Gender Differences among Patients with ST-Elevation Myocardial Infarction (STEMI) Undergoing Primary Percutaneous Coronary Intervention: A Prospective Study

Mohamed El Bordy*, Gamal Abdel Hady*, Ihab Yassin**

*Assistant professor, **Fellow, cardiovascular medicine department, National Heart Institute, Egypt

***Corresponding** Author: Mohamed El Bordy**,** Assistant professor, National heart Institute, Egypt

Abstract

Objectives: To examine the effect of gender on the differences in risk factors, demographic characteristics, and the in-hospital outcomes of primary percutaneous coronary intervention (pPCI) in patients with ST-elevation AMI (STEMI).

Methods: The current study was a prospective cohort non consecutive study that recruited 211 patients with STEMI manifestations presenting to the cardiac intensive care units (CICU) and had pPCI in National Heart Institute. The primary endpoint in our study was the measurement of major adverse cardiovascular and cerebrovascular events (MACCE).

Results: Our study included 200 patients (100 patients for each gender). The association analysis showed that female patients were significantly older than male patients (59.86 ± 10.7 versus 52.56 ± 10.02 years old; p <0.001). In addition, female patients were less likely to be smokers, diabetic, and/or hypertensive (p <0.001). The number of risk factors per patient was significantly higher among males (p =0.002). With regard to number of affected vessels, male patients were more likely to have higher number of multi-vessel affection (p <0.001). The stented area length was longer in female patients (p =0.008). The female patients were more likely to have TIMI flow 3 than male patients (83 % versus 60%; p <0.001). On the other hand, no significant association was detected between gender and mortality (p =0.45).

Conclusion: Overall, female patients had less severe presentation of STEMI. However, gender appears to have no impact on clinical outcomes of STEMI patients undergoing pPCI.

Keywords: Myocardial infarction; STEMI; Gender; Primary PCI

{**Citation:** Mohamed El Bordy, Gamal Abdel Hady,Ihab Yassin. Gender differences among patients with ST-Elevation Myocardial Infarction (STEMI) undergoing primary percutaneous coronary intervention: A prospective study. American Journal of research Communication, 2021, Vol 9(2): 11-29} www.usa-journals.com, ISSN: 2325-4076.

Introduction

Cardiovascular disorders are a leading cause of mortality and morbidity, affecting over 18 million patients worldwide [1]. These disorders produce complications, disabilities, and diminished productivity making them a major challenge to the healthcare system [2]. In the third report: The World Health Organization (WHO) predicted the annual deaths from cardiovascular disorders to reach 25 million by 2020 [3]. Acute myocardial infarction (AMI) is the most frequent cause of death among cardiovascular disorders, accounting for over 15% of global deaths [1,4]. In AMI: myocardial cells start to die as a result of prolonged myocardial ischemia, which finally develops the histological cell death within 20 minutes or less [5].

Complete necrosis needs around 2-4 hours, or longer, to emerge [6]. This variation depends on the efficiency of collateral circulations, the character of coronary arterial occlusion, the responsiveness of the myocardial cells to ischemia, and the body's demand for oxygenation and nutrients [7]. For the sake of urgent intervention: patients with AMI

either designated as having ST-elevation myocardial infarction (STEMI) or non-ST elevation myocardial infarction (NSTEMI) depending on their ECG findings [2]. Previous clinical trials reported a promising role of primary percutaneous coronary intervention (pPCI) in STEMI, showing lower mortality and lower rates of recurrence when compared to the traditional fibrinolytic therapy [8].

In STEMI: several studies reported different characteristics between males and females [9]. For instance, higher mortality usually recognized in females, as well as older age, higher prevalence of modifiable risk factors -such as smoking, obesity, and hypertension-, and also women show more severe symptoms [9–12]. However, other studies show no significant influence of gender on the prognosis of acute coronary syndromes (ACS) [13,14]. Literature also suggests that ACS female patients in developed countries receive more conservative care than males, fewer hospitalizations, fewer fixed therapies, and fewer PCIs [15,16]. Hence, recent investigations considered the out-of-hospital settings and showed a significant gender disparity in AMI management [17,18].

While the role of gender in AMI is still controversial in the developed world, it has an unclear evaluation in the developing countries. Accordingly, our study aims to examine the differences in risk factors, demographic characteristics, and the in-hospital outcomes of pPCI by gender in patients with STEMI.

Material and Methods

We adhered to the recommendations of the Declaration of Helsinki and the guidelines of good clinical practice (GCP) throughout the study's procedures, which did

not violate any of the relevant local regulatory laws. All eligible patients were included only after signing the written informed consents by themselves or first-degree relatives. We followed STROBE statement during the preparation of this manuscript.

Study Design and population

The current study was a prospective cohort non consecutive study that recruited 200 patients (100 for each gender) diagnosed with STEMI and presented to the cardiac intensive care units (CICU) for pPCI in National Heart Institute. The admission of STEMI patients was based on criteria of the American College of Cardiology (ACC) (within 12 hours of acute STEMI). We excluded patients with any of the following: previous history of CABG or PCI; patients with old MI patients admitted for other illness; and/or patients presenting with cardiogenic shock. We adopted non-probability, consecutive, sampling technique to recruit eligible patients. The procedures were implemented following the local practice and at investigator consideration.

All the patients in our study were supjected to coronary angiography and pPCI according to angiographic finding.

Data Collection and Follow-up:

The subsequent data were obtained from every eligible patient:

- Demographic characteristics including age, sex, family history, cardiac risk factors, and previous AMI.
- Onset of AMI, duration before admission, and initial management of AMI
- Findings of general and local examinations
- Routine laboratory investigations

- ECG findings
- Angiographic characteristics
- Rate of intraoperative and immediate postoperative complications

Study Endpoints:

The primary endpoint in our study was the measurement of major adverse cardiovascular and cerebrovascular events (MACCE), described as in-hospital all-cause death, AMI, or ischemic stroke. Secondary outcomes involved complete heart block, sudden cardiac arrest, and cardiogenic shock.

Analysis of Results

The statistical analyses were employed using SPSS software (Statistical Package for the Social Science; SPSS Inc., Chicago, IL, USA) version 22 for Microsoft Windows. The mean ±standard deviation (±SD) or median with interquartile range (IQR) were used to describe numerical variables according to the normality of the data. Frequencies with percentages were applied to present categorical variables. The association between quantitative variables was examined using unpaired Student's t-test for normally distributed data or Mann-Whitney Rank Sum test for non-normally distributed data. The Chi-square test was implemented to identify the level of significance for categorical variables. The level of significance was set at a probability critical value (p-value) lower than 0.05.

Results

A total of 200 non consecutive patients were included during the study period with a mean age of 56.52 ± 10.99 years old. The majority of patients were females. The most commonly encountered risk factors for coronary heart diseases were smoking (33.5%), hypertension (45.5%), and diabetes (34.5%). Almost 31% of the patients had two risk factors and 5% had three or more risk factors. Only two patients had family history of STEMI. The mean systolic blood pressure at admission was 120.26 ± 15.15mmHg. Nearly 57% of the patients had anterior infarction and 41% had inferior infarction. The left anterior descending artery was the most commonly affected artery (72%), followed by right coronary artery (41%) and left circumflex artery (29%). The average length of stented area was 34.66 ± 15.78 mm. (**Table 1**) The Nearly 39.5% of the patients had only one vessel affected, 39% had two vessels, and 21% had three vessels affected. The distribution of TIMI flow was as the following: 0 (6.5%), 1 (13.5%), 2 (8.5%), and 3 (72.5%; Table 2).

Table 1: Demographic Characteristics of the Included Patients

Variables		**Patients (N =211)**	
Age	Mean ± SD	56.52 ± 10.99	
Sex	Male	100	50 %
	Female	100	50 %
Smoking		67	33.5%
HTN		91	45.5%
DM		69	34.5%
Dyslipidemia		9	4.5%
Addiction		4	2%
Family History		2	1%
No of risk factors	0	44	22%
	1.0	84	42%

	2.0	62	31%
	3.0	10	5%
SBP	Mean ± SD	120.26 ± 15.15	
DBP	Mean ± SD	74.96 ± 15.86	
HR	Mean ± SD	79.7 ± 12.75	
Stented area length	Mean+SD	34.66+15.78	

Table 2: Types of AMI and affected vessels in all the study population

Variables		**Patients**	
Type of MI	Anterior	114	57%
	Inferior	82	41%
	lateral	1	.5%
	NSTEMI	5	2.5%
Affected Arteries	LM	11	5.5%
	LAD	144	72%
	LCX	29	14.5%
	RCA	41	20.5%
Number of vessels	1	79	39.5%
	2	78	39%
	3	43	21.5%
TIMI flow	**0**	**13**	**6.5%**
	1	**27**	**13.5%**
	2	**17**	**8.5%**
	3	**143**	**72.5%**

The association analysis showed that female patients were significantly older than male patients (59.86 ± 10.7 versus 52.56 ± 10.02 years old; p <0.001). In addition, female patients were less likely to be smokers, diabetic, and/or hypertensive (p <0.001). Male patients were more likely to be addict (p =0.049). The number of risk factors per patient was significantly higher among males (p =0.002). No significant association was detected between the type of infarction and gender. With regard to number of affected vessels, male patients were more likely to have higher number of multi-vessel affection (p <0.001). The length of stented segment was longer in female patients (p =0.008). The frequency of LAD affection was more common among males (P <0.001; **Table 5**). The length of stented segment was longer in female patients (p =0.008; **Table 3**).

Table 3: Association between gender and continuous variables

	Male	Female	t test		
			t	p value	sig.
Age	52.56 ± 10.02 N = 94	59.86 ± 10.7 N = 111	-5.01	<0.001	S
SBP	120.15 ± 13.65 N = 67	120.36 ± 16.56 N = 70	-0.08	0.936	NS
DBP	75.37 ± 19.25 N = 67	74.57 ± 11.88 N = 70	0.29	0.769	NS
HR	77.79 ± 12.96 N = 56	81.8 ± 12.3 N = 51	-1.64	0.104	NS
Length of Stent	31.35 ± 12.81 N = 81	37.41 ± 17.46 N = 98	-2.67	0.008	S

Table 4: Association between gender and categorical variables

		Male		Female		test of sig.		
		N	%	N	%	value	p value	sig.
Smoking		63	63.0%	4	4 %	$X^2 = 85.64$	<0.001	S
HTN		31	31.0%	60	60%	$X^2 = 16.11$	<0.001	S
DM		21	21.0%	48	48%	$X^2 = 14.56$	<0.001	S
Dyslipidemia		4	4.0%	5	5%	Fisher exact test	0.751	NS
Addiction		4	4.0%	0	0.0%	Fisher exact test	0.049	S
Known IHD		1	1.0%	0	0.0%	Fisher exact test	0.474	NS
No of risk factors	.0	14	14.0%	30	30 %	$X^2 = 15.15$	0.002	S
	1.0	53	53.0%	31	31 %			
	2.0	26	26.0%	36	36 %			
	3.0	7	7.0%	3	3 %			

The female patients were more likely to have TIMI flow 3 than male patients (83% versus 60%; p <0.001; **Figure 1**). On the other hand, no significant association was detected between gender and mortality (p =0.45; **Figure 2**).

Table 5: Types of AMI and number of affected vessels by gender

Variables		Male		Female		Test		
Type of MI	Anterior	59	59.0%	55	55%	$X^2 = 0.21$	0.645	NS
	Inferior	39	39.0%	43	43%	$X^2 = 0.39$	0.532	NS
	lateral	0	0.0%	1	1%	Fisher exact test	1.000	NS
	NSTEMI	4	4.0%	1	1%	Fisher exact test	0.192	NS
Affected arteries	LM	6	6.0%	5	5%	Fisher exact test	0.097	NS
	LAD	78	78%	64	64%	Fisher exact test	<0.001	S
	LCX	13	13.0%	16	16%	$X^2 = 6.08$	0.108	NS
	RCA	19	19.0%	22	22%	$X^2 = 1.67$	0.644	NS
No. of vessels	1	28	28.0%	51	51%	$X^2 = 15.22$	<0.001	S
	2	41	41.0%	37	37%			
	3	31	31.0%	12	12%			

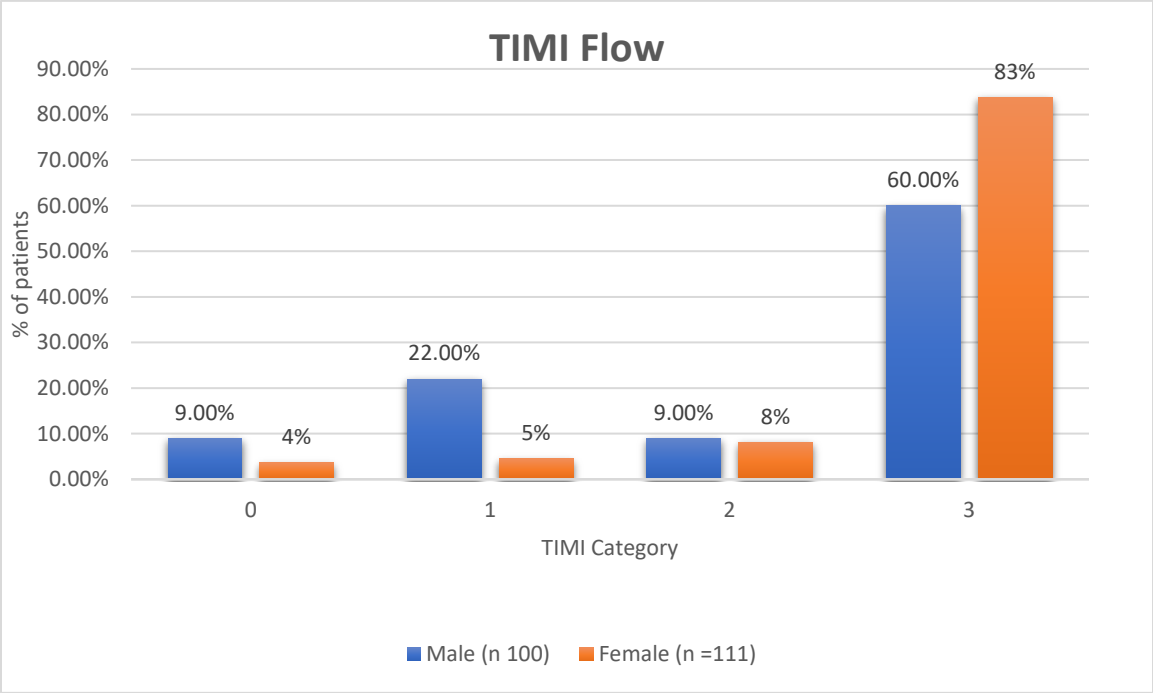

Figure 1: Association between TIMI flow and Gender.

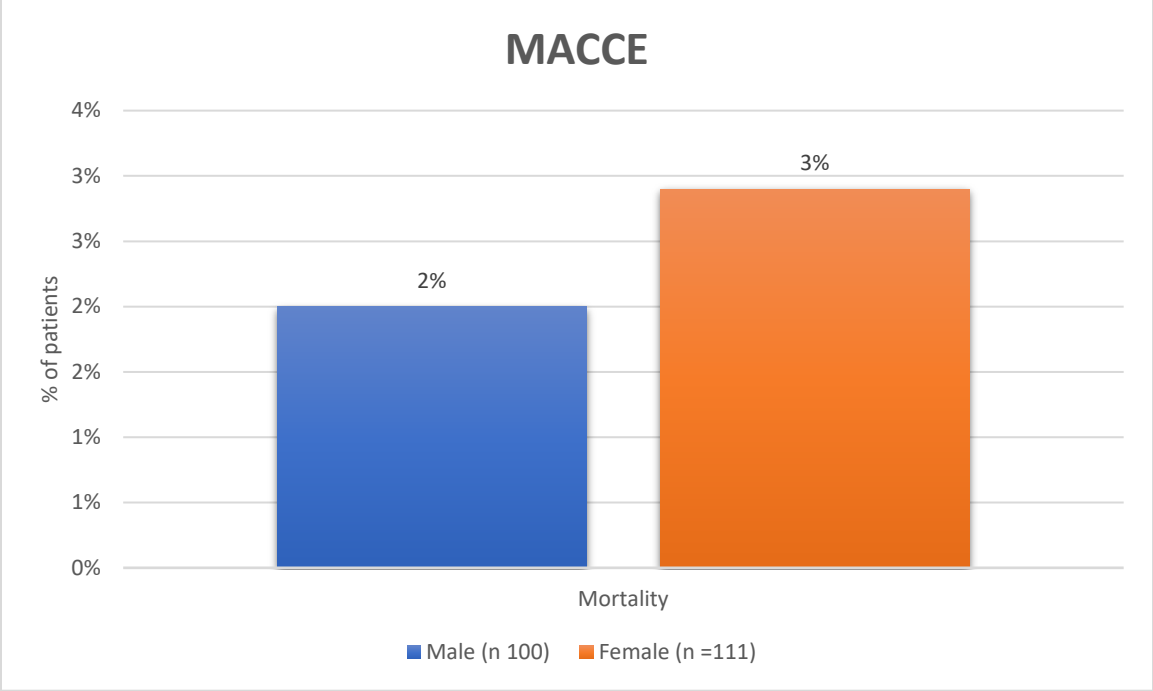

Figure 2: Association between gender and MACCE.

Discussion

Over the past decade, a growing number of studies reported a significant impact of gender on the presentation and outcomes of ACS. Nonetheless, the results of those studies showed conflicting results with no concrete conclusion regarding gender impact on ACS[19,20]. In the present study, we evaluated the role of gender in AMI in Egypt, as one of the developing countries in which cardiovascular diseases account for high proportion of morbidities and related mortality.

In this cross-sectional study, we demonstrated that female patients were significantly older than male patients. In addition, female patients were less likely to have common risk factors for STEMI. Male patients were more likely to have severe presentation, in the form of multivessel affection. The length of stented segment was longer in female patients. On the contrary, no significant association was noted between gender and MACCE, such as mortality.

The recent years have witnessed tremendous improvement in the management and outcomes of ACS, including AMI; according to recent figures, the mortality and complications from AMI have significantly declined owing to the improvement in pre and in-hospital management[21]. Nonetheless, it was recently observed that the landscape of acute coronary syndromes, including AMI, may be different between men and women; previous reports highlighted that women may be prone to higher risks of atypical presentation and short-term mortality than males[20]. While the exact causes of such difference are unclear, many authors have tried to provide many theories explaining this gender-based trend [15,16]. Age at presentation of AMI is one of the most reported

difference between men and women; female patients tend to present with MI at older age owing to protective role of estrogen on histological components of blood vessels, the estrogen level declines significantly after menopause leading to increased risk of atherosclerosis and AMI[22]. In this report, female patients were significantly older than male patients. This was in line with a recent national study from Egypt, which indicated older age at presentation of AMI in female patients, compared to male group[23,24]. Another Egyptian registry showed similar findings[25]. The same observations were observed in other parts of the world [26,27].

In the setting of AMI, several studies reported higher prevalence of modifiable risk factors -such as smoking, obesity, and hypertension- in women than men[9–12]. However, the present study demonstrated that female patients had significantly lower prevalence of common risk factors for STEMI than male patients. On the contrary, Butala et al.[24], reproted higher prevalence of diabetes and hypertension among Egyptian women than men with AMI. While Badran et al. [25], showed no significant difference between male and female patients regarding these parameters. Reports from Australia[28] and Canada[29] showed higher prevalence of common risk factors for AMI among women than men patients. The exact causes of higher prevalence of smoking, hypertension, and diabetes in our report are unclear; however, we believe that this higher prevalence stems from the fact that Egyptian male had higher prevalence of smoking and non-communicable diseases than females[30]. Nonetheless, future studies are warranted to characterize the gender difference regarding the risk factors of AMI.

With regard to gender impact on AMI presentation, previous reports indicated that women are more likely to have delayed arrival to hospital from symptoms onset, atypical

presentation, and less elevation in cardiac markers than male patients[20]. On the other hand, there is controversy regarding the gender impact on the number of affected vessels and the presence of multi-vessel disease[31]. In our study, male patients were more likely to have severe presentation, in the form of multivessel affection. On the contrary to our findings, Ghauharali-Imami et al. [32], reported no significant difference in the number and type of affected vessels between male and female patients undergoing pPCI.

According to previous reports, ACS female patients in developed countries receive more conservative care than males, fewer hospitalizations, fewer fixed therapies, and fewer PCIs [15,16]. Female patients may experience higher risk of short and long-term mortality and other complications. Recent investigations indicated that women with ACS were more prone to death, bleeding, and reinfarction than men[20]. On the contrary, Badran et al. [25] reproted that female gender was predictor of morality among patients with ACS. In a long-term study from United States, the mortality rate was higher among women than men with ACS[33]. Likewise, Otten et al.[34], reproted higher mortality in women undergoing pPCI than their male counterparts.

We acknowledge that this prospective study has some limitations. All patients were recruited from one center only; therefore, these results may not be generalized to all patients. In addition, the small sample size and the lack of long-term follow-up are other limitations.

In conclusion, female patients had less severe presentation of STEMI. However, gender appears to have no impact on clinical outcomes of STEMI patients undergoing pPCI. Nonetheless, the current published literature shows conflicting results regarding

role of gender on STEMI presentation and outcomes. Thus, further studies with multi-national collaboration is required to assess gender disparity in STEMI presentation and outcomes.

References

1. Hannah Ritchie. Causes of Death. *OurWorldInData.org* (2018)

2. Thygesen, K. *et al.* Third universal definition of myocardial infarction. *J. Am. Coll. Cardiol.* **60**, 1581–1598 (2012).

3. Organization, W. H. *WHO expert consultation on rabies: third report*. (World Health Organization, 2018).

4. Gibler, W. B. *et al.* Practical implementation of the guidelines for unstable angina/non–ST-segment elevation myocardial infarction in the emergency department: a scientific statement from the American Heart Association Council on Clinical Cardiology (Subcommittee on Acute Car. *Circulation* **111**, 2699–2710 (2005).

5. Ren, D. *et al.* Hypoxia-induced apoptosis of cardiomyocytes is restricted by ginkgolide B-downregulated microRNA-29. *Cell Cycle* **19**, 1067–1076 (2020).

6. Thygesen, K., Alpert, J. S. & White, H. D. Universal definition of myocardial infarction. *Eur. Heart J.* **28**, 2525–2538 (2007).

7. Reid, C. *et al.* Meta-analysis Comparing Outcomes of Type 2 Myocardial Infarction and Type 1 Myocardial Infarction With a Focus on Dual Antiplatelet Therapy. *CJC open* **2**, 118–128 (2020).

8. Keeley, E. C., Boura, J. A. & Grines, C. L. Primary angioplasty versus intravenous thrombolytic therapy for acute myocardial infarction: a quantitative review of 23 randomised trials. *Lancet* **361**, 13–20 (2003).

9. Siabani, S. *et al.* Gender-based difference in early mortality among patients with ST-segment elevation myocardial infarction: insights from Kermanshah STEMI Registry. *J. Cardiovasc. Thorac. Res.* **12**, 63–68 (2020).

10. Bonarjee, V. V. S. *et al.* Sex-based short- and long-term survival in patients following complicated myocardial infarction. *Eur. Heart J.* **27**, 2177–2183 (2006).

11. Simon, T. *et al.* Impact of age and gender on in-hospital and late mortality after acute myocardial infarction: increased early risk in younger women: results from the French nation-wide USIC registries. *Eur. Heart J.* **27**, 1282–1288 (2006).

12. Pimenta, L., Bassan, R., Potsch, A., Soares, J. F. & Albanesi Filho, F. M. Is female sex an independent predictor of in-hospital mortality in acute myocardial infarction? *Arq. Bras. Cardiol.* **77**, 37–50 (2001).

13. Daly, C. A. *et al.* Predicting prognosis in stable angina--results from the Euro heart survey of stable angina: prospective observational study. *BMJ* **332**, 262–267 (2006).

14. Claassen, M., Sybrandy, K. C., Appelman, Y. E. & Asselbergs, F. W. Gender gap in acute coronary heart disease: Myth or reality? *World J. Cardiol.* **4**, 36–47 (2012).

15. Pope, J. H. *et al.* Missed diagnoses of acute cardiac ischemia in the emergency department. *N. Engl. J. Med.* **342**, 1163–1170 (2000).

16. Blomkalns, A. L. *et al.* Gender disparities in the diagnosis and treatment of non-ST-segment elevation acute coronary syndromes: large-scale observations from

the CRUSADE (Can Rapid Risk Stratification of Unstable Angina Patients Suppress Adverse Outcomes With Early Implementati. *J. Am. Coll. Cardiol.* **45**, 832–837 (2005).

17. Concannon, T. W. *et al.* Elapsed time in emergency medical services for patients with cardiac complaints: are some patients at greater risk for delay? *Circ. Cardiovasc. Qual. Outcomes* **2**, 9–15 (2009).

18. Meisel, Z. F. *et al.* Influence of sex on the out-of-hospital management of chest pain. *Acad. Emerg. Med. Off. J. Soc. Acad. Emerg. Med.* **17**, 80–87 (2010).

19. Kawamoto, K., Duvernoy, C. S. & Davis, M. B. Sex differences in coronary artery disease. in *Sex Differences in Cardiovascular Physiology and Pathophysiology* 185–201 (2019). doi:10.1016/B978-0-12-813197-8.00012-9

20. Graham, G. Acute coronary syndromes in women: Recent treatment trends and outcomes. *Clin. Med. Insights Cardiol.* **10**, 1–10 (2016).

21. Mc Namara, K., Alzubaidi, H. & Jackson, J. K. Cardiovascular disease as a leading cause of death: how are pharmacists getting involved? . *Integr. Pharm. Res. Pract.* **Volume 8**, 1–11 (2019).

22. Chakrabarti, S., Morton, J. S. & Davidge, S. T. Mechanisms of estrogen effects on the endothelium: An overview. *Canadian Journal of Cardiology* **30**, 705–712 (2014).

23. Reda, A. *et al.* The pattern of risk-factor profile in Egyptian patients with acute coronary syndrome: Phase II of the Egyptian cross-sectional CardioRisk project.

Cardiovasc. J. Afr. **30**, 87–94 (2019).

24. Butala, N. M. *et al.* Gender differences in presentation, management, and in-hospital outcomes for patients with ami in a lower-middle income country: Evidence from egypt. *PLoS One* 6(10): e25904.(2011);

25. Badran, H. M., Elgharably, M. A. & Faheem, N. Clinical characteristics and in-hospital outcome of heart failure in women: a single center registry from Egyptian cardiac care unit. *Egypt. Hear. J.* **71**, (2019).

26. Yang, H.-Y., Huang, J.-H., Hsu, C.-Y. & Chen, Y.-J. Gender Differences and the Trend in the Acute Myocardial Infarction: A 10-Year Nationwide Population-Based Analysis. *Sci. World J.* **2012**, 1–11 (2012).

27. Liakos, M. & Parikh, P. B. Gender Disparities in Presentation, Management, and Outcomes of Acute Myocardial Infarction. *Curr. Cardiol. Rep.* **20**, (2018).

28. Yu, J. *et al.* Sex-based differences in bleeding and long term adverse events after percutaneous coronary intervention for acute myocardial infarction: three year results from the HORIZONS-AMI trial. *Catheter. Cardiovasc. Interv.* **85**, 359–368 (2015).

29. Pelletier, R. *et al.* Sex-related differences in access to care among patients with premature acute coronary syndrome. *CMAJ* **186**, 497–504 (2014).

30. Available at: https://www.who.int/ncds/surveillance/steps/STEPS_Report_Egypt_2005-06.pdf. (Accessed: 16th August 2020)

31. Dimitriu-Leen, A. C. *et al.* Gender-Specific Differences in All-Cause Mortality Between Incomplete and Complete Revascularization in Patients With ST-Elevation Myocardial Infarction and Multi-Vessel Coronary Artery Disease. *Am. J. Cardiol.* **121**, 537–543 (2018).

32. Ghauharali-Imami, S. *et al.* The impact of gender on long-term mortality in patients with multivessel disease after primary percutaneous coronary intervention. *Netherlands Hear. J.* **23**, 592–599 (2015).

33. Gupta, A. *et al.* Trends in acute myocardial infarction in young patients and differences by sex and race, 2001 to 2010. *J. Am. Coll. Cardiol.* **64**, 337–345 (2014).

34. Otten, A. M. *et al.* Is the difference in outcome between men and women treated by primary percutaneous coronary intervention age dependent? Gender difference in STEMI stratified on age. *Eur. Hear. J. Acute Cardiovasc. Care* **2**, 334–341 (2013).