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Original Research Article

Sex-based differences in primary percutaneous coronary intervention for ST-elevation myocardial infarction: clinical and angiographic characteristics of women versus men at a Bangladeshi tertiary centre

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ABSTRACT

Background: Women with ST-elevation myocardial infarction (STEMI) receive reperfusion less often and later than men and may have different clinical profiles. Data on sex differences in primary percutaneous coronary intervention (PCI) remain scarce in South Asia. This study assessed the clinical and angiographic characteristics of women and men undergoing primary PCI for STEMI.
Methods: This retrospective observational study used a structured catheterisation-laboratory registry at the Department of Cardiology, Ibrahim Cardiac Hospital and Research Institute, Dhaka, Bangladesh. The study was conducted from January 2006 to December 2026. A total of 1,029 consecutive primary PCI procedures for STEMI recorded between 2006 and 2024 were included. Data were analysed using SPSS version 26.0.
Results: Women comprised 12.1% of the cohort and were older than men (58.2±11.2 vs. 54.5±10.8 years; p<0.001), with higher prevalence of diabetes (63.2% vs. 38.7%) and hypertension (60.0% vs. 39.0%; both p<0.001). Multivessel disease (46.4% vs. 44.5%; p=0.68), ejection fraction (46.8% vs. 46.3%; p=0.58), and adjusted association with multivessel disease (adjusted odds ratio 0.88, 95% CI 0.59-1.29) did not differ significantly. Women were less likely to have left anterior descending artery culprit lesions (40.3% vs. 50.6%; p=0.032) or total culprit occlusion (66.7% vs. 75.6%; p=0.037), but more often had reference vessels <3 mm (59.8% vs. 48.7%; p=0.035). Radial access predominated in both sexes.
Conclusions: Women undergoing primary PCI were older and had greater metabolic risk but no greater angiographic disease burden or worse ventricular function, suggesting that underrepresentation may relate to recognition, referral, and timely reperfusion access rather than disease extent.

Keywords: Percutaneous coronary intervention, ST-elevation MI, Sex-based differences

INTRODUCTION

ST-segment elevation myocardial infarction (STEMI) represents an acute coronary occlusion requiring immediate reperfusion to minimise irreversible myocardial injury and death. Contemporary guidelines recommend primary percutaneous coronary intervention (PPCI) as the preferred reperfusion strategy when it can be performed within 120 minutes of STEMI diagnosis, with rapid electrocardiographic diagnosis, catheterisation-laboratory activation and transfer to a PCI-capable centre forming the basis of effective STEMI systems of care.[1] Although PPCI has substantially improved survival, clinically important differences between women and men remain. A global meta-analysis of 56 studies involving 705,098 patients found that women constituted 31% of

STEMI cases, were older and had more comorbidities, while experiencing a 42.5-minute longer delay to first medical contact and a 4.9-minute longer door-to-balloon time than men. Women also had higher in-hospital mortality (OR 1.91), stroke (OR 1.67) and major bleeding (OR 1.82).[2] Sex-related differences are particularly important because women may reach the catheterisation laboratory with a different clinical risk profile. Evaluating local intervention outcomes, Cader et al. demonstrated that Bangladeshi women undergoing PCI carried a significantly higher burden of hypertension and diabetes compared to men, experiencing increased short-term adverse clinical events despite comparable procedural technical success.[3] A meta-analysis of 16 studies similarly reported that women undergoing PPCI were older, had more hypertension and diabetes, longer ischemic times and more shock at presentation; pooled analyses showed higher risks of in-hospital stroke (OR 1.69) and major bleeding (OR 2.04) in women, although excess mid-term mortality was not demonstrated.[4] The angiographic and procedural profile may also differ between women and men. In a large complex-PCI cohort of 20,419 patients, women had more cardiovascular comorbidity but slightly less anatomically complex coronary disease than men, with a lower mean SYNTAX score (19.5±10.3 vs. 20.6±10.7); nevertheless, unadjusted 1-year major adverse cardiovascular events were higher in women (14.0% vs. 11.6%).[5] Contemporary regional PCI data also demonstrate evolving practice trends regarding procedural delivery. In a national scoping review, Sazzad and Rahman observed a steady transformation in Bangladeshi tertiary care toward alternative vascular routes, reflecting growing institutional adoption of transradial access for coronary revascularization.[6] More recent Queensland registry data involving 2,747 PPCI-treated STEMI patients showed that women remained older (65.9 vs. 61.9 years) and had longer total ischemic time (69 vs. 52 minutes), with fewer achieving the <90-minute STEMI performance target (50% vs. 58%), although adjusted 30-day and 1-year cardiovascular mortality was not significantly attributable to female sex.[7] Evidence from regional settings further demonstrates why local evaluation is necessary. In a Bangladeshi study by Datta et al involving patients undergoing primary PCI, women presented with a significantly higher prevalence of diabetes and hypertension than men, experiencing greater rates of in-hospital adverse clinical events despite similar procedural success.[8] Conversely, a 2025 Swiss STEMI registry of 1,177 patients found that women had a longer first-medical-contact-to-reperfusion time (1.31 vs. 1.27 hours; p=0.035), higher rates of hypertension and renal insufficiency, whereas men had more diabetes, smoking and dyslipidaemia; importantly, 1- and 5-year clinical outcomes were comparable.[9] These contemporary findings reinforce that sex differences are not uniform and may vary according to population characteristics, healthcare systems, treatment pathways and coronary anatomy. Therefore, the present study aimed to assess the clinical and angiographic characteristics of women and men undergoing primary PCI for STEMI at a Bangladeshi tertiary centre.

METHODS

This retrospective observational study was conducted using a structured catheterisation laboratory registry maintained at the Department of Cardiology, Ibrahim Cardiac Hospital and Research Institute, Dhaka, Bangladesh, in which coronary procedures had been prospectively recorded since 2005. The study was conducted from January 2006 to December 2024. Severe coronary disease was defined as ≥70% stenosis in a major epicardial coronary artery or ≥50% stenosis of the left main coronary artery, while multivessel disease was defined as severe stenosis or total occlusion involving at least two of the left anterior descending, circumflex and right coronary arteries. The culprit vessel was assigned using a predefined hierarchy consisting of the structured target-vessel field, operative narrative, electrocardiographic infarct territory supported by angiography, and manual review when necessary. Chronic total occlusion was distinguished from acute occlusion according to documented chronicity; an acutely occluded culprit with collateral filling was retained as an acute occlusion. Premature coronary disease was defined as presentation before 45 years of age. Device calibre was extracted from intervention reports recording balloon and stent diameters and was considered an exploratory variable. Continuous variables were summarised as mean±standard deviation or median, as appropriate, and compared using the independent-samples t-test or Mann-Whitney U test. Categorical variables were presented as frequencies and percentages and compared using the chi-square or Fisher's exact test, as appropriate. The independent association between female sex and multivessel disease was evaluated using multivariable logistic regression adjusted for age, diabetes mellitus and hypertension. All tests were two-sided, and a p value <0.05 was considered statistically significant. Data were analysed using SPSS version 26.0, in accordance with the Declaration of Helsinki, with institutional ethical approval.

Inclusion criteria

All consecutive patients who underwent primary PCI for STEMI during the study period and whose procedures were designated by the treating operator as primary PCI for STEMI were included in the analysis.

Exclusion criteria

Procedures performed for indications other than STEMI, procedures not classified as primary PCI, and cases with insufficient or indeterminate data for the principal clinical, angiographic, or procedural variables required for analysis were excluded.

RESULTS

Women accounted for just 125 of the 1,029 primary PCI procedures (12.1%; Figure 1). They were, as a group, older than men (58.2±11.2 vs 54.5±10.8 years; p<0.001), and the age structure was shifted upward: only 8.8% of women were younger than 45 years compared with 17.5% of men, while 32.8% of women were at least 65 years old versus 19.7% of men. Diabetes was recorded in 63.2% of women against 38.7% of men, and hypertension in 60.0% against 39.0% (both p<0.001). Documented dyslipidaemia was numerically higher in women (11.2% vs. 6.6%; p=0.093), and no woman was recorded as a smoker compared with 3.9% of men (p=0.016), a contrast that mirrors regional smoking patterns in women and is compounded by incomplete documentation (Table 1).

Table 1: Age and risk factor burden by sex (n=1029).

Characteristics	Women (n=125)	Men (n=904)	P
Age (years)			
Mean ± SD	58.2±11.2	54.5±10.8	<0.001
Age <45 years, (%)	8.8	17.5	0.014
Age ≥65 years, (%)	32.8	19.7	0.001
Risk-factor burden			
Diabetes mellitus, (%)	63.2	38.7	<0.001
Hypertension, (%)	60.0	39.0	<0.001
Dyslipidaemia*, (%)	11.2	6.6	0.093
Current/ex-smoker*, (%)	0.0	3.9	0.016
LV ejection fraction, % (mean)	46.8 (n=54)	46.3 (n=403)	0.58

SD: standard deviation; LV: left ventricular; *Smoking and dyslipidaemia were under-recorded in the source registry and are shown as documented prevalence only. Age comparisons excluded one male record with an implausible recorded age. *p* values were obtained using the independent-samples *t*-test for continuous variables and chi-squared or Fisher's exact test for categorical variables, as appropriate.

Table 2: Angiographic and procedural characteristics by sex (n=1029).

Characteristics	Women (n=125) (%)	Men (n=904) (%)	P
LAD culprit	40.3	50.6	0.032
Multivessel disease	46.4	44.5	0.68
Angiographic thrombus	12.8	15.9	0.37
Culprit total occlusion	66.7	75.6	0.037
Radial access	87.2	91.5	0.12
Pre-dilatation	52.0	54.2	0.64
Post-dilatation	16.8	18.5	0.65
Largest device diameter, mm (median)	2.50	3.00	0.013
Reference vessel <3 mm	59.8	48.7	0.035

Statistical test: p-values were calculated using the chi-square test or Fisher's exact test for categorical variables, and the Mann–Whitney U test for largest device diameter (median).

Table 3: Association of sex with angiographic and left ventricular characteristics (n=1029).

Characteristics	Women (n=125)	Men (n=904)	P
Multivessel disease, (%)	46.4	44.5	0.68
Adjusted odds ratio for multivessel disease*	0.88 (95% CI: 0.59-1.29)	Reference	0.51
LV ejection fraction, % (mean)	46.8	46.3	0.58
LAD culprit, (%)	40.3	50.6	0.032
Culprit total occlusion, (%)	66.7	75.6	0.037

LV: left ventricular; LAD: left anterior descending; CI: confidence interval; *Adjusted for age, diabetes mellitus and hypertension; women were compared with men as the reference group.

Radial access was the norm in both sexes (women 87.2% vs. men 91.5%; p=0.12). Pre-dilatation (52.0% vs. 54.2%) and post-dilatation (16.8% vs. 18.5%) rates were closely matched. The devices used in women were of smaller calibre: a reference vessel below 3 mm was treated in 59.8% of women against 48.7% of men (p=0.035), and the median largest device diameter was 2.50 mm in women

versus 3.00 mm in men-a difference consistent with smaller body and vessel size (Table 2).

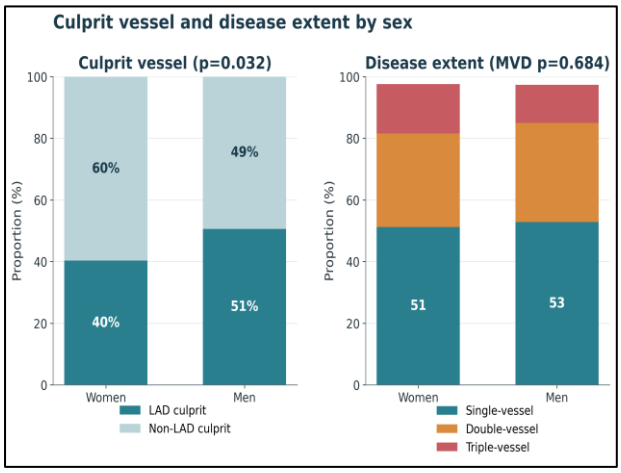


Figure 1: Culprit vessel and disease extent by sex. Women less often had a left anterior descending culprit, while the overall distribution of single-, double- and triple-vessel disease was similar between the sexes.

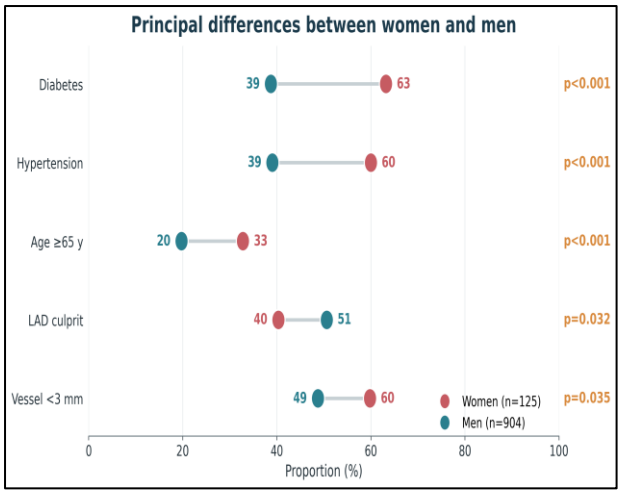


Figure 2: Principal differences between women and men, shown as paired points for each variable (women in red, men in teal) joined by a connector; the horizontal gap conveys the size of each difference, with the corresponding p-value at right.

Multivessel disease was present in 46.4% of women and 44.5% of men (p=0.68), and once age, diabetes and hypertension were taken into account, female sex bore no independent relationship to multivessel disease (adjusted odds ratio 0.88, 95% CI 0.59-1.29; p=0.51). Mean ejection fraction was likewise comparable (46.8% vs. 46.3%; p=0.58). Women were, however, less likely to have the left anterior descending artery as the culprit vessel (40.3% vs. 50.6%; p=0.032) and less likely to present with a totally occluded culprit (Table 3).

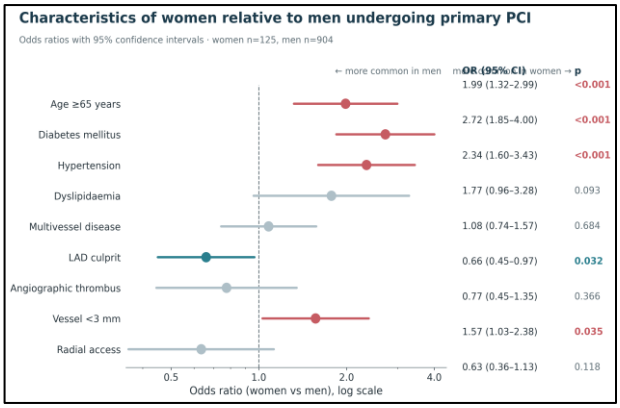


Figure 3: Odds ratios with 95% confidence intervals for clinical, angiographic and procedural features in women relative to men. Values above 1mark features more common in women, and below 1 those more common in men.

Relative to men, women were more than twice as likely to have diabetes (odds ratio 2.72, 95% CI 1.85-4.00), hypertension (2.34, 1.60-3.43) and to be at least 65 years old (1.99, 1.32-2.99), and were more likely to be treated in a vessel narrower than 3 mm (1.57, 1.03-2.38). In the opposite direction, women were less likely to present with a left anterior descending culprit (0.66, 0.45-0.97), whereas multivessel disease (1.08, 0.74-1.57) and angiographic thrombus (0.77, 0.45-1.35) did not differ by sex. The intervals for the risk-factor comparisons sit well to the right of unity, underlining the heavier comorbidity of the women who reach primary PCI (Figure 3).

DISCUSSION

In this retrospective analysis of 1,029 STEMI patients undergoing primary PCI, women constituted 12.1% of the cohort and had a distinctly higher clinical risk profile than men. This study showed that women were older (58.2±11.2 vs. 54.5±10.8 years; p<0.001), with a greater proportion aged ≥65 years (32.8% vs. 19.7%; p=0.001) and a lower proportion aged <45 years (8.8% vs. 17.5%; p=0.014). Diabetes (63.2% vs. 38.7%; p<0.001) and hypertension (60.0% vs. 39.0%; p<0.001) were also substantially more frequent in women, whereas documented smoking was lower (0% vs. 3.9%; p=0.016). Conrotto et al in their meta-analysis of 26 studies involving 98,778 patients, found that women were older and more frequently had hypertension, diabetes and hypercholesterolaemia, while men were more often smokers.4 Barthélémy et al. reported a mean age of 70±15 years in women versus 61±13 years in men, with hypertension in 56.0% versus 52.7% and current smoking in 26.9% versus 25.8%, respectively, among matched patients.[3] Similarly, Savage et al found women to be older than men (65.9±13.0 vs. 60.9±11.9 years) and less likely to have a smoking history.[10] Thus, this study's findings reproduce the established pattern of older age and greater cardiometabolic burden among women, although the markedly high diabetes prevalence in our female group

(63.2%) exceeds that reported in these Western cohorts. The angiographic findings indicate that greater comorbidity among women was not accompanied by more extensive coronary disease. Multivessel disease was present in 46.4% of women and 44.5% of men (p=0.68), and angiographic thrombus occurred in 12.8% and 15.9%, respectively (p=0.37). Yasmin et al studying 247 PCI-treated myocardial infarction patients in Pakistan, reported three-vessel disease in 7.4% of women versus 18.9% of men (p=0.013), while one-vessel disease occurred in 17.0% versus 19.6% (p=0.612).[8] Barthélémy et al likewise found multivessel disease in 46.7% of women and 48.9% of age- and diabetes-matched men (p=0.75).[3] These observations support the finding that female sex does not necessarily confer a greater angiographic disease burden despite a heavier risk-factor profile. Specific culprit-vessel characteristics nevertheless differed. In our cohort, LAD was the culprit artery in 40.3% of women compared with 50.6% of men (p=0.032), while total culprit occlusion occurred in 66.7% versus 75.6% (p=0.037). Barthélémy et al reported LAD culprit lesions in 40.7% of women and 48.9% of matched men, while right coronary involvement was higher among women (41.2% vs. 30.8%).[3] Another study also found a significant association between culprit artery and sex in STEMI (p=0.005), with LAD being the most frequent culprit in both sexes.[11] Therefore, our lower frequency of LAD involvement among women is consistent with documented sex-related differences in culprit-vessel distribution, although the exact pattern varies between populations. The procedural findings showed no significant sex difference in radial access (87.2% vs. 91.5%; p=0.12), pre-dilatation (52.0% vs. 54.2%; p=0.64) or post-dilatation (16.8% vs. 18.5%; p=0.65). In contrast, women received smaller devices, with a median largest diameter of 2.50 versus 3.00 mm (p=0.013), and more often had reference vessels <3 mm (59.8% vs. 48.7%; p=0.035). Kosmidou et al analysing more than 32,000 PCI-treated lesions, similarly found smaller reference vessel diameters in women (2.67±0.60 vs. 2.80±0.67 mm; p<0.0001) and fewer complete occlusions before PCI (9.1% vs. 11.7%).[12] Barthélémy et al reported radial PCI in 81.3% of women versus 90.1% of men (p=0.024) and mean stent diameter of 2.8±0.4 versus 2.9±0.5 mm, respectively.[3] Our higher overall radial-use rate and absence of a significant access difference may reflect increasing contemporary adoption of radial PCI. This study further clarifies the relationship between sex and angiographic burden. After adjustment for age, diabetes and hypertension, female sex was not independently associated with multivessel disease (adjusted OR 0.88, 95% CI 0.59-1.29; p=0.51), despite the crude prevalence of 46.4% versus 44.5%. Mean LV ejection fraction was also virtually identical (46.8% vs. 46.3%; p=0.58). This interpretation is consistent with Barthélémy et al., who found that female sex was not independently associated with mortality after adjustment (OR 1.01, 95% CI 0.55-1.87; p=0.97), despite women having a higher baseline-risk profile.[3]

Limitations

This work is retrospective and confined to one centre, and the female subgroup, though informative, is modest (n=125), which limits power for the smaller contrasts. Because the size of the underlying STEMI population is unknown, the female share reflects those treated rather than true incidence. Smoking and dyslipidaemia were under-documented in the source records. The device field combines balloon and stent sizes, so calibre metrics are exploratory. Outcome, timing and complication data were not reliably captured, precluding any prognostic comparison.

CONCLUSION

Across nearly two decades of primary PCI at this Bangladeshi centre, women were markedly under-represented and, when treated, were older and more comorbid than men despite comparable disease extent and ventricular function. The findings are consistent with a sex disparity in access to timely reperfusion and make the case for focused efforts to improve the recognition and referral of women with STEMI.

Recommendations

Targeted measures should be implemented to improve early recognition, referral and timely access to primary PCI among women with STEMI. Sex-specific awareness among healthcare providers and patients, alongside streamlined referral pathways and equitable STEMI care protocols, may help reduce delays and improve access to reperfusion for women.

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