diameter.[22] The study outcome was defined as the composite of in-hospital adverse events (death, new-onset/worsening heart failure, mechanical complications, recurrent myocardial infarction, and ischemic stroke).

Statistical Analysis

Continuous variables were presented as mean±SD or median with 25th to 75th percentiles as appropriate. Categorical variables were presented as frequencies and proportions. We developed a 2-step approach to identifying patterns of multimorbidity: first using a hierarchical cluster analysis to identify chronic conditions that cluster together and then using association rules mining (ARM) to investigate patterns within these clusters more closely. To enhance the clinical-epidemiologic interpretation of the findings, only medical conditions with prevalence >1% in this specific population were included in the analysis. Multimorbidity patterns were derived on the basis of hierarchical cluster analysis.[12,23] The Yule Q distance quantified dissimilarity among medical conditions/histories. The Wald distance, minimizing variances by reducing the sum of squares between 2 patterns, gauged pattern dissimilarity. Each medical condition/history could only belong to 1 pattern. Dendrograms visually represented the aggregation of medical conditions/histories. The number of extracted multimorbidity patterns was determined by balancing the dendrogram results with clinical significance,[12,23] while the optimal number of clusters was selected using the majority rule from the R-package "NbClust." Using ARM to investigate the connections within these patterns more closely,[24] the analysis was conducted using the "arules" package in R. ARM evaluates relationships between conditions using measures such as support, confidence, and lift. Support measures the frequency of a condition within the data set, whereas confidence evaluates the likelihood of a condition occurring given another condition. The lift metric assesses the significance of a rule, with a lift value exceeding 1 indicating a higher-than-expected frequency of co-occurrence between antecedent and consequent conditions, suggesting a positive association. Conversely, a lift value of <1 reflects a lower-than-expected co-occurrence, implying a negative association. Higher lift values signify stronger associations between conditions. Results of the ARM analysis are presented as summary tables of association rules and heat maps. To visualize the complex relationships within the multimorbidity patterns, association rule graphs were created to illustrate the frequent co-occurrence of conditions and facilitate understanding. Associations between multimorbidity patterns and clinical outcomes were evaluated by multivariable-adjusted logistic regression models. Covariates included age, admission blood pressure and heart rate, receipt of reperfusion therapy, and medical therapies in hospital (antiplatelet medications, statins, β-blockers, and anticoagulants). Statistical analyses were performed using Stata version 15.1 (StataCorp, College Station, TX) and R (version 4.1.3, http://www.R-project.org). A 2-tailed $P<0.05$ was considered statistically significant.

RESULTS

Baseline Participant Characteristics

The analysis included 9570 female patients with STEMI (median age, 50 years [range, 47.0–53.0 years]), 4781 (50.0%) with no multimorbidity and 4789 (50.0%) with multimorbidity. The major admission modality was walk-in admission (61.5%). Hypertension, coronary artery disease, and diabetes were the 3 most common conditions, with prevalences of 46.5%, 37.5%, and 25.0%, respectively. Among 8097 patients who received reperfusion therapy, 66.5% underwent primary PCI, 12.6% received thrombolytic therapy, and 10.6% were treated with elective PCI. A total of 174 deaths, 36 recurrent myocardial infarction events, 27 ischemic strokes, 71 in-hospital bleeds, and 732 new-onset/worsening heart failures were recorded during a median hospital stay of 8 (interquartile range, 6–11) days ().

Patterns of Multimorbidity

On the basis of hierarchical cluster analysis, dendrogram, and NbClust package results, 4 optimal clusters were identified (Figures S1 and S2, Figure 2A): (1) pattern 1, cerebrovascular cluster (1.8% [173/9570]; histories of cerebrovascular disease and hypertension); (2) pattern 2, traditional CVD risk factors cluster (13.8% [1319/9570]; histories of hyperlipidemia, obesity, diabetes, family history of CVD, and smoking); (3) pattern 3, coronary-heart failure cluster (6.7% [364/9570]; histories of heart failure, coronary artery disease, peripheral arterial disease, and thyroid dysfunction); and (4) pattern 4, anemia-renal dysfunction cluster (0.5% [54/9570]; histories of atrial fibrillation, anemia, chronic kidney disease, and peptic ulcer). Besides, 2640 patients were classified as having no specific cluster (pattern 5, no

Table. Descriptive Characteristics of the Study Population

Characteristics	Overall (n=9570)	With no multimorbidity (4781)	With multimorbidity (4789)	*P* value
Age, y	50.0 (47.0–53.0)	50.0 (46.0–52.0)	51.0 (47.0–53.0)	<0.001*
Pattern of patient arrival, n (%)				
EMS	952 (9.9)	514 (10.8)	438 (9.1)	0.049†
Transfer	2393 (25.0)	1186 (24.8)	1207 (25.2)	
Walk-in	5889 (61.5)	2924 (61.2)	2965 (61.9)	
In-hospital onset	335 (3.5)	157 (3.3)	178 (3.7)	
Heart rate, beats/min	79.7±19.8	78.9±19.7	81.0±20.0	<0.001‡
SBP, mm Hg	133.7±27.8	130.7±26.7	136.6±28.5	<0.001‡
Medical conditions/histories, n (%)				
History of smoking	633 (6.8)	112 (2.3)	521 (10.9)	<0.001†
Obesity	849 (9.2)	79 (1.7)	770 (16.1)	<0.001†
Family history of early-onset CVD	560 (6.0)	84 (1.8)	476 (9.9)	<0.001†
Hypertension	4308 (46.5)	979 (20.5)	3329 (69.5)	<0.001†
Hyperlipemia	2164 (23.4)	263 (5.5)	1901 (39.7)	<0.001†
Diabetes	2220 (25.0)	268 (5.6)	1952 (40.8)	<0.001†
Coronary artery disease	3478 (37.5)	667 (14.0)	2811 (58.7)	<0.001†
Atrial fibrillation	119 (1.3)	16 (0.3)	103 (2.2)	<0.001†
Chronic heart failure	405 (4.8)	13 (0.3)	392 (8.2)	<0.001†
Cerebrovascular disease	351 (3.9)	22 (0.5)	329 (6.9)	<0.001†
Peripheral arterial disease	236 (2.7)	12 (0.3)	224 (4.7)	<0.001†
Chronic kidney disease	189 (2.1)	9 (0.2)	180 (3.8)	<0.001†
Anemia	423 (4.8)	57 (1.2)	366 (7.6)	<0.001†
Peptic ulcer	126 (1.4)	10 (0.2)	116 (2.4)	<0.001†
Thyroid dysfunction	245 (2.8)	30 (0.6)	215 (4.5)	<0.001†
COPD	35 (0.4)	10 (0.2)	25 (0.5)	0.011†
Valvular heart disease	99 (1.0)	34 (0.7)	65 (1.4)	0.002†
Malignancy	94 (1.0)	40 (0.8)	54 (1.1)	0.150†
Aortic aneurysm	5 (0.1)	1 (<0.1)	4 (0.1)	0.230†
Medications within 24 h, n (%)				
Aspirin	8161 (90.8)	4059 (89.7)	4102 (92.0)	<0.001†
$P2Y_{12}$ inhibitors	7618 (79.6)	3651 (76.4)	3967 (82.8)	<0.001†
Statins	7092 (74.1)	3435 (71.8)	3657 (76.4)	<0.001†
β-Blockers	3323 (34.7)	1539 (32.2)	1784 (37.3)	<0.001†
Anticoagulation drugs	4314 (45.1)	2172 (45.4)	2142 (44.7)	0.490†
Reperfusion therapy, n (%)	8097 (84.6)	3964 (82.9)	4133 (86.3)	<0.001†
Primary PCI	5382 (66.5)	2566 (64.7)	2816 (68.1)	<0.001†
Thrombolytic therapy	1023 (12.6)	565 (14.3)	458 (11.6)	
Elective PCI	861 (10.6)	342 (8.6)	519 (12.6)	
CABG	10 (0.1)	3 (0.1)	7 (0.2)	
Transfer PCI	486 (6.0)	329 (8.3)	157 (3.8)	
Unknown	336 (4.1)	159 (4.0)	177 (4.3)	
Hospital stays, d	8.0 (6.0–11.0)	7.0 (5.0–10.0)	8.0 (6.0–11.0)	<0.001*
Clinical outcome, n (%)				
Death	174 (1.8)	100 (2.1)	74 (1.5)	0.045†
New-onset/worsening heart failure	732 (7.6)	312 (6.5)	420 (8.8)	<0.001†
Mechanical complication	24 (0.3)	12 (0.3)	12 (0.3)	1.000†
Recurrent myocardial infarction	36 (0.4)	14 (0.3)	22 (0.5)	0.180†
Ischemic stroke	27 (0.6)	9 (0.2)	18 (0.4)	0.084†
Composite adverse events	907 (9.5)	404 (8.5)	503 (10.5)	<0.001†

Data are given as median (interquartile range) unless otherwise indicated. Variables were analyzed using different statistical methods, as indicated by the symbols in the *P* value column. Each symbol corresponds to the statistical test used for the respective variable. CABG indicates coronary artery bypass grafting; COPD, chronic obstructive pulmonary disease; CVD, cardiovascular disease; EMS, emergency medical services; PCI, percutaneous coronary intervention; and SBP, systolic blood pressure.

*Mann-Whitney *U* test.

†χ^2 Test.

‡Independent-sample *t*-test.

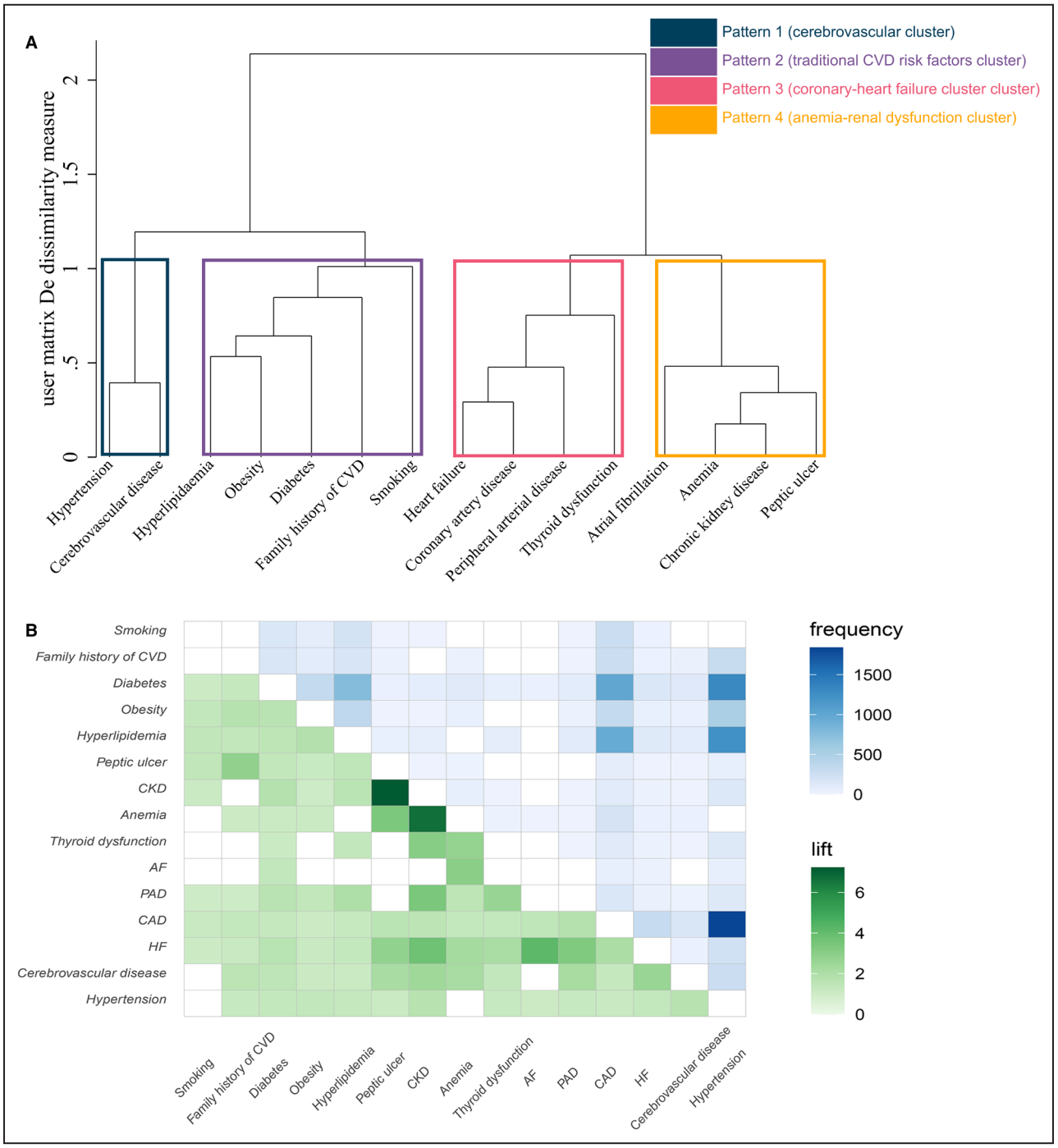

Figure 2. Dendrograms of cluster analysis and heat map of multimorbidity relationships.
Definition of multimorbidity pattern: with no multimorbidity (<2 medical conditions/histories in the same individual), pattern 1 (cerebrovascular cluster), pattern 2 (traditional CVD risk factors cluster), pattern 3 (coronary-heart failure cluster), and pattern 4 (anemia–renal dysfunction cluster). **A**, Dendrogram of cluster analysis showing 4 patterns. **B**, Heat maps developed from association rule mining of multimorbidity. AF indicates atrial fibrillation; CAD, coronary artery disease; CKD, chronic kidney disease; CVD, cardiovascular disease; HF, heart failure; and PAD, peripheral arterial disease.

specific cluster pattern), whereas 289 patients had conditions spanning ≥2 clusters (pattern 6, multiple cluster pattern). Detailed comparisons of baseline characteristics between groups are provided in Table S1. In addition, hierarchical clustering analysis revealed that the dendrogram for young women (aged <55 years) with STEMI differed from that of patients with STEMI in other age and sex groups (Figure S1).

Patients within a given pattern exhibited similar characteristics, whereas those in different patterns

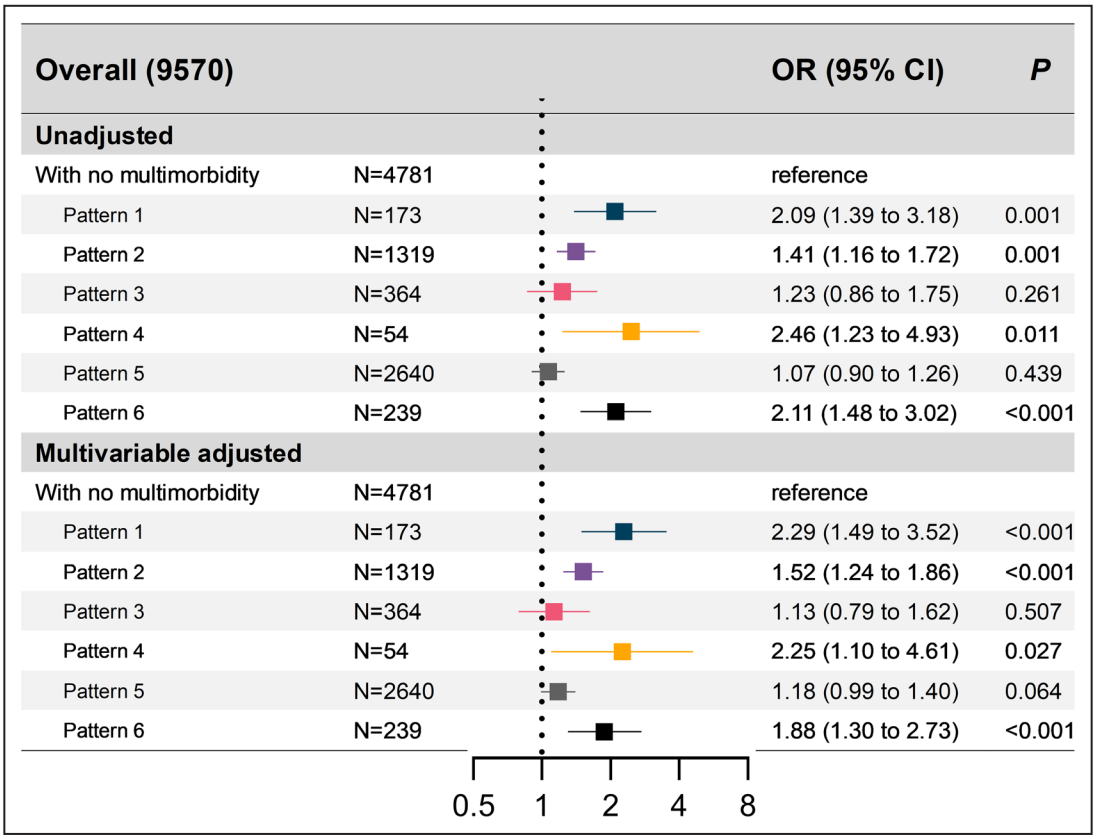

Figure 3. Differences of in-hospital composite outcomes by multimorbidity patterns.
Multivariable adjusted model: adjusted for age, admission systolic blood pressure, heart rate, receipt of reperfusion therapy, and use of antiplatelet medications, statins, β-blockers, and anticoagulants. Definition of multimorbidity pattern: with no multimorbidity (<2 medical conditions/histories in the same individual), pattern 1 (cerebrovascular cluster), pattern 2 (traditional CVD risk factors cluster), pattern 3 (coronary-heart failure cluster), pattern 4 (anemia–renal dysfunction cluster), pattern 5 (no specific cluster pattern, patients with conditions not forming any defined cluster), and pattern 6 (multiple cluster pattern, patients with conditions spanning ≥2 clusters). CVD indicates cardiovascular disease; and OR, odds ratio.

displayed distinct traits. Pattern 1 comprised 173 individuals with histories of both hypertension and cerebrovascular disease. It exhibited a lift of 1.69, indicating that the likelihood of cerebrovascular disease is 1.69 times higher when hypertension is present, and vice versa. The strongest association was found between chronic kidney disease and peptic ulcer (lift=7.23), indicating that there is ≈7.2 times higher likelihood of these 2 conditions occurring together than in isolation (Figure 2B and Table S2). The ARM results for multimorbidity across the 3 clusters were further visualized using network graphs (Figure S3).

Of the 5910 patients with complete coronary angiographic data, 391 (6.6%) had angiographic findings suggestive of nonobstructive lesions. The most common sites were the anterior descending branch (41.3%) and the right coronary (28.9%), with left main stem lesions accounting for <1%. Patients with multimorbidity were more likely to have obstructive lesions and bifurcation lesions than the group without multimorbidity, with a higher proportion of multivessel coronary disease in pattern 1 (25.4%) and pattern 4 (25.8%) (Table S3).

Association Between Multimorbidity Patterns and In-Hospital Outcomes

After the adjustment for age, admission systolic blood pressure and heart rate, receiving reperfusion treatment or not, and medical therapies or not in hospital (antiplatelet medications, statins, β-blockers and anticoagulants), compared with patients without multimorbidity, pattern 1 (odds ratio [OR], 2.29 [95% CI, 1.49–3.52]), pattern 2 (OR, 1.52 [95% CI, 1.24–1.86]), and pattern 4 (OR, 2.25 [95% CI, 1.10–4.61]) demonstrated relatively higher risks for in-hospital composite outcomes. Pattern 6 exhibited an 88% increased risk of in-hospital composite outcomes (OR, 1.88 [95% CI, 1.30–2.73]) (Figure 3). The clustering of the above multimorbidity patterns dose dependently augmented the

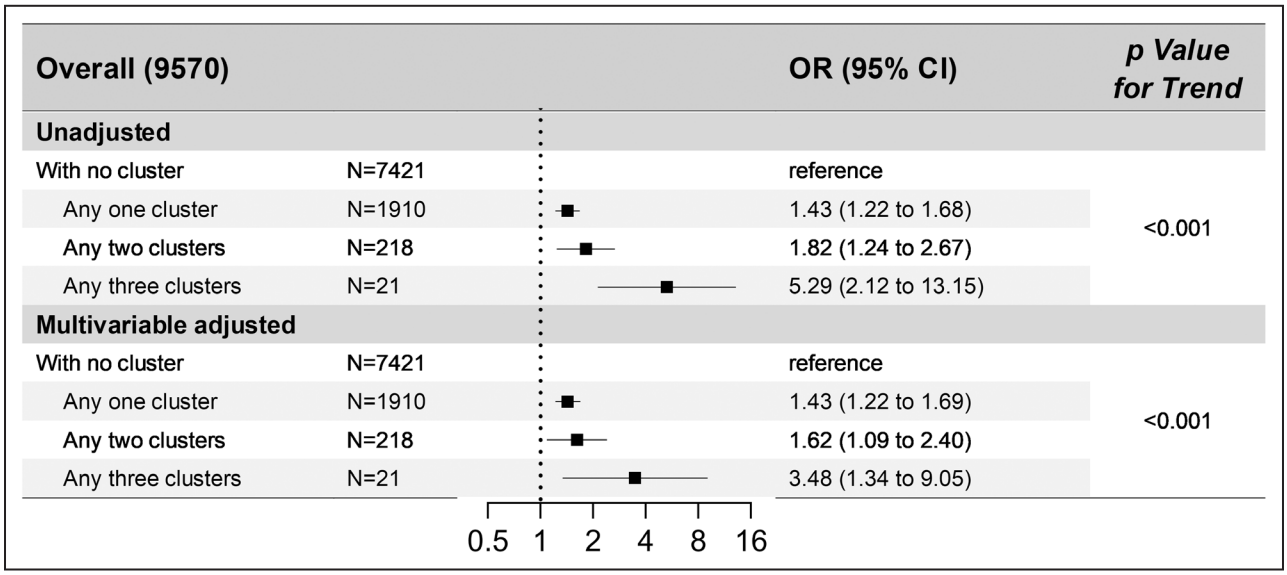

Figure 4. Dose-response between multimorbidity patterns and in-hospital composite outcomes.
Multivariable-adjusted model: adjusted for age, admission systolic blood pressure, heart rate, receipt of reperfusion therapy, and use of antiplatelet medications, statins, β-blockers, and anticoagulants. OR indicates odds ratio.

risks for in-hospital composite outcomes, from any 1 cluster to any 2 clusters and to 3 clusters (*P* for trend <0.001) (Figure 4). Patients categorized within any cluster (patterns 1, 2, 3, 4, or 6) exhibited an adjusted OR of 1.31 (95% CI, 1.09–1.59) compared with those in the reference group with no specific cluster (pattern 5), as detailed in Table S4.

DISCUSSION

To our knowledge, this is the first study assessing patterns of multimorbidity among young women (aged <55 years) presenting with STEMI. Using data from >400 000 patients with STEMI in the CCPC database, which systematically collects information on 15 medical conditions and patient histories for accurate identification, we assessed the clinical characteristics, in-hospital management, and outcomes of STEMI hospitalizations in women aged 18 to 55 years, stratified by multimorbidity patterns. Our main findings were as follows, from 2016 to 2021: (1) In this study, 50.0% of 9570 young women (aged <55 years) presenting with STEMI had multimorbidity. Among the patients with multimorbidity, we identified 4 specific multimorbidity patterns, including pattern 1 (cerebrovascular cluster), pattern 2 (traditional CVD risk factors cluster), pattern 3 (coronary-heart failure cluster), and pattern 4 (anemia–renal dysfunction cluster). (2) Patients with multimorbidity had higher likelihood of complex coronary lesions and complications (ischemic stroke, new or worsening heart failure) during hospitalization compared with patients without multimorbidity. (3) Compared with patients without multimorbidity, pattern 1, pattern 2, pattern 4, and pattern 6 were associated with an increased risk for in-hospital composite outcomes. Moreover, the clustering of 3 multimorbidity patterns (pattern 1, pattern 2, pattern 3, and pattern 4) dose dependently amplified these risks.

This study extends the field in 3 important ways. First, we identified 6 distinct patterns (including 4 specific multimorbidity patterns in the dendrogram) among the 4789 female patients with STEMI with multimorbidity. Previous research has demonstrated that multimorbidity is not solely associated with older individuals,[25] and women exhibit a higher prevalence of multimorbidity than men.[26,27] A recent case-control study demonstrated significant differences in risk factor profiles and associations based on sex and acute myocardial infarction subtype.[28] However, few studies have investigated the patterns of multimorbidity in young female patients. Most association rules in these patterns seemed biologically plausible on visual examination. Only cerebrovascular accidents and hypertension were clustered into "pattern 1," whereas diabetes and other traditional CVD risk factors were not, likely for the following reasons. First, hypertension is one of the strongest risk factors for cerebrovascular disease, whether ischemic or hemorrhagic. Moreover, hypertensive disorders of pregnancy, such as gestational hypertension, chronic hypertension, preeclampsia, and chronic hypertension-superimposed preeclampsia, are unique to this population and significantly increase the risk of postpartum cerebrovascular events.[29,30] Some combinations, such as chronic kidney disease and peptic ulcer, are less common. Nevertheless, a study from Taiwan showed patients with chronic kidney disease have a substantially increased peptic ulcer risk.[31]

Second, this study investigated the association of multimorbidity patterns and both clinical characteristics and treatment strategies. As many as half of the young female population with STEMI experience multimorbidity (median age, 50 years), highlighting the significant burden of hypertension, coronary artery disease, and diabetes in this population. Among patients with available coronary angiography data, 6.6% had nonobstructive lesions, and ≈18% had multivessel disease, a lower proportion than in previous studies.[13,32] Patients with multimorbidity had higher rates of acceptance of pharmacologic treatments, including dual-antiplatelet therapy, statins, and β-blockers, as well as primary PCI therapy, compared with patients without multimorbidity.

Third, we demonstrated the correlation between the combination of pattern 1, pattern 2, pattern 4, and pattern 6 and the risk of in-hospital composite outcomes. Additionally, we found that having at least 1 cluster was associated with worse in-hospital outcomes compared with patients with multimorbidity but no clusters. The risk of cardiovascular events in women increases abruptly after menopause, and both declining estrogen levels and an increased burden of multimorbidity have been suggested as important contributors.[33] However, women with STEMI still have a worse prognosis than men of the same age.[13,34,35] A potential explanation for this is that the prognostic impact of risk factors or diseases may differ between sexes, interacting to create a clustering effect. Diabetes and smoking have been shown to diminish the age-related cardioprotective effects in young women.[13,36,37] It is plausible that the clustering of traditional risk factors, such as diabetes and smoking, may further impact the prognosis of young women with STEMI.

A study from Improving Care for Cardiovascular Disease in China–Acute Coronary Syndrome (ACS) Project showed a significant gap between guideline recommendations and actual clinical practice for patients with STEMI in China.[38] Notably, only 10% of patients arrived via emergency medical services, whereas 60% presented through walk-in visits, indicating that further research is needed to understand why ≈90% of patients did not use emergency medical services. Given the lower CVD awareness and reduced treatment acceptance among female patients compared with age-matched male patients,[39,40] ongoing efforts to raise community awareness of STEMI and other major CVDs are crucial. Although the first-time PCI acceptance rate increased significantly from 2013 to 2014 (46.0%–66.5%),[15] the overall reperfusion rate remained lower than that reported in the previous VIRGO (US Variations in Recovery: Role of Gender on Outcomes of Young AMI Patients) study (84.6% versus 91.0%).[41] These findings highlight the urgent need for enhanced public health education to improve emergency medical services use and ensure timely reperfusion therapy for young women with STEMI in China. Moreover, further research is required to elucidate the role of non–chest pain symptoms, nontraditional cardiovascular risk factors, and coronary artery lesion characteristics in the poorer prognosis observed among female patients.

Limitations

This study has several limitations. First, as an observational study, it cannot establish causal relationships between multimorbidity patterns and in-hospital outcomes. Second, because of the exploratory nature of cluster analysis, there is no optimal number of patterns, and different clustering algorithms may produce varying patterns and constituents.[23] Third, granular clinical and procedural data, such as psychiatric and autoimmune history, prehospital medication use, echocardiographic findings, and detailed data on spontaneous coronary artery dissection (especially from intravascular ultrasound), were not available in this study. Fourth, the registry data used in this study depend on information documented in medical records for clinical purposes, which may introduce variability in data quality and completeness, including limitations in obtaining comprehensive symptom descriptions. Nevertheless, real-world data studies offer a unique opportunity to reflect the actual conditions of diagnosis and treatment, providing valuable insights with significant clinical applicability.

CONCLUSIONS

In a nationwide STEMI registry, we assessed the clinical characteristics, in hospital presentation, and outcomes of Chinese young women (aged <55 years) with STEMI. Our results provided the proof-of-concept evidence that specific multimorbidity patterns in this population are associated with differential in-hospital outcomes. Further work is needed to validate the utility of these multimorbidity patterns in supporting decision-making and developing appropriate management strategies for young women with STEMI.

ARTICLE INFORMATION

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Disclosures

None.

Supplemental Material

Tables S1–S4
Figures S1–S3

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