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Comparison of 30-day mortality and readmission frequency in women versus men with acute myocardial infarction

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ABSTRACT

This study aimed to assess gender differences in hospitalization incidence, 30-day mortality, and 30-day readmission rates for acute myocardial infarction (AMI) in a Southwestern US medical center. Hospital billing records for AMI admissions were compiled from January 2013 to June 2019, resulting in a sample size of 2394. Billing data included gender, age, principal procedure, insurance status, principal diagnosis, and race/ethnicity. Multivariate logistic regression was used to estimate gender differences in mortality after adjustment for the aforementioned factors. Men were hospitalized for AMI over twice as frequently, yet women had higher AMI mortality than men (9.3% vs. 6.1%, $P < 0.01$). Female AMI patients were older on average and slightly less likely to undergo percutaneous transluminal coronary angioplasty than men. Thirty-day readmission rates did not differ by gender. In absolute terms, AMI hospitalizations and deaths are larger in number in men, but AMI hospitalizations more frequently end in death in women.

KEYWORDS Acute myocardial infarction; gender; mortality; sex

Cardiovascular disease is the leading cause of death in the United States, accounting for 23% of deaths in 2019.[1] Gender differences in cardiovascular outcomes remain important, as women's mortality rates (9.6%) after acute myocardial infarction (AMI) are higher than those in men (5.3%) within 30 days of onset.[2] Women hospitalized for AMI tend to be older than men.[3] Women also tend to have significantly higher in-hospital mortality for ST segment elevation myocardial infarction (STEMI) events than men.[4–6] Female STEMI patients are generally older at hospitalization and have higher comorbidity rates.[7] Gender differences in non–ST elevation myocardial infarction (NSTEMI) events have produced more mixed results, showing both women and men having higher in-hospital mortality in different samples.[8,9] We compared AMI hospitalization incidence, 30-day mortality, and 30-day readmission by gender at a large regional medical center.

METHODS

This study used billing data from all hospital admissions for AMI at a large regional medical center in the Southwestern United States. Six and a half years of data, from January 2013 to June 2019, were analyzed to maximize the study population size. The study was approved for exempt review by the Texas Tech University Health Sciences

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Table 1. Characteristics of acute myocardial infarction hospitalizations by gender

Variable	Men	Women	*P* value
Overall	1693 (70.7%)	701 (29.3%)	
Age (hospitalized): mean (SD)	61.83 (12.57)	64.82 (13.63)	<0.001
Age (deceased): mean (SD)	65.76 (13.02)	74.97 (11.60)	<0.001
Length of stay: mean (SD)	5.34 (5.54)	5.77 (6.22)	0.098
Age at AMI hospitalization: median	61	64	<0.001
Age at death among AMI hospitalization: median	65	76	<0.001
30-day mortality			0.005
Living	1590 (93.9%)	636 (90.7%)	
Deceased	103 (6.1%)	65 (9.3%)	
30-day readmission			0.81
No	1527 (90.2%)	630 (89.9%)	
Yes	166 (9.8%)	71 (10.1%)	
Race/ethnicity			0.58
White	1356 (80.1%)	552 (78.7%)	
African American	105 (6.2%)	40 (5.7%)	
Hispanic	109 (6.4%)	47 (6.7%)	
Other/unknown	123 (7.3%)	62 (8.8%)	
Insurance			<0.001
Private	372 (22.0%)	100 (14.3%)	
Medicare	752 (44.4%)	403 (57.5%)	
Medicaid	109 (6.4%)	66 (9.4%)	
Self-pay	227 (13.4%)	81 (11.6%)	
Other/unknown	233 (13.8%)	51 (7.3%)	

AMI indicates acute myocardial infarction; SD, standard deviation.

Center institutional review board. Following approval, the hospital provided deidentified patient data for all hospital admissions for AMI during the approved time period. Confidential patient information, such as patient identification number, medical record number, date of birth, and zip code, were not included in data provided to the research team.

Outcome variables included 30-day mortality for patients hospitalized for AMI and readmission rates, in alignment with the Hospital Readmission Reduction Program requirements federally mandated by the Centers for Medicare and Medicaid Services. The 30-day mortality and readmission rates were dichotomized as living vs. deceased and readmitted vs. not readmitted, respectively.

Independent variables included sociodemographics (age, gender, race/ethnicity, and insurance status) and clinical factors related to outcome (admission date, discharge date, principal diagnosis, discharge status, standard payer, principal procedure, and length of stay). This study period included a shift from ICD-9 to ICD-10 classification in October 2015; as such, diagnosis and procedure codes were matched. Principal diagnosis was classified as STEMI or non-STEMI with codes matched across ICD-9 and ICD-10.[10,11] Principal procedures were grouped into four categories and matched across ICD-9 and ICD-10, including none specified.

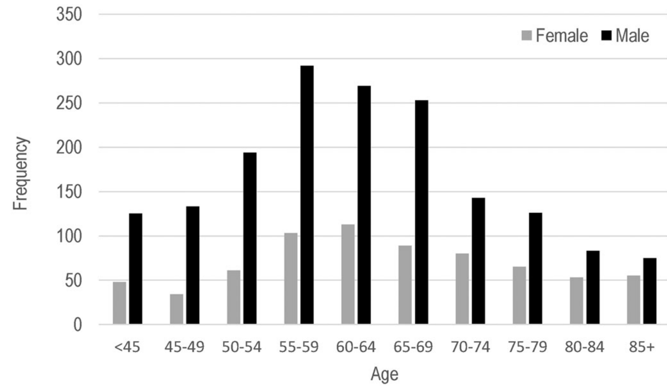

Figure 1. Incidence of hospitalization for acute myocardial infarction, by gender and age.

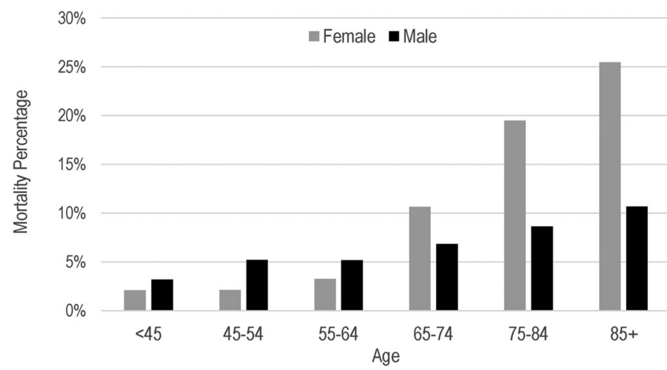

Figure 2. Mortality percentage among those hospitalized for acute myocardial infarction, by gender and age.

Bivariate tests compared mean differences using *t* tests, median differences using Mann-Whitney-Wilcoxon tests, and group proportions using chi-square tests. Multivariate logistic regression was used to analyze the two binary outcomes of 30-day mortality and 30-day readmission. Analysis for the study was performed using Stata 16.1. Statistical significance was set at $\alpha < 0.05$.

RESULTS

The AMI hospitalization data from January 2013 to June 2019 yielded a sample of 2394 patients, with a 7.0% (N = 168) 30-day mortality rate. Men (70.7%, N = 1693) outnumbered women (29.3%, N = 701) over two to one in the sample. Women hospitalized for AMI were about 3 years older

Table 2. Procedures by gender and mortality status for acute myocardial infarction hospitalizations (respiratory assistance excluded)

Variable	Men	Women	*P* value
NSTEMI	1020 (60.3%)	446 (63.6%)	0.12
STEMI	673 (39.8%)	255 (36.4%)	
Dilation of coronary artery/PTCA	833 (49.2%)	317 (45.2%)	0.03
Bypass	299 (17.7%)	109 (15.6%)	
Other procedure	478 (28.2%)	227 (32.4%)	
No procedure	83 (4.9%)	48 (6.9%)	
	Deceased	**Not deceased**	
NSTEMI	57 (33.9%)	1409 (63.3%)	<0.001
STEMI	111 (66.1%)	817 (36.7%)	
NSTEMI			0.097
Women	23 (40.4%)	423 (30.0%)	
Men	34 (59.7%)	986 (70.0%)	
STEMI			0.009
Women	42 (37.8%)	213 (26.1%)	
Men	69 (62.2%)	604 (73.9%)	
Procedure			<0.001
Dilation of coronary artery/PTCA	46 (27.4%)	1104 (49.6%)	
Bypass	13 (7.8%)	395 (17.7%)	
Other procedure	99 (58.9%)	606 (27.2%)	
No procedure	10 (6.0%)	121 (5.4%)	

NSTEMI indicates non–ST-elevation myocardial infarction; PTCA, percutaneous transluminal coronary angioplasty; STEMI, ST elevation myocardial infarction.

than men, on average; the average age of women at death was over 9 years older than men *(Table 1)*. Women hospitalized for AMI died more frequently than men (9.3% vs. 6.1%, $P < 0.01$). Thirty-day readmission rates did not differ by gender and were not analyzed in multivariate analysis.

Figure 1 shows AMI hospitalization incidence by gender and age during the time period. AMI hospitalizations were higher for men at every age interval. AMI hospitalization frequency in men was over twice that of women for all ages up to age 70, after which the gender gap decreased substantially. *Figure 2* shows the percentage of individuals who died among those hospitalized over the time frame. Despite the substantially higher incidence of hospitalizations of men at younger ages, mortality rates by gender were largely similar until age 65, at which point mortality for AMI hospitalizations among women increased substantially.

STEMI represented about 39% of the total sample and occurred in 66.1% of the patients who died *(Table 2)*. Women were significantly more likely to die from a STEMI

Table 3. Adjusted logistic regression odds ratios predicting mortality among acute myocardial infarction hospitalizations

Variable	OR	95% CI	*P* value
Men (women = ref)	8.11	1.08, 60.95	0.04
Age	1.05	1.03, 1.08	<0.001
STEMI (NSTEMI = ref)	5.49	3.80, 7.93	<0.001
Men × Age	0.97	0.94, 0.99	0.02
Procedure (PTCA = ref)			
Bypass	1.16	0.61, 2.22	0.65
Other	5.15	3.46, 7.66	<0.001
No procedure	2.66	1.21, 5.86	0.02
Year	0.88	0.81, 0.96	0.004
Insurance (private = ref)			
Medicare	1.74	0.94, 3.19	0.08
Medicaid	1.46	0.64, 3.34	0.37
Self-pay	0.82	0.37, 1.80	0.64
Other insurance	0.90	0.40, 2.01	0.79

N = 2394; R-squared = 0.177. CI indicates confidence interval; NSTEMI, non–ST-elevation myocardial infarction; OR, odds ratio; PTCA, percutaneous transluminal coronary angioplasty; STEMI, ST elevation myocardial infarction.

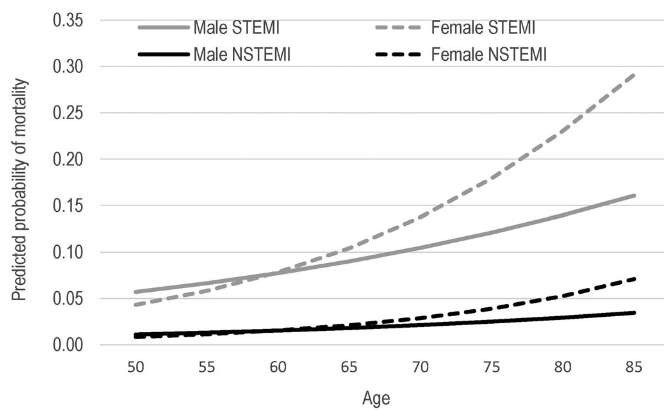

Figure 3. Predicted probability of mortality by type of acute myocardial infarction, gender, and age using adjusted logistic regression coefficients.

event than men (16.5% vs. 10.2%, $P < 0.01$). Fewer women (45.2%) than men (49.2%) underwent percutaneous transluminal coronary angioplasty, and women were more likely to have an "other procedure" (32.4%) or no procedure (6.9%) compared to men (28.2% and 4.9%, respectively, $\chi^2 = 9.3$, $P = 0.026$). Individuals in the "other procedure" category comprised 58.9% of the population that died; procedures included respiratory assistance or ventilation and percutaneous left ventricular assist device insertion.

After adjusting for insurance type, STEMI vs. NSTEMI, procedure, and year, significant effects were found for gender, age, and the interaction term of gender and age, suggesting that men's and women's mortality risk differs as age increases *(Table 3)*. *Figure 3* shows predicted probabilities of mortality using the logistic regression coefficients for the interaction effect for gender and age. These results suggest that women's in-hospital STEMI mortality diverges from male mortality beginning around age 65.

DISCUSSION

Our study reports higher overall AMI and STEMI mortality in women after adjusting for age and other factors. Past research has suggested that women have longer delays from symptom onset to hospitalization and, as a result, tend to have higher 30-day mortality rates for STEMI events than men.[12] However, the billing data used in our study did not include clinical information, such as the time from symptom onset to hospitalization or time from symptom onset to procedure. Hospital billing data can be used to track population health outcomes like 30-day mortality and 30-day readmission rates, but these billing data likely miss nuanced differences in the populations of interest. Categorization of STEMI and NSTEMI events in billing data may lack sensitivity of an individual clinical diagnosis, and therefore, one must exercise caution inferring group differences in quality of care using just billing data.

Important disease characteristics include the rates of hospitalization and mortality, with possible adjustments based on age and gender. In this study, men comprised about 71% of AMI cases during the 6.5-year span, with particularly large differences between ages 50 and 70. However, mortality rates were higher in women than men beginning around age 65. Our analysis did not find definite gender differences in procedures. Therefore, few conclusions can be reached about interventional strategies using the entire cohort during this time period, given the constraints of using principal procedure billed.

Older patients with chronic cardiovascular disorders frequently have two or more other chronic medical conditions, a condition called multimorbidity.[12–19] This population also exhibits geriatric syndromes, frailty, and significant functional limitations.[14,15] Consequently, management needs to be comprehensive, and single cardiac interventions may not improve outcomes. In addition, the analysis of the factors influencing any particular outcome becomes much more complicated, particularly when these multiple factors are not entered into the database. The information collected in this study does not provide an opportunity to analyze multimorbidity, geriatric syndromes, or patient preferences. The increased mortality in women is likely explained by their increased age and a more complex set of medical problems.[17] The reduced number of procedures in women may reflect an analysis of risk and benefit by physicians or may reflect patient decisions regarding risk and benefits.

This study focused on a single hospital over 6.5 years. As a county hospital, this health care organization may have a patient demographic with a lower socioeconomic status than other hospitals in the area. Although socioeconomic status is widely understood to shape health disparities, we have no reason to believe that gender differences in AMI or AMI outcomes should be appreciably different in this hospital compared to others. Future investigator-initiated cohort or case control studies of gender disparities may benefit from multi-hospital samples and greater contextual information about the clinical course and comorbid conditions.

AMI hospitalizations among men in our study outnumbered women by over 2 to 1, yet the AMI mortality rate was higher in women. Public health efforts should consider potential differences in education about identification of AMI symptoms based on gender. The relatively higher AMI hospitalization rates in men suggest the need for overall behavioral changes for major risk factors, such as smoking, diet, and exercise. However, since heart disease in women often develops at an older age than in men, and women's cardiovascular disease symptoms may be underrecognized, more effort is needed to raise cardiovascular disease awareness in women and to enroll more women in clinical trials.[2,3] The higher mortality rate for women, particularly for STEMI events, suggests that clinicians should manage women with acute cardiac presentations as a high-risk population. Finally, prospective clinical trials with older women may identify better management strategies and outcomes.

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1. Kochanek KD, Xu JQ, Arias E. *Mortality in the United States, 2019 [NCHS Data Brief, No 395]*. Hyattsville, MD: National Center for Health Statistics; 2020.
2. Berger JS, Elliott L, Gallup D, et al. Sex differences in mortality following acute coronary syndromes. *JAMA*. 2009;302(8):874–882. doi: 10.1001/jama.2009.1227.
3. Hao Y, Liu J, Liu J, On behalf of the CCC-ACS Investigators, et al. Sex differences in in-hospital management and outcomes of patients with acute coronary syndrome: findings from the CCC Project. *Circulation*. 2019; 139(15):1776–1785. doi:10.1161/CIRCULATIONAHA.118.037655.
4. Pancholy SB, Shantha GP, Patel T, Cheskin LJ. Sex differences in short-term and long-term all-cause mortality among patients with ST-segment elevation myocardial infarction treated by primary percutaneous intervention: a meta-analysis. *JAMA Intern Med*. 2014;174(11): 1822–1830. doi:10.1001/jamainternmed.2014.4762.
5. Langabeer JR, Henry TD, Fowler R, Champagne-Langabeer T, Kim J, Jacobs AK. Sex-based differences in discharge disposition and

outcomes for ST-segment elevation myocardial infarction patients within a regional network. *J Womens Health*. 2018;27(8):1001–1006. doi:10.1089/jwh.2017.6553.
6. Huded CP, Johnson M, Kravitz K, et al. 4-step protocol for disparities in STEMI Care and Outcomes in Women. *J Am Coll Cardiol*. 2018;71(19):2122–2132. doi:10.1016/j.jacc.2018.02.039.
7. Haider A, Bengs S, Luu J, et al. Sex and gender in cardiovascular medicine: presentation and outcomes of acute coronary syndrome. *Eur Heart J*. 2020;41(13):1328–1336. doi:10.1093/eurheartj/ehz898.
8. Langabeer JR II, Champagne-Langabeer T, Fowler R, Henry T. Gender-based outcome differences for emergency department presentation of non-STEMI acute coronary syndrome. *Am J Emerg Med*. 2019;37(2):179–182. doi:10.1016/j.ajem.2018.05.005.
9. Zhang Z, Fang J, Gillespie C, Wang G, Hong Y, Yoon PW. Age-specific gender differences in in-hospital mortality by type of acute myocardial infarction. *Am J Cardiol*. 2012;109(8):1097–1103. doi:10.1016/j.amjcard.2011.12.001.
10. ICD-9Data.com. The web's free ICD-9-CM coding reference. http://www.icd9data.com/2015/Volume1/default.htm. Accessed December 20, 2020.
11. ICD-10Data.com. The Web's Free 2021 ICD-10-CM/PCS medical coding reference. https://www.icd10data.com/ICD10CM/Codes. Accessed December 20, 2020.
12. Stehli J, Martin C, Brennan A, Dinh DT, Lefkovits J, Zaman S. Sex differences persist in time to presentation, revascularization, and mortality in myocardial infarction treated with percutaneous coronary intervention. *J Am Heart Assoc*. 2019;8(10) doi:10.1161/JAHA.119.012161.
13. Abad-Díez JM, Calderón-Larrañaga A, Poncel-Falcó A, et al. Age and gender differences in the prevalence and patterns of multimorbidity in the older population. *BMC Geriatr*. 2014;14:75. doi:10.1186/1471-2318-14-75.
14. Bell SP, Saraf AA. Epidemiology of multimorbidity in older adults with cardiovascular disease. *Clin Geriatr Med*. 2016;32(2):215–226. doi:10.1016/j.cger.2016.01.013.
15. Manemann SM, Chamberlain AM, Roger VL, et al. Multimorbidity and functional limitation in individuals with heart failure: a prospective community study. *J Am Geriatr Soc*. 2018;66(6):1101–1107. doi:10.1111/jgs.15336.
16. Dunlay SM, Chamberlain AM. Multimorbidity in older patients with cardiovascular disease. *Curr Cardiovasc Risk Rep*. 2016;10(1):3. doi:10.1007/s12170-016-0491-8.
17. Almagro P, Ponce A, Komal S, et al. Multimorbidity gender patterns in hospitalized elderly patients. *PLoS One*. 2020;15(1):e0227252. doi:10.1371/journal.pone.0227252.
18. Orkaby AR, Forman DE. Assessing risks and benefits of invasive cardiac procedures in patients with advanced multimorbidity. *Clin Geriatr Med*. 2016;32(2):359–371. doi:10.1016/j.cger.2016.01.004.
19. Manemann SM, Chamberlain AM, Boyd CM, et al. Multimorbidity in heart failure: effect on outcomes. *J Am Geriatr Soc*. 2016;64(7):1469–1474. doi:10.1111/jgs.14206.