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ORIGINAL RESEARCH

Clinical Profiles, Outcomes, and Sex Differences of Patients With STEMI

Findings From the NORIN-STEMI Registry

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ABSTRACT

BACKGROUND Low- and middle-income countries account for most of the global burden of coronary artery disease. There is a paucity of data regarding epidemiology and outcomes for ST-segment elevation myocardial infarction (STEMI) patients in these regions.

OBJECTIVES The authors studied the contemporary characteristics, practice patterns, outcomes, and sex differences in patients with STEMI in India.

METHODS NORIN-STEMI (North India ST-Segment Elevation Myocardial Infarction Registry) is an investigator-initiated prospective cohort study of patients presenting with STEMI at tertiary medical centers in North India.

RESULTS Of 3,635 participants, 16% were female patients, one-third were <50 years of age, 53% had a history of smoking, 29% hypertension, and 24% diabetes. The median time from symptom onset to coronary angiography was 71 hours; the majority (93%) presented first to a non-percutaneous coronary intervention (PCI)-capable facility. Almost all received aspirin, statin, $P2Y_{12}$ inhibitors, and heparin on presentation; 66% were treated with PCI (98% femoral access) and 13% received fibrinolytics. The left ventricular ejection fraction was <40% in 46% of patients. The 30-day and 1-year mortality rates were 9% and 11%, respectively. Compared with male patients, female patients were less likely to receive PCI (62% vs 73%; $P < 0.0001$) and had a more than 2-fold greater 1-year mortality (22% vs 9%; adjusted HR: 2.1; 95% CI: 1.7-2.7; $P < 0.001$).

CONCLUSIONS In this contemporary registry of patients with STEMI in India, female patients were less likely to receive PCI after STEMI and had a higher 1-year mortality compared with male patients. These findings have important public health implications, and further efforts are required to reduce these gaps. (JACC: Asia 2023;3:431-442) © 2023 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

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ABBREVIATIONS AND ACRONYMS

ACS = acute coronary syndrome

ASCVD = atherosclerotic cardiovascular diseases

CVD = cardiovascular disease

DM = diabetes mellitus

LVEF = left ventricular ejection fraction

MI = myocardial infarction

PCI = percutaneous coronary intervention

STEMI = ST-segment elevation myocardial infarction

In the last 2 decades, low- and middle-income countries such as India have seen an epidemiological transition in disease burden from infectious diseases to atherosclerotic cardiovascular diseases (ASCVD). India now accounts for a major percentage of the global ASCVD burden, and has more annual ASCVD deaths than any other country in the world.[1-3] ST-segment elevation myocardial infarction (STEMI), a common and dreaded manifestation of ASCVD has historically been associated with high rates of mortality. High-income countries have adopted and effectively implemented strategies such as reducing door to balloon time, which have dramatically improved outcomes in patients with STEMI.[4] These strategies remain elusive for countries like India, despite an alarming increase in the incidence of STEMI.[5] Additionally, awareness about prevention of ASCVD, early recognition, and timely management of STEMI continues to lag behind other priorities in India. Public health care expenditure for treatment and research remains miniscule, and the majority of the population continues to spend out of pocket when faced with acute health emergencies such as STEMI.[5-7]

Cardiovascular disease has long been seen as a disease primarily affecting male patients, but the proportional burden of STEMI in female patients has increased in the last 2 decades.[8] Despite this trend, female patients were less likely to receive timely care or undergo evidence-based invasive procedures after STEMI[8-10] and are less likely to receive guideline-directed medical therapies, resulting in higher mortality rates in the setting of STEMI, even in high-income countries.[10-14] Such sex disparities in receiving quality care for STEMI may be exaggerated in India.[7,15,16] The present study aims to improve our understanding of contemporary risk factor profiles, patterns of presentation, clinical management, and outcomes of patients with STEMI in this population, and further stratify these by sex.

METHODS

STUDY POPULATION. The design and rationale of the NORIN-STEMI (North India ST-Segment Elevation Myocardial Infarction Registry) have been described previously.[17] In brief, the NORIN-STEMI registry is a prospective study of patients hospitalized with STEMI in India. The registry enrolled all consenting patients >18 years of age who present at either Gobind Ballabh Pant Institute of Postgraduate Medical Education and Research and Janakpuri Superspecialty Hospital in New Delhi, India. Both hospitals have PCI capabilities and are government funded, providing cardiovascular care largely free of cost to patients. Therefore, they are 2 major cardiac centers serving many surrounding states in the region, including Delhi, Haryana, Punjab, Uttar Pradesh, Madhya Pradesh, Bihar, and the North-Eastern States.

ENROLLMENT. The study protocol was approved by the Institutional Review Board at both institutions. All adults ≥18 years of age presenting with STEMI to 2 tertiary medical centers in Delhi from January 1, 2019, to February 2020 participated in this registry. Written informed consent was obtained from patients or next of kin if the patient lacked decisional capacity. ST-segment elevation was defined by the European Society of Cardiology/American College of Cardiology/American Heart Association/World Heart Federation Task Force for the fourth Universal Definition of Myocardial Infarction as new ST-segment elevation at the J point in at least 2 contiguous leads of ≥2.0 mm in male patients or ≥1.5 mm in female patients in leads V_2 to V_3 and/or of ≥1 mm in other contiguous chest leads or limb leads.[18] Patients presenting ≥21 days after symptom onset were excluded.

DATA ASCERTAINMENT. Baseline demographics were reported by patients and included mode of transportation to the hospital, education, occupation, diet, physical activity, sleep, stress, socioeconomic status, and health care coverage. Family history of coronary artery disease was defined as a myocardial infarction (MI) or coronary revascularization in any first-degree relative; premature coronary artery disease was defined as the above before 55 years of age in male patients and 65 years of age in female patients. Risk factors were first evaluated by detailed medical record review and self-report; prior diagnosis and treatment for all risk factors was ascertained. Chronic kidney disease was defined by an estimated glomerular filtration rate of <60 mL/min/m^2 before admission. History of smoking was categorized as current (within the last month), former, or never; pack-years were calculated. To account for missed screening opportunities, several risk factors were also evaluated on

The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the Author Center.

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presentation. Hypertension was defined as systolic blood pressure of ≥140 mm Hg and a diastolic blood pressure of ≥90 mm Hg. Dyslipidemia was defined per National Cholesterol Education Plan criteria as a total cholesterol of ≥240 mg/dL, serum triglycerides of ≥150 mg/dL, or high-density lipoprotein cholesterol of <40 mg/dL in male patients or <50 mg/dL in female patients.[19] Diabetes mellitus (DM) was defined as a glycated hemoglobin of ≥6.5%. A medication reconciliation was completed and use of lipid-lowering medications, antihypertensives, oral or intramuscular DM medications, and insulin was recorded.

On presentation, patients self-reported clinical symptoms, duration of symptoms, preceding activity, time since symptom onset, and location of first evaluation. Objective vitals including height, weight, heart rate, and blood pressure were recorded. Licensed physicians in the departments of cardiology interpreted presenting electrocardiographs and determined MI territory (anterior, lateral, inferior, posterior). Guideline-directed acute coronary syndrome (ACS) therapy including aspirin, statin, beta-blocker, anticoagulation, and $P2Y_{12}$ inhibitor use were documented both in-hospital and on discharge. In-hospital thrombolytic use was also recorded. Each patient received an echocardiogram on presentation, which was evaluated for regional wall motion abnormalities, left ventricular ejection fraction, mitral regurgitation grade, and mechanical complications such as papillary muscle rupture, acute mitral regurgitation, interventricular septum rupture, ventricular septal defect, cardiac tamponade, and left ventricular aneurysm by experienced cardiologists. Laboratory values collected at presentation included creatinine, hemoglobin, hemoglobin A1c, total cholesterol, calculated low-density lipoprotein cholesterol, high-density lipoprotein cholesterol, and triglycerides.

Clinical events of interest included use of coronary angiography, PCI, and mortality. Findings of angiography were interpreted by licensed cardiologists and included the number of diseased vessels, infarct-related artery (arteries), and infarct territory. Complications of interest related to STEMI were repeat infarction, mechanical ventilation, dialysis, ventricular arrhythmias, bleeding, cardiogenic shock, in-hospital mortality, and PCI-related complications, such as stent thrombosis, stroke, access site complications, and contrast-induced nephropathy. Mechanical complications were also assessed with echocardiogram as described elsewhere in this article.

All study participants were followed at 30 days and 1 year via prospective telephone calls and/or in-clinic follow-up visits, as well as a detailed medical record review. Mortality, adherence to guideline-directed therapies, smoking cessation, rehospitalization, and complications such as stent thrombosis, contrast nephropathy, bleeding, stroke, reinfarction, and reintervention via PCI or coronary artery bypass grafting were evaluated.

OUTCOMES AND DEFINITIONS. For the present study, primary outcomes of interest included in-hospital, 30-day, and 1-year mortality. Sex was self-reported. Outcomes were collected by phone call, in-office visit, or through a detailed review of medical records. Cardiovascular risk factors were identified via history or by laboratory findings at presentation. Dyslipidemia and DM were defined on history or presentation, as descried elsewhere in this article.

STATISTICAL ANALYSIS. Descriptive statistics were used to evaluate the distributions of continuous variables and frequencies of categorical variables. Bivariable comparisons were performed between female patients and male patients using analysis of variance, Kruskal-Wallis test, chi-square test, and Fisher exact test where appropriate.

We developed a multivariable logistic regression model to identify predictors of in-hospital and 30-day mortality. Characteristics of interest were identified both a priori and by bivariable analyses and adjusted OR and the corresponding 95% CIs were reported. Potential predictors included age, sex, location of first presentation (PCI capable vs referral site), dietary status, physical activity, socioeconomic status, substance use, time from symptom onset to health care contact, PCI, history of diabetes, hypertension, atrial fibrillation, congestive heart failure, stroke, MI, coronary artery bypass grafting, peripheral artery disease, and baseline use of medications. Additionally, a multivariable Cox proportional hazards model was then used to examine the association of female sex with mortality to 1 year, and multivariable logistic regression evaluated the association of female sex with other outcomes of interest. Both models were adjusted for age, history of hypertension, DM (established or newly detected), heart failure, prior MI, prior cerebrovascular accident, tobacco use, and obesity. The proportional hazards assumption was assessed using the Supremum test as well as visually examined Schoenfeld residuals. All analyses were performed using SAS 9.4 (SAS Institute).

RESULTS

BASELINE CHARACTERISTICS OF PATIENTS WITH STEMI. A total of 3635 patients were enrolled in the registry from January 2019 to February 2020, of whom 582 (16%) were female patients and 3053 (84%) were male patients. The median age of enrolled patients

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TABLE 1 Baseline Characteristics of Patients in the NORIN-STEMI Registry, Stratified by Sex

	All (N = 3,635)	Female (n = 582,16%)	Male (n = 3,053,84%)	*P* Value (2-Sided)
Age, y	55 (45-62)	60 (52-65)	53 (45-60)	<0.0001
≥60	1,336 (37)	325 (56)	1,011 (33)	
50-59	1,106 (30)	147 (25)	959 (31)	<0.0001
40-49	874 (24)	95 (16)	779 (26)	
<40	319 (9)	15 (3)	304 (10)	
Medical history				
Diabetes mellitus	855 (24)	215 (37)	640 (21)	<0.0001
Hypertension	1,039 (29)	264 (45)	775 (25)	<0.0001
Cancer	7 (0)	0 (0)	7 (0)	0.60
Atrial fibrillation	76 (2)	8 (1)	68 (2)	0.19
Hemodialysis	1 (0)	0 (0)	1 (0)	0.99
Heart failure	38 (1)	9 (2)	29 (1)	0.19
Dyslipidemia	77 (2)	17 (3)	60 (2)	0.14
Prior cerebrovascular accident	43 (1)	5 (1)	38 (1)	0.43
Prior myocardial infarction	443 (12)	64 (11)	379 (12)	0.34
Prior CABG	6 (0)	0 (0)	6 (0)	0.60
Peripheral artery disease	4 (0)	0 (0)	4 (0)	0.99
Tobacco use				
Never	1,349 (37)	486 (84)	863 (28)	<0.0001
Former	272 (7)	17 (3)	255 (8)	
Current, some days	103 (3)	11 (2)	92 (3)	
Current, every day	1,909 (53)	67 (12)	1,842 (60)	
Physical activity				
Yes	482 (13)	49 (8)	433 (14)	0.0002
BMI				
Underweight (<18.5 kg/m^2)	90 (2)	28 (5)	62 (2)	<0.0001
Normal body weight (18.5-25 kg/m^2)	1,564 (43)	260 (45)	1,304 (43)	
Overweight (25-30 kg/m^2)	1,565 (43)	202 (35)	1,363 (45)	
Obese (>30 kg/m^2)	416 (11)	92 (16)	324 (11)	
Socioeconomic factors				
Education				
College graduate	271 (7)	16 (3)	255 (8)	<0.0001
High school	557 (15)	33 (6)	524 (17)	
Middle school	951 (26)	93 (16)	858 (28)	
No formal education	1,856 (51)	440 (76)	1416 (46)	
Insurance, self-pay	3,578 (98)	577 (99)	3,001 (98)	0.12
Income quartile				
Upper middle	96 (3)	11 (2)	85 (3)	0.51
Lower middle	1,184 (33)	195 (34)	989 (32)	
Upper lower	1,369 (38)	226 (39)	1,143 (37)	
Lower	983 (27)	150 (26)	833 (27)	
Alcohol				
Never	2,737 (75)	575 (98)	2,162 (71)	<0.0001
Former	183 (5)	1 (0)	182 (6)	
Current, some days	393 (11)	6 (1)	387 (13)	
Current, every day	322 (9)	0 (0)	322 (11)	
Medications at baseline				
Aspirin	389 (11)	56 (10)	333 (11)	0.36
Statin	386 (11)	57 (10)	329 (11)	0.48
Beta-blocker	467 (13)	83 (13)	384 (13)	0.27
ACE inhibitor/ARB	447 (12)	90 (16)	357 (12)	0.01
Calcium channel blocker	194 (5)	56 (10)	138 (5)	<0.0001

Values are median (IQR) or n (%).

ACE = angiotensin converting enzyme inhibitors; ARB = angiotensin receptor blockers; BMI = body mass index; CABG = coronary artery bypass grafting; NORIN-STEMI = North India ST-Segment Elevation Myocardial Infarction Registry.

TABLE 2 Details of Presentations of Patients in the NORIN-STEMI Registry, Stratified by Sex

	All (N = 3,635)	Female (n = 582,16%)	Male (n = 3,053,84%)	*P* Value (2-Sided)
Presentation				
Direct	242 (7)	38 (7)	204 (7)	0.89
Referral	3,393 (93)	544 (93)	2,849 (93)	
Mode of transport				
Ambulance	190 (5)	36 (6)	154 (5)	0.007
Public transport	1,346 (37)	244 (42)	1,102 (36)	
Self/family	2,099 (58)	302 (52)	1,797 (59)	
Location of first evaluation				
Non-PCI center (clinic)	573 (16)	91 (16)	482 (16)	0.55
Non-PCI center (hospital)	2,801 (77)	443 (76)	2,359 (77)	
PCI center	261 (7)	48 (8)	213 (7)	
Symptoms onset to first health care contact				
<1 h	2,309 (64)	344 (59)	1,965 (64)	0.03
1-3 h	516 (14)	90 (15)	426 (14)	
3-12 h	362 (10)	58 (10)	304 (10)	
12-24 h	150 (4)	26 (4)	124 (4)	
≥24 h	285 (8)	63 (11)	222 (7)	
Reason for delay[a]				
Lack of transport	382 (29)	71 (30)	311 (29)	0.84
Patient/relative unwillingness	177 (14)	35 (15)	142 (13)	
Misinterpretation of symptoms	597 (46)	104 (44)	493 (46)	
Transient resolution of symptoms	152 (12)	25 (11)	127 (12)	
MI type on electrocardiogram				
Anterior wall MI	1,975 (54)	296 (51)	1,679 (55)	0.391
Inferior wall MI	1,553 (43)	265 (46)	1,288 (42)	
Lateral wall MI	39 (1)	11 (2)	28 (1)	0.52
Posterior wall MI	16 (0)	2 (0)	14 (0)	
Ventricular fibrillation	24 (1)	9 (2)	15 (0)	0.004
Hours from admission to catheter laboratory arrival	8 (1-27)	4 (1-26)	8 (1-28)	0.720

Values are n (%) or median (IQR). [a]Not available for 2327 patients.
MI = myocardial infarction; PCI = percutaneous coronary intervention; other abbreviation as in Table 1.

was 55 years (IQR: 45-62 years) and 51% self-reported illiteracy. A history of hypertension was present in 29%, diabetes in 24%, and obesity in 11%. A total of 53% used tobacco products including cigarettes, beedi, and/or hookah at the time of presentation. Before their presentation with STEMI, 11% reported daily aspirin use and 11% were on statins. Female patients were older (median age 60 years vs 53 years) and more likely to have a history of diabetes, hypertension, obesity, and illiteracy compared with male patients. Female patients were less likely to use tobacco, drink alcohol, or be physically active. Baseline characteristics of patients enrolled in the registry stratified by sex are shown in **Table 1**.

CLINICAL PRESENTATION AND MANAGEMENT. Clinical presentation and in-hospital characteristics are summarized in **Table 2** and Supplemental Table 1. Most patients (64%) made health care contact within 1 hour of symptom onset; however, 93% first presented to a non-PCI-capable hospital and were subsequently referred to PCI-capable centers. On arrival, nearly 100% of patients received aspirin, a statin, and a $P2Y_{12}$ inhibitor (Supplemental Table 2). Laboratory tests at presentation revealed that most of the patients (78%) had dyslipidemia. Female patients were more likely to present with lipid profiles diagnostic of dyslipidemia than male patients (89% vs 76%; $P < 0.001$). Anterior wall MI was the most common type of MI by electrocardiogram for both sexes (51% vs 54%; $P = 0.39$). On echocardiogram, 46% of patients had an ejection fraction of <40% with no differences by sex (40% vs 37%; $P = 0.40$), and 79% had regional wall motion abnormalities, also without any sex difference (78% vs 80%; $P = 0.40$).

Coronary angiography was performed in 72% of patients. Female patients were significantly less likely to undergo coronary angiography (62% vs 73%; $P < 0.0001$) and PCI (58% vs 67%; adjusted OR: 1.46; 95% CI: 1.18-1.81; $P = 0.0005$) than male patients. Most had single vessel disease (68%) and the left anterior descending artery was the most common culprit vessel (55%). PCI was performed in 66% of the overall

TABLE 3 Procedural Details and Discharge Medications of Patients in the NORIN-STEMI Registry, Stratified by Sex

	All (N = 3,635)	Female Patients (n = 582,16%)	Male Patients (n = 3,053,84%)	*P* Value (2-Sided)
Angiography	2,600 (72)	361 (62)	2,239 (73)	<0.0001
Arterial access site				
Femoral	2,506 (98)	349 (97)	2,157 (98)	0.621
Radial	62 (2)	10 (3)	52 (2)	
Culprit vessels				
LMCA	7 (0)	2 (1)	5 (0)	0.539
LAD	1,103 (55)	139 (52)	964 (56)	
RCA	670 (34)	93 (35)	577 (33)	
LCx	211 (11)	34 (13)	177 (10)	
No. of vessels				
Normal	28 (1)	2 (1)	26 (1)	0.167
Single-vessel disease	1,761 (68)	237 (66)	1,524 (68)	
Double-vessel disease	600 (23)	83 (23)	517 (23)	
Triple-vessel disease	211 (8)	39 (11)	172 (8)	
PCI	2,381 (66)	337 (58)	2,044 (67)	<0.0001
Thrombolytics	474 (13)	94 (16)	380 (12)	0.02
Time from symptom onset to PCI				
≤12 h	350 (18)	56 (20)	294 (17)	0.522
12-24 h	283 (14)	37 (13)	246 (15)	
24-72 h	240 (12)	39 (14)	201 (12)	
>72 h	1,089 (56)	149 (53)	940 (56)	
Discharge medications				
Aspirin	3,353 (100)	497 (100)	2,856 (100)	0.999
Statin	3,339 (100)	495 (100)	2,844 (100)	0.999
P2Y12 inhibitors	3,338 (99)	494 (99)	2,844 (100)	0.730
Prasugrel	21 (1)	2 (0)	19 (1)	<0.0001
Clopidogrel	3255 (97)	474 (95)	2781 (97)	
Ticagrelor	62 (2)	18 (4)	44 (2)	
Beta-blocker	3,298 (98)	487 (98)	2,811 (98)	0.558
ACE/ARB	2,961 (88)	428 (86)	2,533 (89)	0.108

Values are n (%).

RCA = right coronary artery; LAD = left anterior descending artery; LCx = left circumflex artery; LMCA = left main coronary artery; other abbreviations as in Tables 1 and 2.

population. The median time from symptom onset to coronary angiography was 71 hours (IQR: 15-217 hours). Culprit vessels and the number of vessels with significant stenosis on angiography did not differ between the sexes. All patients were discharged on dual antiplatelets, statin and beta-blockers. Clopidogrel was the most common $P2Y_{12}$ inhibitor used and medications at discharge did not differ between male patients and female patients (Table 3).

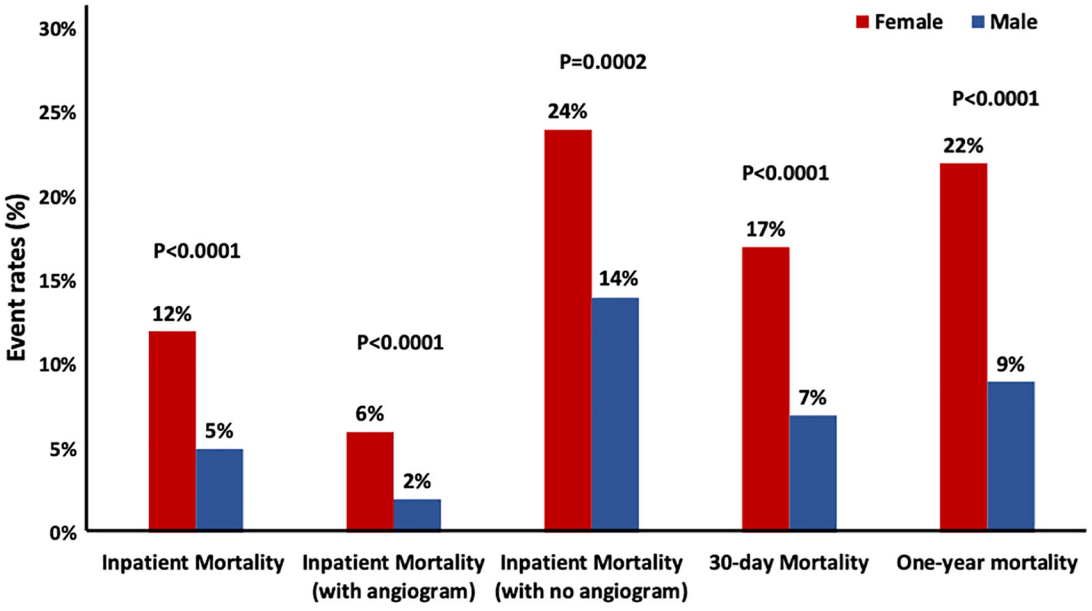
MORTALITY. Overall, 216 patients (6%) died during the index hospitalization, 296 (8%) at 30 days, and 410 (11%) at 1 year. The overall rates of inpatient mortality were significantly higher in female patients than in male patients (12% vs 5%; $P < 0.0001$) (Figure 1). The multivariable regression model identified several risk factors that independently affected inpatient and 30-day mortality (Figure 2). Among these risk factors, lack of revascularization with PCI and being a female patients emerged as the strongest predictors of inpatient and 30-day mortality. The multivariable Cox proportional hazards model further revealed that, even after adjustment for other clinical variables, female patients were twice as likely to die at 1 year after STEMI as compared with male patients (22% vs 9%; adjusted HR: 2.1; 95% CI: 1.7-2.7; $P < 0.001$) (Figure 3).

DISCUSSION

The present study is the largest contemporary prospective registry evaluating the epidemiology, management patterns, and outcomes of STEMI in an underserved population in Northern India (Central Illustration). Female patients comprised only 16% of our patients. Compared with contemporary data from the United States and Europe or even with prior registry studies from Southern India, the median age in our population was younger and smoking rates were much higher. The prevalence of hypertension, dyslipidemia, and diabetes among patients with STEMI have remained stagnant over the last decade[7,20] and highlights the lack of identification and undertreatment of traditional risk factors before presentation. The majority of patients (93%) initially presented to non-PCI-capable facilities, resulting in significant delays during transfer from time of symptom onset to arrival at the PCI-capable centers. These transfer delays resulted in high rates of post-STEMI left ventricular systolic dysfunction and mechanical complications. Only two-thirds of patients received PCI, largely owing to delays in transfer to tertiary facilities and 1-year mortality rates are still higher compared with current data from the United States and Europe. Compared with male patients, female patients were older, were more likely to have diabetes and hypertension, faced longer delays from symptom onset to first health care contact, were significantly less likely to receive PCI, and had a 2-fold increased risk of mortality.

Compared with previous registry studies of ACS patients in India (Supplemental Table 3) and in keeping with various cross-sectional surveys,[7,20-22] our study highlights the significant increase in the use of tobacco and tobacco-related products. The increase in prevalence of smoking especially among young adults in India is alarmingly high, even compared with prevalence from the United States and Europe. "Beedi' smoking was more prevalent than cigarette smoking. Although the association of beedi smoking with ASCVD is unclear, a stronger association with oral cancer than traditional cigarette suggests a higher likelihood of ASCVD patients in these

FIGURE 1 Sex Differences in Clinical Outcomes for Patients With STEMI in India



Event rates for inpatient, 30-day and 1-year mortality stratified by sex. The overall rates of inpatient mortality were significantly higher in female patients than in male patients. Female patients also experienced higher 30-day and 1 year mortality compared with male patients.
STEMI = ST-segment elevation myocardial infarction.

patients.[23,24] These products remain unregulated in India and awareness of their deleterious effects remain inadequately understood. This factor is of concern and warrants stringent population-based policy interventions and the intensification of existing health promotion campaigns.

The lack of PCI was the strongest independent predictor of inpatient and 30-day mortality for patients presenting with STEMI. Although the use of coronary angiography and PCI in our study was higher than prior studies in India,[6,7,16] it was still lower than observed in the United States or Europe.[25,26] The low rates of revascularization were largely due to the time delay from symptom onset to presentation at a PCI capable facility and unclear benefit of PCI ≥12 hours after an event among patients without signs of ongoing ischemia owing to a lack of viability of the infarcted myocardium.[27] Despite an increase in PCI-capable centers in India in the last decade, prompt access to these centers remains a major hindrance in STEMI care in this country. In our study, 64% of patients presented to the first health care contact within 1 hour of symptom onset and 78% within 3 hours of symptom onset. Although the average time to health care contact remain comparable with studies from the United States and Europe,[25,26] the vast majority of these patients (93%) presented to a non-PCI-capable facility as the initial point of contact. Considering these patients had to rely on self-transport or public transportation to reach PCI-capable centers, there were significant delays in being transported to our PCI centers. The lack of financial means to access medical care at nearby PCI-capable private centers could also have contributed to delays in timely revascularization. Up to 98% of the patients in our cohort had no medical insurance and had to pay out of pocket for their medical costs. Government-funded tertiary care centers such as those included in our study provide medical care largely free of cost; however, these centers are scarce and have high patient volumes, limiting timely evaluation and treatment of patients with STEMI. Unsurprisingly, we found high rates of post-MI left ventricular systolic dysfunction and high 1-year mortality rates in our registry.

A possible solution for increasing PCI use rates comes from the Tamil Nadu STEMI initiative.[6] In this referral-based hub-and-spoke model, PCI centers were

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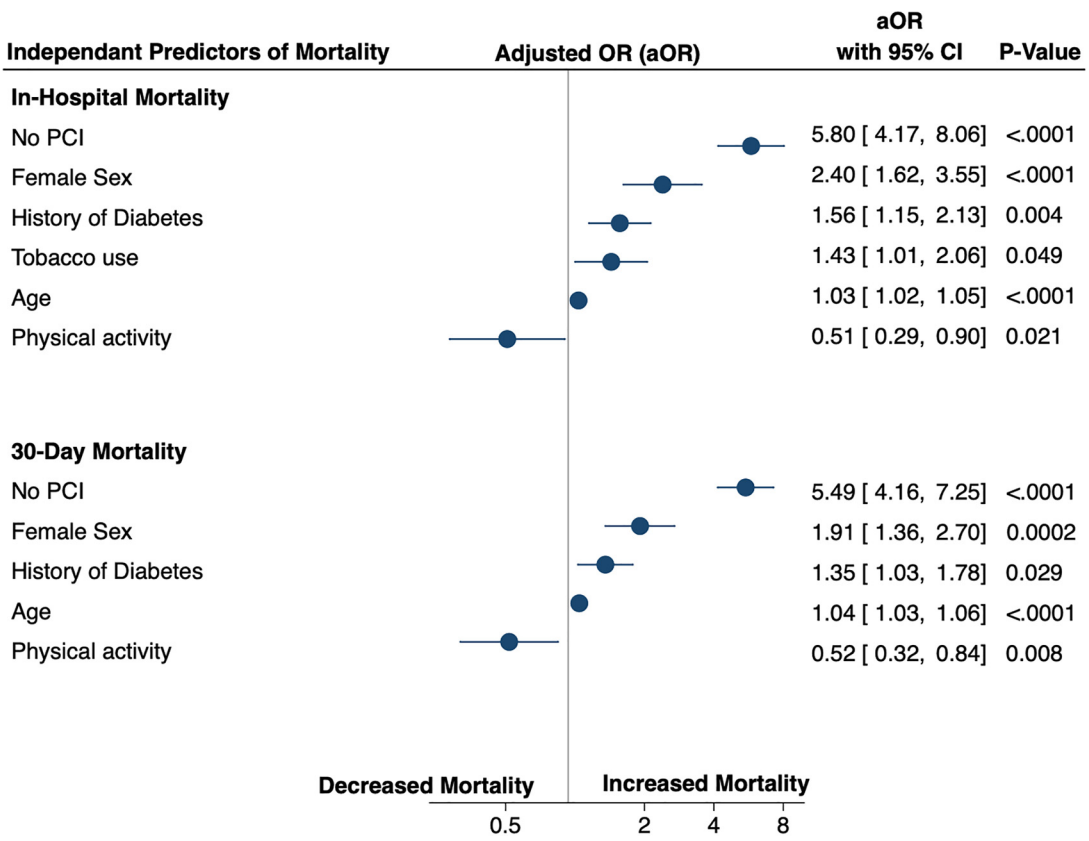
FIGURE 2 Independent Predictors of In-Hospital and 30-Day Mortality



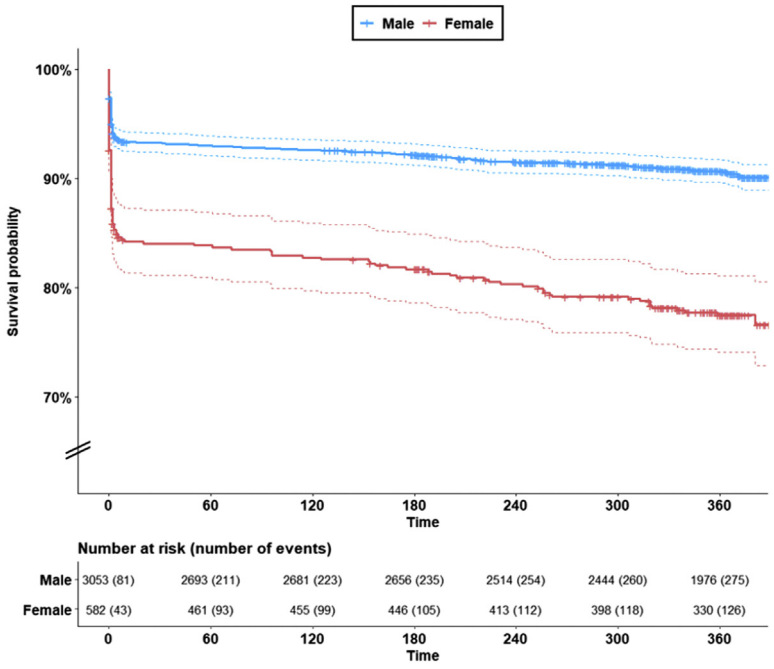
A multivariable logistic regression model was used to identify predictors of in-hospital and 30-day mortality. Treatment without PCI was the strongest predictor of inpatient mortality, followed by female sex, history of diabetes, tobacco use, and advancing age. Self-reported physical activity was protective. At 30 days, independent predictors of mortality remained largely unchanged. PCI = percutaneous coronary intervention.

connected to non-PCI centers through a dedicated ambulance service capable of transmitting electrocardiographs, resulting in decreased in delays in presentation. Although national implementation of this model is limited owing to the wide heterogeneity of health care setups across India, the effectiveness of telehealth as a means for prompt identification and triage of patients with STEMI offers potential ways to address this barrier and expand access to timely revascularization.[28]

Findings from our registry offer a more contemporary view of STEMI epidemiology and management practices from 2 large PCI-capable tertiary centers catering to patients from multiple states can be used to inform similar future initiatives aimed at improving the standard of care for STEMI in India.

SEX DIFFERENCES IN THE MANAGEMENT AND OUTCOMES FOR STEMI. Sex differences in the management of acute coronary syndrome persist in the contemporary era. In a recent analysis from the Atherosclerosis Risk in Communities Study, these differences in ACS management across sex were even noted in young adults.[8] Despite an abundance of studies concentrated on evaluating these differences, studies from India remain limited. Female patients presenting with STEMI were older and had a higher prevalence of hypertension and DM, which is consistent with data from prior registry studies. Even after adjusting for these factors, female sex remained an independent predictor of in-hospital mortality and was associated with a 2-fold risk of mortality at 1 year compared with male sex. Only 16% of our population presenting for STEMI were female patients. The proportion of female patients in prior multicenter registry studies of ACS patients in India varies between 18% and 23%[7,16,20] (Supplemental Table 3). This finding contrasts with a global meta-analysis that demonstrated

FIGURE 3 **Sex Differences in Mortality in Patients With STEMI in India**



A multivariable Cox proportional hazards model was used to generate the survival curves demonstrating the difference in mortality between male patients and female patients presenting with STEMI to tertiary centers in Northern India. Relative to male patients, female patients were twice as likely to die at 1 year after follow-up (adjusted HR: 2.1; 95% CI: 1.7-2.7; $P < 0.0001$). Abbreviations as in Figures 1 and 2.

that female patients constituted ≤31% of all patients presenting with STEMI, which suggests that female patients are unable to access medical services in a timely manner compared with male patients.[29] These delays were attributed to misinterpretation of symptoms or lack of transport, which are modifiable factors. In the VIRGO (Variation in Recovery: Role of Gender on Outcomes of Young AMI Patients) study,[30] young female patients diagnosed with STEMI were more likely to present with chest pain, but also had an increased frequency of accompanying symptoms such as epigastric pain, shoulder, and jaw pain, compared with young male patients. Thus, physicians should have a low threshold for initiating ischemic evaluation in female patients (or male patients) who present with accompanying symptoms if they have a high cardiometabolic risk.[31]

These sex-related differences can be addressed using systems-based approach to STEMI care.[31] In 1 quality improvement trial that was implemented in a quaternary care center in the United States, implementation of standardized care bundles helped to improve the door-to-balloon time and increased rates of goal-directed pharmacotherapy in female patients with STEMI.[32] The initiative focused on decreasing the door-to-balloon time by ensuring immediate transfer to PCI-capable facilities, developing STEMI handoff lists, instituting standardized criteria for early triage to the catheterization laboratory, and a preference for a radial approach. This strategy resulted in significant improvements in in-hospital and 30-day mortality, especially in female patients. Similar strategies are urgently needed to improve outcomes in female patients with STEMI in India.

STUDY LIMITATIONS. Our study has certain limitations that must be considered while interpreting the results. Currently, patients were enrolled from 2 large tertiary PCI-capable centers located in a metropolitan city in Northern India. We do not have detailed information on patients with STEMI who were not transferred to our hospitals. Although we plan to recruit patients from additional centers in the future, present data may not be fully reflective of all management practices for STEMI in other Indian states or practice settings. The data analyzed were observational in nature and, despite the use of multivariate analysis, unmeasured confounders may be present. Additionally, clinical events were physician adjudicated, which

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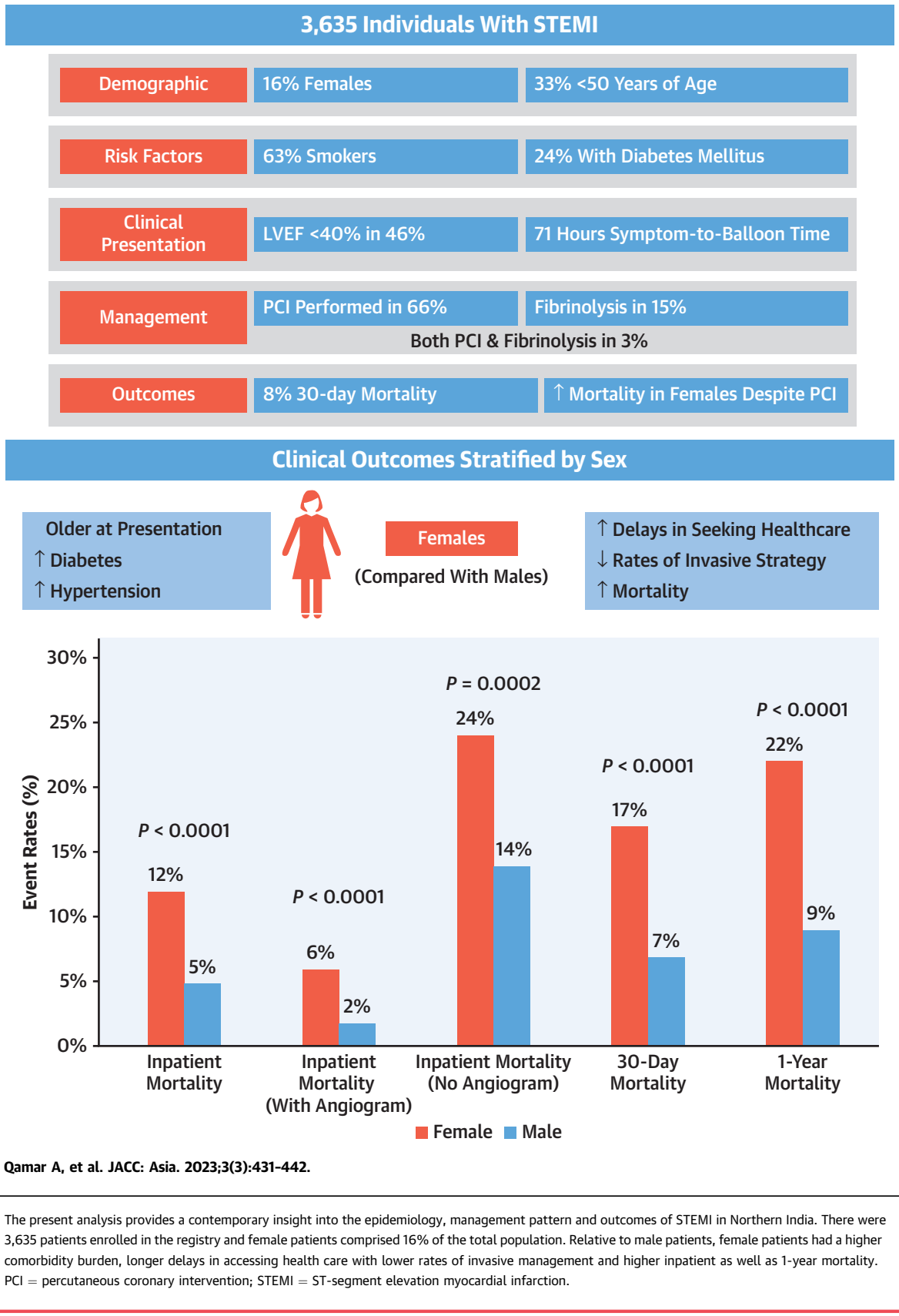
CENTRAL ILLUSTRATION **Risk Factors, Management, and Outcomes of Patients With STEMI in India**



Qamar A, et al. JACC: Asia. 2023;3(3):431–442.

The present analysis provides a contemporary insight into the epidemiology, management pattern and outcomes of STEMI in Northern India. There were 3,635 patients enrolled in the registry and female patients comprised 16% of the total population. Relative to male patients, female patients had a higher comorbidity burden, longer delays in accessing health care with lower rates of invasive management and higher inpatient as well as 1-year mortality.
PCI = percutaneous coronary intervention; STEMI = ST-segment elevation myocardial infarction.

makes our data susceptible to observer bias. Outcomes regarding hospital readmission were unavailable for many patients, leading to the loss of potentially significant clinical endpoints during follow-up. However, the results of this study provide contemporary data about STEMI care in India. Awareness of the deficiencies is the steppingstone for improving care and making it more equitable.

CONCLUSIONS

In this contemporary STEMI registry from India, more than one-third of patients were <50 years of age and the majority were smokers. There were significant delays in reperfusion, largely owing to transportation time to a PCI-capable center. Compared with male patients, female patients presenting with STEMI were older, had a higher burden of traditional risk factors, and sought care later. Female patients were less likely to undergo coronary angiography or PCI and had significantly higher mortality compared with male patients. Urgent strategies and synchronized efforts are needed to improve the outcomes of patients presenting with STEMI in India.

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PERSPECTIVES

COMPETENCY IN PATIENT CARE: Patients with STEMI in India continue to face significant delays in receiving timely reperfusion therapy. Compared with male patients, female patients are less likely to undergo coronary revascularization with PCI and have higher in-hospital and 1-year mortality rates.

TRANSLATIONAL OUTLOOK: The current study can provide information to guide future efforts aimed at improving clinical outcomes and sex differences in the care of patients with STEMI in India.

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KEY WORDS cardiovascular disease, disparities, female patients, sex differences, STEMI

APPENDIX For supplemental tables, please see the online version of this paper.