Original Article
DOI: https://doi.org/10.70749/ijbr.v3i1.573

INDUS JOURNAL OF BIOSCIENCE RESEARCH
https://induspublishers.com/IJBR
ISSN: 2960-2793/ 2960-2807

# Gender Differences in Outcomes of ST Elevation Myocardial Infarction undergoing Primary Percutaneous Coronary Intervention

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## ARTICLE INFO

**Keywords**

STEMI, PPCI, Gender Disparities, Outcomes, Pakistan.

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**Declaration**

**Author's Contributions:** All authors equally contributed to the study and approved the final manuscript.
**Conflict of Interest:** No conflict of interest.
**Funding:** No funding received by the authors.

**Article History**

Received: 28-11-2024
Revised: 10-01-2025
Accepted: 23-01-2025

## ABSTRACT

**Introduction:** Despite the growing use of technology and clinical process improvement initiatives in the field of cardiology, particularly on the utilization of PPCI, the number of STEMI and its results by gender have remained unchanged. There are always disparities where women receive their treatments later than men and have poorer results than men. **Objectives:** To compare the clinical outcome, complications, and procedural success of STEMI patients across gender and evaluate the difference in gender for PPCI in a hospital setting in Pakistan. **Materials and Methods:** This hospital-based, observational study reviewed 300 patients with STEMI who underwent PPCI for six months. The collected demographic characteristics, procedural data points, and longitudinal results were compiled and compared for sexually dimorphic analyses. **Results:** Compared to male patients, female patients were younger, had more comorbids, and experienced longer delays to PPCI. Bleeding and in-hospital mortality increased in women through procedural complications. Multivariate analysis also showed that age and late PPCI are predictors of adverse outcomes in female patients. **Conclusion:** The outcomes of STEMI for men and women remain significantly different, and gender considerations should be maintained when considering optimal interventions, awareness, and equal treatment for both genders.

## INTRODUCTION

The rationale of this study is concerned with the significant topic of gender disparities in the prognosis of STEMI patients treated with PPCI. STEMI, which is a result of a total occlusion of a coronary artery, becomes an emergent condition for which reperfusion needs to be achieved to prevent further myocardial ischemia. PPCI is still the recommended approach and superior to thrombolytic therapy in terms of reduction of mortality and improvement of clinical outcomes. Despite the progress in interventional cardiology, there are still significant differences between genders when it comes to this disease and its further treatment. A few literature have clearly indicated that women are more prone to cardiovascular diseases, and most of them present with different symptoms, which deters diagnosis and treatment (2). The consequences of these delays are significant, given the critical role of early PPCI in decreasing mortality and enhancing post-procedure outcomes. Savage et al. (1) revealed that women with STEMI often face more time to treatment with PPCI in comparison with men, which may result in poorer outcomes. Additionally, demographic variations such as sex differences in cardiovascular structure and function whereby women have smaller coronary vessel diameters and higher prevalence of microvascular dysfunction may negate the utility of PPCI and expose women to adverse events (3).

Current studies show how it is crucial to study these differences regarding gender to enhance clinical practices and healthcare practices. Additionally, Sulaiman et al. (2) noted that women are more likely to experience PPCI-related problems including bleeding and stent thrombosis. Such conclusions were upheld by Afaque et al. (3), who compared the clinical characteristics and prognosis of male and female Pakistani patients and stated that female patients are older and have more diseases, including diabetes and hypertension. This demographic difference may further

intensify already existing differences in outcomes. In this context, Greco and Capodanno (4) pointed out that women may present various patterns of response to stent implantation, with a greater hazard ratio for restenosis and stent thrombosis, which probably requires distinct therapeutic approaches. Heydari et al. (5) supported these assertions when they pointed out increased complications among women who underwent primary percutaneous coronary angioplasty. More importantly, the study's results highlight the need to adopt gender-sensitive policies in the management of STEMI.

Large-scale investigations and meta-analyses offer further insights regarding such disparities. Shah et al. (6) also reported a systematic review of differences in in-hospital treatment and outcomes with STEMI patients, where women were inherently disadvantaged than men. Among the findings, the work pointed out that women are disadvantaged when it comes to receipt of guideline-directed therapies, including timely PPCI and optimal medical management. Such differences are magnified by social-cultural aspects of disease disparities, especially in the utilization of health care services and health promotion, especially in the developing countries of the region, such as Pakistan (7). The disparities of pre-hospital delays are another crucial area that affects the results. Stehli et al. (9) further reported a sexual dimorphism in the time spent before seeking medical help as well as transport to the health care facilities. It is evident that women were likely to experience long hours of delay because this directly affected the success of PPCI. This delay could explain why Li et al. (10) noted that gender differences in biomarkers, including D-dimer, are associated with worse in-hospital outcomes in women. Such findings stress the complex nature of gender differences in STEMI outcomes.

More specifically, emerging research has started to investigate the complex interrelationships between biological and clinical characteristics and procedures that underlie these disparities. Milan et al. (7) and Takeji et al. (11) showed that though men and women receive similar successful procedures of PPCI, female patients have a higher risk of heart failure and mortality in the long run. This is in accordance with Kuehnemund et al.'s (12) cross-sectional study in Germany, which showed that male and female patients presented with equal AMI rates, but their management and outcomes significantly differed. Moreover, there is evidence that females are at higher risk of both major early and longer-term consequences, including stent thrombosis and bleeding. Dillinger et al. (13), reviewing the data of the TAO trial, reported that women are at higher risk of bleeding, which means that caution should be taken while choosing anticoagulation. Similarly, Kumar et al. (15) report higher short-term major adverse cardiovascular events rates in women who underwent PPCI in Pakistan. These outcomes highlight the concerns for clinicians to extend individualized care approaches in managing STEMI patients, especially focusing on factors such as gender differences.

These differences are crucial to comprehend, especially in low and middle-income countries such as Pakistan, whose health care system and availability of resources differ from that of developed countries. Tung et al. (14) emphasized that young people are also diverse in STEMI treatment and care in such formal environments, thus adding some confounding factors to the gender issue. Jamal et al. (8) further pointed out that gender modulates the long-term prognosis of STEMI regardless of the high end of interventional cardiology services. Thus, exploring gender differences in the outcomes of STEMI treated by PPCI is one of the most significant research agendas with important practical relevance. To eliminate these disparities, timely diagnosis, equal access to care, and sensitive gender approaches should be applied. This study also intends to add new data to the existing literature regarding these disparities in the Pakistani population, which can help in increasing the knowledge regarding the distinct ways of management of STEMI in men and women.

### Objective

The aim of the present study is to examine gender disparities in the treatment, clinical prognosis, and results of patients with ST-elevation myocardial infarction managed with primary percutaneous coronary intervention at a large tertiary care teaching hospital in Pakistan.

## MATERIALS AND METHODS

**Study Design:** The current research utilized observational retrospective research to compare the impact of STEMI interventional treatment with PCI on both sexes. Account data covered clinical and procedural success and adverse event outcomes that were retrieved from medical records.

**Study Setting:** This research work was conducted at the Cardiology Department, Pakistan Institute of Medical Sciences (PIMS) in Islamabad.

**Duration of the Study:** The data were retrieved for the six months from June to November of 2024 for the patients who have undergone PPCI in this duration.

### Inclusion Criteria

The target population was adult patients who were eighteen years old or above, diagnosed with STEMI with ECG and clinical characteristics, and who had undergone PPCI in the first twelve hours of the manifestation of STEMI. Moreover, to evaluate the safety of the procedure, data only from patients with complete medical history, angiogram information, and follow-up were included. With this approach, there was a way of ascertaining that only those patients who

actually underwent the procedure of PPCI as outlined were actually being analyzed, thus making the comparison of the given results by gender group much more valid.

### Exclusion Criteria

The potential sources of patient selection bias were addressed by excluding patients with missing data on the main predictors or those who received thrombolytic therapy rather than PPCI. Patients who had gone through CABG or patients with other serious clinical illnesses, such as cancer or severe renal illness, were also excluded. However, the patients who came to the hospital after 12 hours of the onset of the symptoms and patients with NSTEMI were excluded to ensure that the participants were similar and equal in the sample.

### Methods

The current cross-sectional exploratory study was conducted based on the optimized self-reported questionnaires arrived at from the medical records of STEMI patients who underwent PPCI at the Cardiology Department, Pakistan Institute of Medical Sciences (PIMS) in Islamabad. The collection of the data was done for half a year, from June to November of the given specific year 2024. These patients were clinically diagnosed with ST-segment elevation myocardial infarction, and the primary PCI was done within the first 12 hours since the onset of symptoms. The patient demographics, diagnoses, procedures and other features, in-hospital mortality and other adverse events were retrieved from the medical records. This included age, gender, time to PPCI, angiographic coronary artery disease severity, procedural success, and complications, which included bleeding, stent thrombosis and mortality rate in the hospital. Both qualitative and cross-sectional analysis was applied to capture the clinical condition, management as well as the complication involving the male and female patient populations. Descriptive statistics were used to present socio-demographic and clinical characteristics, while independent samples t-test and chi-square test were used for comparing categorical and continuous variables. To minimize the effect of other variables, gender differences in STEMI outcomes were examined in multivariate logistic regression analysis, controlling for age and co-morbidities.

## RESULTS

The study sample involved 300 patients who had ST elevation myocardial infarction and had undergone PPCI, of which 180 (60%) were males and 120 (40%) were females. The mean age of the patients of the cohort was 55.6±12.3 years, and female patients attended the clinic at an older age as compared to male patients [Mean = 60.2±11.8, Mean = 52.4 ±12.6 ($p< 0.01$). Hypertension and diabetes were found to be more common in women than in men, and a history of smoking was seen as more common in men than in women at baseline.

**Table 1**

*Baseline Characteristics of Study Population*

| Characteristic | Men (n=180) | Women (n=120) | p-value |
|---|---|---|---|
| Mean Age (years) | 52.4 ± 12.6 | 60.2 ± 11.8 | <0.01 |
| Hypertension (%) | 45.5 | 67.5 | <0.01 |
| Diabetes Mellitus (%) | 30.2 | 52.3 | <0.01 |
| Smoking History (%) | 65.8 | 15.4 | <0.01 |

Analyzing the procedural metrics, it has been stated that the door-to-balloon time was higher in females as compared to males (55±12 mins vs. 47± 10min, $P < 0.01$). However, as shown in Table 2, angiographic success is almost identical, with no significant difference between the two groups (97% for men vs 95% for women $p = 0.42$). Nonetheless, factors such as bleeding were major concerns among women as compared to men with complications.

**Table 2**

*Procedural Metrics and Outcomes*

| Metric/Outcome | Men (n=180) | Women (n=120) | p-value |
|---|---|---|---|
| Door-to-Balloon Time (min) | 47 ± 10 | 55 ± 12 | <0.01 |
| Angiographic Success (%) | 97 | 95 | 0.42 |
| Bleeding Complications (%) | 5.2 | 12.8 | <0.01 |

The mortality rate within the hospital setting was notably higher in female patients (10 %) as opposed to males (5%, $p = 0.03$). Women also experienced more often the severe adverse cardiovascular events (SAEV), including reinfarction and heart failure. Regression analysis was used in the statistical study, and the results showed that delayed PPCI and increased age were significant predictors of negative results for women.

**Table 3**

*In-Hospital Outcomes*

| Outcome | Men (n=180) | Women (n=120) | p-value |
|---|---|---|---|
| In-Hospital Mortality (%) | 5 | 10 | 0.03 |
| MACE (%) | 7.3 | 15.2 | <0.01 |
| Heart Failure (%) | 9.5 | 18.4 | <0.01 |

Collectively, the findings have demonstrated a suboptimal prognosis for women with STEMI and worse PCI outcomes when compared to male patients. These results highlight the importance of further efforts to eliminate these disparities and better treatment, such as minimising the time to diagnosis and the management of patients in the post-procedure period for women.

## DISCUSSION

The results of this study show an increased mortality rate among women patients who have undergone ST-elevation myocardial infarction (STEMI) and primary percutaneous coronary intervention (PPCI). These differences include gender distribution, procedural

aspects, and clinical events during the index hospitalization and after STEMI management. The mean age of women was significantly higher than that of men and this could be due to female hormones, which make women more protected against cardiovascular diseases before reaching menopausal age. This presentation at a comparatively older age is associated with increased comorbid conditions such as hypertension and diabetes conditions, which were more rampant among women in the present study. These factors may explain the difference in the result, as it is known that coexisting diseases often make STEMI treatment more challenging and may lead to unfavourable outcomes (3, 6).

Another serious cause of gender differences was prehospital delays. In other words, the overall door-to-balloon time was longer in women in terms of delay time in seeking medical help and receiving the PPCI. In relation to this, Stehli et al. (9) similarly observed that female patients particularly fail to identify signs of myocardial infarction and seek treatment early. Prolonged time to reperfusion increases myocardial damage and could be the reason for worsening outcomes among women as compared to men. Teaching women about the signs of STEMI is crucial to reducing these gaps, considering awareness creating educational campaigns. Procedural characteristics were also different depending on the gender. This was despite attaining similar levels of revascularisation as male patients. Women had a higher risk of periprocedural adverse events such as bleeding and stent thrombosis. As pointed out by Greco and Capodanno (4), women are likely to have smaller vessels and higher levels of endothelial dysfunction. Dillinger et al. (13) also pointed out that increased bleeding risk in women may be due to unequal representation of women during anticoagulant therapy studies. This emphasizes the fact there is a need to develop a personalized approach to anticoagulation for female patients undergoing PPCI.

The present finding of elevated in-hospital mortality and incidence of MACE supports the previous work of other researchers (7, 12). The cause of a higher risk of developing a heart failure in women could be due to a delay in seeking treatment and the presence of other diseases. Secondly, the female gender entails a later presentation time and worse cardiac function during a myocardial infarction, which can lead to a less favorable prognosis (8, 15). This study revealed that multiple variables affect the outcomes of female patients – the results of multivariate analyses also included PPCI delay and increased age of patients. Such outcomes may also be due to gender disparities in the use of and access to health care services. Shah et al. (6) showed that women are not only less likely to undergo timely PPCI but also have inferior rates of evidence-based therapy for STEMI, including guideline-directed medical therapies. This variation could be due to differences in perception between the clinicians when making decisions or patients' attitudes to their health. Thus, in resource-scarce environments such as Pakistan, these disparities can be magnified by, on top of the socio-cultural restraints, most reproductive-aged women are both financially and socially restricted from accessing health care services.

To overcome these disparities, they need to be addressed from different angles. First, raising the public's knowledge of signs of STEMI, especially among females, and avoiding long waiting times before seeking medical assistance is essential. Second, the gender issue is considered crucial in the process of shaping the healthcare systems to improve patients' timely and effective access to care. This includes issues such as time to PPCI and guideline-directed medical therapy. Moreover, there is a necessity for the integration of the data on risk factors and complications associated with gender into the clinician's training concerning STEMI treatment. The therapies also need specific targeted interventions for women to improve the results of the therapies (4, 13). Intravascular ultrasound (IVUS) and optical coherence tomography (OCT) can help improve the deployment of the stents and decrease restenosis risk in women with smaller calibre coronary arteries.

Researches which focus on the effect of sex hormones and genetic and psychosocial factors on STEMI outcomes may be useful. Furthermore, future large-scale intervention trials with sufficient numbers of female participants are required to replicate the results and inform gender-sensitive clinical management. This work adds to the existing literature on the impact of gender on STEMI prognosis, specifically in Pakistan. It re-emphasizes the imperative to develop country or region-specific solutions to these disparities owing to the differences in socio-cultural context and health care systems in developing countries. For example, the enhancement of health centers, especially in the rural regions of the world, and the incorporation of community-based approaches may be useful in closing the gender divide in STEMI treatment. Finally, the inequality that has been identified in this work underlines the need for further efforts to enhance STEMI management in women. Clinicians and policymakers need to focus on pre-hospital time delays, procedural complications and barriers to accessing healthcare in an effort to reduce gender disparities that exist in the management of STEMI.

## CONCLUSION

This paper reveals gender-related differences in the prognosis of STEMI patients treated with PPCI. Regarding patient characteristics, women were older, had more comorbidities like hypertension and diabetes, and had longer times to PPCI compared to men. In terms

of angiographic success, women had similar results to men but suffered higher levels of procedural complications, including bleeding, and poorer hospital outcomes such as mortality and major adverse cardiovascular events. Such differences outlined make it imperative to conduct gender-wise STEMI intervention measures such as gender-sensitive prehospital delay and awareness, gender-sensitive management of risks affecting different genders, and gender-equitable access to the treatment. It is important that these problems are solved so that women with STEMI can also benefit from cardiovascular advancement. Thus, future work should address these questions in order to elucidate the nature of these disparities more effectively.

## REFERENCES

1- Savage, M., Hay, K., Murdoch, D., Walters, D. L., Denman, R., Ranasinghe, I., & Raffel, C. (2022). Sex differences in time to primary percutaneous coronary intervention and outcomes in patients presenting with ST-segment elevation myocardial infarction. *Catheterization and Cardiovascular Interventions*, *100*(4), 520-529. https://doi.org/10.1002/ccd.30357

2- Sulaiman, S., Kawsara, A., Mohamed, M. O., Van Spall, H. G., Sutton, N., Holmes, D. R., Mamas, M. A., & Alkhouli, M. (2021). Treatment effect of percutaneous coronary intervention in men versus women with ST-segment–elevation myocardial infarction. *Journal of the American Heart Association*, *10*(18). https://doi.org/10.1161/jaha.121.021638

3- Afaque, S. M., Muhammad, A. S., Kumar, M., Aamir, K. F., Ahmed, A., Soomro, N. A., Karim, M., & Ashraf, T. (2021). Gender-based differences in clinical profile and outcome of primary percutaneous coronary intervention in patients with St-segment elevation myocardial infarction. *Pakistan Heart Journal*, *54*(3), 254-260. https://doi.org/10.47144/phj.v54i3.2167

4- Greco, A., & Capodanno, D. (2021). Differences in coronary artery disease and outcomes of percutaneous coronary intervention with drug-eluting stents in women and men. *Expert Review of Cardiovascular Therapy*, *19*(4), 301-312. https://doi.org/10.1080/14779072.2021.1902806

5- Heydari, A., Zahergivar, A., Izadpanah, P., Aquino, G., & Burt, J. R. (2021). Role of gender on the outcomes of ST-elevation myocardial infarction patients following primary coronary angioplasty. *Cureus*. https://doi.org/10.7759/cureus.17892

6- Shah, T., Haimi, I., Yang, Y., Gaston, S., Taoutel, R., Mehta, S., Lee, H. J., Zambahari, R., Baumbach, A., Henry, T. D., Grines, C. L., Lansky, A., & Tirziu, D. (2021). Meta-analysis of gender disparities in in-hospital care and outcomes in patients with ST-segment elevation myocardial infarction. *The American Journal of Cardiology*, *147*, 23-32. https://doi.org/10.1016/j.amjcard.2021.02.015

7- Milan, V. B., Alves, Y. F., Machado, G. P., Araujo, G. N., Krepsky, A. M., Chies, A., Niches, M., Fracasso, J., Goncalves, S. C., Wainstein, M., & Polanczyk, C. A. (2023). Diferenças entre OS Sexos nos Desfechos de Pacientes com Infarto do Miocárdio com Supradesnivelamento do Segmento ST Submetidos a Intervenção Coronária Percutânea Primária. *Arquivos Brasileiros de Cardiologia*, *120*(6). https://doi.org/10.36660/abc.20220673

8- Jamal, J., Idris, H., Faour, A., Yang, W., McLean, A., Burgess, S., Shugman, I., Wales, K., O'Loughlin, A., Leung, D., Mussap, C. J., Juergens, C. P., Lo, S., & French, J. K. (2022). Late outcomes of ST-elevation myocardial infarction treated by pharmaco-invasive or primary percutaneous coronary intervention. *European Heart Journal*, *44*(6), 516-528. https://doi.org/10.1093/eurheartj/ehac661

9- Stehli, J., Dinh, D., Dagan, M., Duffy, S. J., Brennan, A., Smith, K., Andrew, E., Nehme, Z., Reid, C. M., Lefkovits, J., Stub, D., & Zaman, S. (2021). Sex differences in prehospital delays in patients with ST-segment–elevation myocardial infarction undergoing percutaneous coronary intervention. *Journal of the American Heart Association*, *10*(13). https://doi.org/10.1161/jaha.120.019938

10- Li, L., Wang, W., Li, T., Sun, Y., Gao, Y., Wang, L., & Yao, H. (2021). Gender-related difference in D-dimer level predicts in-hospital heart failure after primary PCI for ST-segment elevation myocardial infarction. *Disease Markers*, *2021*, 1-8. https://doi.org/10.1155/2021/7641138

11- Takeji, Y., Morimoto, T., Shiomi, H., Kato, E. T., Imada, K., Yoshikawa, Y., Matsumura-Nakano, Y., Yamamoto, K., Yamaji, K., Toyota, T., Tada, T., Tazaki, J., Yamamoto, E., Nakatsuma, K., Suwa, S., Ehara, N., Taniguchi, R., Tamura, T., Watanabe, H., … Kimura, T. (2023). Sex differences in clinical

outcomes after percutaneous coronary intervention. *Circulation Journal*, *87*(2), 277-286. https://doi.org/10.1253/circj.cj-22-0517

12- Kuehnemund, L., Koeppe, J., Feld, J., Wiederhold, A., Illner, J., Makowski, L., Gerß, J., Reinecke, H., & Freisinger, E. (2021). Gender differences in acute myocardial infarction—A nationwide German real-life analysis from 2014 to 2017. *Clinical Cardiology*, *44*(7), 890-898. https://doi.org/10.1002/clc.23662

13- Dillinger, J., Ducrocq, G., Elbez, Y., Cohen, M., Bode, C., Pollack, C., Petrauskiene, B., Henry, P., Dorobantu, M., French, W. J., Wiviott, S. D., Sabatine, M. S., Mehta, S. R., & Steg, P. G. (2021). Sex differences in ischemic and bleeding outcomes in patients with non–st-segment–elevation acute coronary syndrome undergoing percutaneous coronary intervention. *Circulation: Cardiovascular Interventions*, *14*(1). https://doi.org/10.1161/circinterventions.120.009759

14- Tung, B. W., Ng, Z. Y., Kristanto, W., Saw, K. W., Chan, S., Sia, W., Chan, K. H., Chan, M., Kong, W., Lee, R., Loh, J. P., Low, A. F., Poh, K. K., Tay, E., Tan, H. C., Yeo, T., & Loh, P. H. (2021). Characteristics and outcomes of young patients with ST segment elevation myocardial infarction undergoing primary percutaneous coronary intervention: Retrospective analysis in a multiethnic Asian population. *Open Heart*, *8*(1), e001437. https://doi.org/10.1136/openhrt-2020-001437

15- Kumar, A., Kumar, R., Mujtaba, M., Ahmed, R., Rahooja, K., Rasool, G., Talpur, M. F., Ali, A., Basit, A., Samad, M., Yaqoob, S., Siddiqui, M. N., Wadhwani, A., Kumar, Y., & Raja, R. (2022). Association of gender with stent thrombosis and short-term major adverse cardiovascular events in patients undergoing primary percutaneous coronary intervention. *Pakistan Heart Journal*, *55*(3), 218-223. https://doi.org/10.47144/phj.v55i3.2306