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ORIGINAL INVESTIGATIONS

# Trends in Acute Myocardial Infarction in Young Patients and Differences by Sex and Race, 2001 to 2010

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## ABSTRACT

**BACKGROUND** Various national campaigns launched in recent years have focused on young women with acute myocardial infarctions (AMIs). Contemporary longitudinal data about sex differences in clinical characteristics, hospitalization rates, length of stay (LOS), and mortality have not been examined.

**OBJECTIVES** This study sought to determine sex differences in clinical characteristics, hospitalization rates, LOS, and in-hospital mortality by age group and race among young patients with AMIs using a large national dataset of U.S. hospital discharges.

**METHODS** Using the National Inpatient Sample, clinical characteristics, AMI hospitalization rates, LOS, and in-hospital mortality were compared for patients with AMI across ages 30 to 54 years, dividing them into 5-year subgroups from 2001 to 2010, using survey data analysis techniques.

**RESULTS** A total of 230,684 hospitalizations were identified with principal discharge diagnoses of AMI in 30- to 54-year-old patients from Nationwide Inpatient Sample data, representing an estimated 1,129,949 hospitalizations in the United States from 2001 to 2010. No statistically significant declines in AMI hospitalization rates were observed in the age groups <55 years or stratified by sex. Prevalence of comorbidities was higher in women and increased among both sexes through the study period. Women had longer LOS and higher in-hospital mortality than men across all age groups. However, observed in-hospital mortality declined significantly for women from 2001 to 2010 (from 3.3% to 2.3%, relative change 30.5%; p for trend $< 0.0001$) but not for men (from 2% to 1.8%, relative change 8.6%; p for trend $= 0.60$).

**CONCLUSIONS** AMI hospitalization rates for young people have not declined over the past decade. Young women with AMIs have more comorbidity, longer LOS, and higher in-hospital mortality than young men, although their mortality rates are decreasing. (J Am Coll Cardiol 2014;64:337–45) © 2014 by the American College of Cardiology Foundation

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**ABBREVIATIONS AND ACRONYMS**

**AMI** = acute myocardial infarction

**HCUP** = Healthcare Cost and Utilization Project

**LOS** = length of stay

**NIS** = Nationwide Inpatient Sample

Each year, more than 30,000 women younger than 55 years of age are hospitalized with acute myocardial infarction (AMI) in the United States alone (1). Growing public recognition of the importance of heart disease in young women in the late 1990s and early 2000s led to several national campaigns (2) and evidence-based guidelines with a focus on young women. However, contemporary data about trends in clinical characteristics, hospitalization, and mortality rates of young patients with AMI are lacking. Moreover, patients younger than 55 years of age with AMIs have been historically examined collectively in prior studies, yielding little insight into the relationships of age and race with sex differences in the epidemiology of this disease within that group.

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Accordingly, we studied sex differences in patient characteristics, hospitalization rates, and short-term outcomes among a national sample of patients 30 to 54 years of age with AMIs from 2001 through 2010. Specifically, we examined temporal trends with attention to subgroups of age and race. We used data from the Nationwide Inpatient Sample (NIS), a national all-payer administrative database, and U.S. census data to obtain a national perspective on recent trends. Then, we stratified secondary analyses by age, race, and sex subgroups in the 21 states that collected data on race during this time period.

## METHODS

**DATA SOURCES AND CODING.** We obtained data from the Agency for Healthcare Research and Quality's Healthcare Cost and Utilization Project (HCUP) NIS files between 2001 and 2010. It is the largest all-payer inpatient database publicly available in the United States, comprising discharge data from more than 1,000 hospitals across 44 states. The database was designed to approximate a 20% stratified sample of U.S. community hospitals, representing more than 95% of the U.S. population (including urban and rural hospitals across all geographic locations) (3). Statistical sampling weights provided by the NIS allow extrapolation to calculate expected hospitalization rates within the United States (4). The NIS includes all claims from each selected hospital regardless of payer or insurance status, because it is derived from state-mandated hospital discharge reports. We classified a hospital admission as AMI if the principal discharge diagnosis code was International Classification of Diseases-Ninth Revision-Clinical Modification 410.xx, excluding cases for which the last digit was 2 (410.x2), which does not indicate an acute event.

**STUDY COHORT AND PATIENT CHARACTERISTICS.** From an initial sample of all discharges in the HCUP NIS from 2001 through 2010 (n = 79,171,880), we excluded the following hospitalizations: those with missing data on patient age, sex, length of stay (LOS), or in-hospital death (n = 278,653); discharges in which patients were <30 or >54 years of age (n = 58,687,675); discharges in which patients were admitted and discharged alive the same day (n = 474,676), as they may not reflect diagnoses of AMI; and discharges in which patients were admitted from other hospitals (n = 419,817) to avoid duplication of records, leaving a cohort of 19,311,059 discharges. Secondary analyses stratified by age, race, and sex subgroups were conducted in a subset of patients hospitalized in 21 states that reported complete data on patient race during this time period, leaving a cohort of 12,059,714 discharges. These states represent approximately 60% of the U.S. population and include approximately 60% of Caucasians and 60% of African Americans of the national population, which may not be representative of the entire country. However, an Agency for Healthcare Research and Quality study comparing the HCUP NIS database with the National Hospital Discharge Survey database showed that there were no significant differences in the discharge estimates for the white and black subgroups (5). Additionally, different states do not compare uniformly for inclusion criteria for the "other race" subgroup. We did not include the "other races" in our analyses, because they include many missing values and are very heterogeneous for comparison.

We examined subgroups of age by 5-year categories (30 to 34, 35 to 39, 40 to 44, 45 to 49, and

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50 to 54 years of age), sex (women and men), and race (white and black). We identified clinical comorbidities using International Classification of Diseases-Ninth Revision-Clinical Modification secondary diagnosis codes and classified them according to hierarchical condition categories, similar to those used by the Centers for Medicare & Medicaid Services for calculating their 30-day AMI mortality measure (6).

**STATISTICAL ANALYSES.** We used survey analysis methods that used hospital-level discharge weights provided by the NIS to estimate the number of AMI hospitalizations on a national level (7). We examined AMI hospitalization rates among subgroups of age, sex, and ethnicity for each year between 2001 and 2010 and reported them as the rates per 100,000 persons. We assessed the annual trend over time in AMI hospitalization rates using Poisson regression that included a variable representing the time of the year.

We evaluated in-hospital mortality and LOS among AMI admissions for patients in subgroups of age (30 to 34, 35 to 39, 40 to 44, 45 to 49, and 50 to 54 years of age), sex (women and men), and race (white and black). We also examined trends in these outcomes stratified by age, sex, and race. We assessed annual changes in in-hospital mortality rate and mean LOS using linear regression.

All p values were 2-sided, with a significance threshold of $p < 0.05$. Statistical analyses were performed using SAS version 9.2 (SAS Institute Inc.,

**TABLE 1 Characteristics of Patients Hospitalized for AMI, 2001 to 2010**

| | Overall | | Age 30–34 yrs | | Age 35–39 yrs | | Age 40–44 yrs | | Age 45–49 yrs | | Age 50–54 yrs | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Description | Male | Female | Male | Female | Male | Female | Male | Female | Male | Female | Male | Female |
| Race | | | | | | | | | | | | |
| White | 54.0 | 49.2 | 45.3 | 43.5 | 50.4 | 45.7 | 52.3 | 47.7 | 54.5 | 49.2 | 55.4 | 50.7 |
| Black | 8.4 | 15.4 | 13.3 | 21.2 | 10.3 | 17.4 | 8.7 | 15.6 | 8.0 | 15.3 | 8.0 | 14.6 |
| Hispanic | 6.8 | 6.5 | 10.9 | 7.4 | 7.5 | 6.7 | 7.1 | 6.4 | 6.4 | 6.4 | 6.6 | 6.5 |
| Other | 30.8 | 28.9 | 30.5 | 28.0 | 31.8 | 30.3 | 31.9 | 30.3 | 31.1 | 29.1 | 30.0 | 28.1 |
| Cardiovascular | | | | | | | | | | | | |
| PTCA | 9.7 | 7.5 | 5.5 | 5.0 | 7.9 | 6.3 | 9.0 | 7.2 | 10.0 | 8.1 | 10.4 | 7.7 |
| CABG | 3.2 | 3.0 | 0.9 | 1.7 | 1.5 | 1.6 | 2.2 | 2.3 | 2.9 | 2.3 | 4.2 | 3.6 |
| Congestive heart failure | 13.7 | 18.8 | 12.8 | 16.3 | 11.0 | 15.8 | 11.4 | 14.9 | 12.8 | 17.8 | 15.8 | 21.8 |
| AMI | 1.0 | 0.9 | 1.0 | 0.7 | 0.9 | 1.0 | 1.0 | 0.9 | 1.0 | 0.9 | 1.0 | 1.0 |
| Unstable angina | 1.8 | 1.7 | 1.7 | 1.9 | 1.7 | 1.8 | 2.0 | 1.9 | 1.8 | 1.7 | 1.8 | 1.7 |
| Anterior myocardial infarction | 18.3 | 14.3 | 18.6 | 18.1 | 19.8 | 16.6 | 19.3 | 16.1 | 18.6 | 13.8 | 17.4 | 13.4 |
| Other location of myocardial infarction | 29.4 | 21.8 | 26.4 | 19.7 | 29.1 | 20.2 | 30.1 | 21.9 | 29.9 | 22.4 | 29.0 | 21.8 |
| Chronic atherosclerosis | 78.7 | 70.9 | 65.1 | 62.6 | 74.0 | 67.1 | 77.5 | 69.7 | 79.6 | 71.8 | 80.3 | 71.9 |
| Cardiorespiratory failure and shock | 9.4 | 10.5 | 6.8 | 9.6 | 7.6 | 9.4 | 8.3 | 9.0 | 9.2 | 10.3 | 10.5 | 11.4 |
| Valvular or rheumatic heart disease | 4.2 | 6.4 | 3.8 | 5.9 | 3.3 | 5.8 | 3.4 | 5.8 | 3.9 | 6.1 | 4.8 | 7.0 |
| Comorbidity | | | | | | | | | | | | |
| Hypertension | 48.5 | 51.1 | 36.8 | 34.3 | 42.5 | 40.2 | 45.2 | 46.7 | 48.5 | 52.1 | 51.6 | 54.9 |
| Stroke | 0.6 | 0.9 | 0.5 | 0.6 | 0.5 | 0.9 | 0.5 | 0.7 | 0.5 | 0.7 | 0.7 | 1.1 |
| Cerebrovascular disease | 0.7 | 1.2 | 0.2 | 0.4 | 0.3 | 0.7 | 0.4 | 0.9 | 0.7 | 1.1 | 1.0 | 1.6 |
| Renal failure | 6.7 | 9.5 | 6.9 | 10.0 | 5.9 | 9.6 | 5.7 | 7.6 | 6.0 | 8.8 | 7.7 | 10.6 |
| Chronic obstructive pulmonary disease | 7.7 | 11.4 | 2.7 | 3.4 | 2.9 | 5.2 | 5.0 | 8.3 | 7.3 | 11.0 | 10.2 | 14.3 |
| Pneumonia | 3.7 | 4.5 | 3.2 | 4.0 | 3.0 | 3.3 | 3.1 | 3.9 | 3.4 | 4.2 | 4.2 | 5.2 |
| DM and DM complications | 22.7 | 32.6 | 15.3 | 25.7 | 18.1 | 29.5 | 19.9 | 29.2 | 22.1 | 32.2 | 25.5 | 35.3 |
| Dyslipidemia | 14.1 | 11.5 | 11.3 | 8.7 | 13.8 | 8.7 | 13.9 | 10.1 | 14.3 | 11.9 | 14.2 | 12.3 |
| Protein-calorie malnutrition | 0.5 | 0.8 | 0.4 | 0.6 | 0.3 | 0.6 | 0.4 | 0.6 | 0.4 | 0.8 | 0.6 | 1.0 |
| Dementia and senility | 0.2 | 0.3 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.3 | 0.2 | 0.3 |
| Hemiplegia, paralysis, and functional disability | 1.3 | 1.8 | 1.0 | 1.3 | 1.0 | 1.7 | 0.9 | 1.5 | 1.3 | 1.7 | 1.6 | 2.2 |
| Vascular or circulatory disease | 4.2 | 6.2 | 2.0 | 4.3 | 2.3 | 4.4 | 2.8 | 4.9 | 3.9 | 6.0 | 5.3 | 7.4 |
| Metastatic cancer and acute leukemia | 0.3 | 0.6 | 0.2 | 0.4 | 0.1 | 0.2 | 0.1 | 0.3 | 0.3 | 0.5 | 0.4 | 0.8 |
| Trauma | 1.0 | 0.8 | 1.1 | 0.6 | 1.1 | 0.8 | 0.9 | 0.7 | 1.0 | 0.9 | 1.1 | 0.9 |
| Major psychiatric disorders | 1.8 | 3.1 | 2.1 | 3.5 | 1.8 | 3.4 | 1.9 | 3.2 | 1.7 | 3.3 | 1.7 | 2.9 |
| Liver and biliary disease | 1.1 | 1.0 | 0.6 | 0.8 | 0.6 | 0.6 | 0.7 | 0.8 | 1.1 | 1.0 | 1.4 | 1.2 |

Values are %.

AMI = acute myocardial infarction; CABG = coronary artery bypass grafting; DM = diabetes mellitus; PTCA = percutaneous transluminal coronary angioplasty.

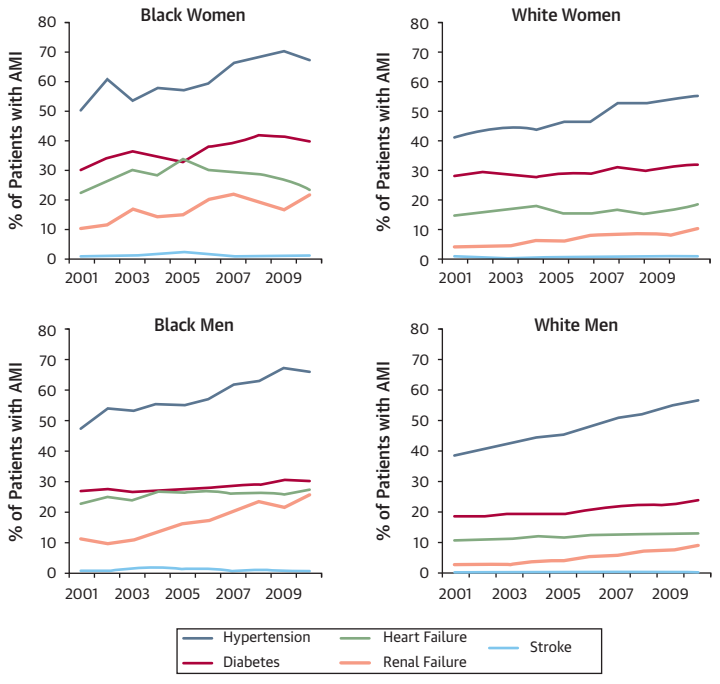



**FIGURE 1 Trends in Selected Comorbidities Among Young Patients With AMIs, 2001 to 2010**

Trends in selected comorbidities, including hypertension, diabetes, heart failure, renal failure, and stroke are shown for black women, white women, black men, and white men with acute myocardial infarctions (AMIs) from 2001 to 2010. Black women had the highest prevalence of hypertension, diabetes, and heart failure across all groups. The prevalence of hypertension and diabetes increased significantly for all subgroups from 2001 to 2010.

Cary, North Carolina). Yale University's Institutional Review Board approved the study protocol.

## RESULTS

Our final study sample consisted of 230,684 hospitalizations with principal discharge diagnoses of AMI among patients 30 to 54 years of age in the United States from 2001 to 2010, corresponding to an estimated 1,129,949 AMI hospitalizations nationally during the same time period after applying sampling weights.

For secondary analyses involving race comparisons, our study sample consisted of 134,150 hospitalizations with principal discharge diagnoses of AMI from the 21 states that report complete race data, corresponding to an estimated 656,436 AMI hospitalizations from these states from 2001 to 2010 after applying sampling weights.

**PATIENT CHARACTERISTICS.** Women represented approximately one-quarter of young patients hospitalized with AMI (women, 25.9%; men, 74.1%). Secondary analyses involving race revealed that more women were black (19.7%) than men (10.5%). Several comorbidities were more prevalent in women compared with men across all age subgroups, including congestive heart failure, hypertension, renal failure, chronic obstructive pulmonary disease, and diabetes mellitus (Table 1). Dyslipidemia, however, was more prevalent in men than in women (14.1% vs. 11.5%). In trend analyses for selected

**TABLE 2 Hospitalization Rates (per 100,000 Persons) for Young Patients With AMIs Stratified by Age and Sex, 2001 to 2010**

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | p for Trend |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Overall | | | | | | | | | | | |
| Male | 174 | 168 | 173 | 150 | 153 | 160 | 153 | 173 | 181 | 171 | 0.70 |
| Female | 56 | 57 | 57 | 52 | 53 | 55 | 55 | 61 | 65 | 61 | 0.40 |
| Age 30–34 yrs | | | | | | | | | | | |
| Male | 25 | 25 | 28 | 23 | 26 | 25 | 26 | 26 | 27 | 26 | 0.80 |
| Female | 8 | 8 | 8 | 8 | 8 | 9 | 9 | 9 | 8 | 9 | 0.70 |
| Age 35–39 yrs | | | | | | | | | | | |
| Male | 62 | 59 | 61 | 51 | 54 | 55 | 57 | 66 | 65 | 63 | 0.50 |
| Female | 20 | 21 | 20 | 20 | 20 | 19 | 19 | 21 | 25 | 22 | 0.60 |
| Age 40–44 yrs | | | | | | | | | | | |
| Male | 142 | 136 | 137 | 114 | 125 | 128 | 118 | 138 | 139 | 132 | 0.80 |
| Female | 44 | 46 | 44 | 43 | 41 | 45 | 43 | 49 | 51 | 50 | 0.40 |
| Age 45–49 yrs | | | | | | | | | | | |
| Male | 258 | 251 | 259 | 224 | 220 | 229 | 217 | 246 | 259 | 237 | 0.50 |
| Female | 80 | 80 | 81 | 74 | 76 | 79 | 78 | 88 | 92 | 88 | 0.20 |
| Age 50–54 yrs | | | | | | | | | | | |
| Male | 427 | 406 | 412 | 357 | 348 | 361 | 343 | 379 | 399 | 370 | 0.06 |
| Female | 140 | 137 | 138 | 116 | 115 | 118 | 118 | 127 | 139 | 126 | 0.50 |

Abbreviation as in Table 1.

comorbidities, the prevalence of hypertension and diabetes increased significantly for all the groups from 2001 to 2010 (Fig. 1).

In secondary analyses, black women had the highest prevalence of selected comorbidities, including hypertension, heart failure, and diabetes, compared with white women, black men, and white men. Although the prevalence of heart failure was highest among black women, they did not show a significant change, as opposed to other groups that showed increases through the study period (white women, 24.5%; black men, 18%; white men, 21.1%).

**AMI HOSPITALIZATION RATES.** Hospitalization rates for AMI were higher in men compared with women across all age subgroups (Table 2). The absolute number of discharges for AMI among women increased from 28,681 (56 per 100,000) in 2001 to 31,777 (61 per 100,000) in 2010. In contrast, the absolute number of discharges for AMI among men decreased from 87,084 (174 per 100,000) to 86,734 (171 per 100,000). Although absolute declines were noted for most subgroups of men, women demonstrated either no change (30 to 34 and 35 to 39 years of age) or a slight absolute increase (40 to 44 and 45 to 49 years of age) in hospitalization rates.

In secondary analyses including age, sex, and race comparisons, black women had much higher hospitalization rates than white women consistently

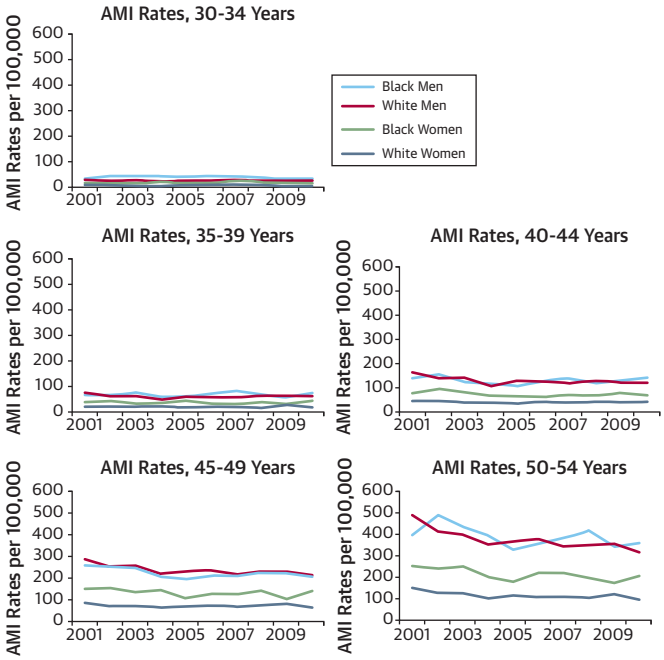



**FIGURE 2 AMI Hospitalization Rates by Race and Sex Among Young Patients With AMIs, 2001 to 2010**

Trends in hospitalization rate for persons ages 30 to 54 years with AMIs are shown by race and sex across 5-year subgroups of age. Of note, black women had much higher hospitalization rates than white women consistently from 2001 to 2010, whereas hospitalization rates were comparable for black and white men. Abbreviation as in Figure 1.

**TABLE 3 In-Hospital Mortality (Percentages) Among Men and Women With AMIs 30 to 54 Years of Age in the United States, 2001 to 2010**

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | p for Trend |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Overall | | | | | | | | | | | |
| Male | 2.0 | 2.0 | 1.7 | 2.1 | 1.9 | 1.9 | 1.9 | 2.0 | 1.9 | 1.8 | 0.60 |
| Female | 3.3 | 3.0 | 3.3 | 3.0 | 2.5 | 2.5 | 2.4 | 2.2 | 2.1 | 2.3 | <0.01 |
| Age 30–34 yrs | | | | | | | | | | | |
| Male | 2.1 | 2.0 | 1.7 | 2.3 | 2.0 | 1.4 | 1.3 | 1.4 | 1.6 | 1.6 | 0.30 |
| Female | 2.3 | 1.7 | 3.7 | 1.3 | 3.9 | 1.2 | 2.4 | 1.7 | 2.6 | 2.6 | 1.00 |
| Age 35–39 yrs | | | | | | | | | | | |
| Male | 0.8 | 1.6 | 1.2 | 1.9 | 0.9 | 2.0 | 1.4 | 1.4 | 1.5 | 1.3 | 0.30 |
| Female | 3.5 | 1.7 | 2.9 | 2.3 | 3.1 | 1.5 | 2.1 | 0.7 | 2.5 | 1.1 | 0.03 |
| Age 40–44 yrs | | | | | | | | | | | |
| Male | 1.6 | 1.4 | 1.1 | 1.7 | 1.3 | 1.1 | 1.6 | 1.6 | 1.8 | 1.8 | 0.10 |
| Female | 3.2 | 2.1 | 3.1 | 2.5 | 2.2 | 2.3 | 1.7 | 1.6 | 2.1 | 1.9 | 0.01 |
| Age 45–49 yrs | | | | | | | | | | | |
| Male | 1.8 | 1.8 | 1.4 | 1.7 | 1.7 | 2.2 | 1.8 | 1.8 | 1.6 | 1.5 | 0.90 |
| Female | 2.5 | 3.2 | 2.8 | 2.9 | 2.0 | 2.7 | 2.2 | 2.3 | 1.9 | 2.1 | 0.01 |
| Age 50–54 yrs | | | | | | | | | | | |
| Male | 2.6 | 2.5 | 2.1 | 2.6 | 2.5 | 2.1 | 2.3 | 2.4 | 2.3 | 2.1 | 0.10 |
| Female | 3.9 | 3.6 | 3.9 | 3.6 | 2.8 | 2.6 | 2.9 | 2.6 | 2.2 | 2.8 | <0.01 |

Abbreviation as in Table 1.

**TABLE 4** In-Hospital Mortality (Percentages) by Race and Sex Among Patients With AMIs 30 to 54 Years of Age in the United States, 2001 to 2010

| Subgroup | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| Black men | 2.7 | 3.2 | 2.8 | 3.4 | 3.0 | 2.7 | 2.6 | 2.2 | 2.1 | 1.6 |
| White men | 2.1 | 1.8 | 1.4 | 2.2 | 1.7 | 1.9 | 1.8 | 1.9 | 1.8 | 1.8 |
| Black women | 4.8 | 5.2 | 5.2 | 4.1 | 2.4 | 2.7 | 2.9 | 1.8 | 3.5 | 2.1 |
| White women | 3.0 | 2.6 | 2.8 | 2.9 | 2.5 | 2.7 | 2.2 | 2.4 | 1.8 | 2.2 |

Abbreviation as in Table 1.

from 2001 to 2010, whereas hospitalization rates were comparable for black and white men (Fig. 2). Trend analyses from 2001 to 2010 demonstrated a significant decline among black men in all age subgroups more than 35 years of age ($p < 0.05$ for all), without significant declines in all age subgroups of white men. We observed no significant change among black women, however, with statistically significant declines in AMI hospitalization rates demonstrated by a few subgroups of white women (30 to 34, 40 to 44, and 45 to 49 years of age; $p < 0.05$ for all).

**IN-HOSPITAL MORTALITY.** Women had higher in-hospital mortality than men across all subgroups (Tables 3 and 4). From 2001 to 2010, overall observed in-hospital mortality for women with AMIs declined significantly (from 3.3% to 2.3%, a 30.6% decrease; p for trend <0.0001); however, the decrease for men was not significant (from 2% to 1.8%, an 8.5% decrease; p for trend = 0.6). In age and sex analyses, statistically significant declines were noted among women in all age subgroups 35 to 54 years of age. Women had longer LOS than men across all age subgroups (Tables 5 and 6).

## DISCUSSION

Using a national all-payer database, we found several important sex and race differences among younger patients with AMIs. First, in contrast to what is occurring in older patients (8), younger people are not experiencing reductions in AMI hospitalizations. In addition, differences between hospitalization rates of blacks and whites are much more pronounced among young women compared with men. We demonstrated that young women with AMIs have a higher prevalence of several comorbidities than men and that the prevalence of comorbidities has increased in both groups over the past decade (Central Illustration). Additionally, young women had higher in-hospital mortality and longer LOS compared with men.

Our most notable finding is an absence of significant declines in hospitalization rates among young women and men across all age subgroups from 2001 to 2010. This observation is in contrast to the Medicare population studies, in which we described a >20% decline in hospitalization rates for AMI during this time period (8). One potential explanation for this difference could be a lack of awareness and poorer control of risk factors among the young

**TABLE 5** Length of Stay (Days) Among Men and Women With AMIs 30 to 54 Years of Age in the United States, 2001 to 2010

| | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | p for Trend |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Overall | | | | | | | | | | | |
| Male | 4.1 | 4.0 | 4.0 | 4.0 | 3.8 | 3.9 | 3.8 | 3.8 | 3.9 | 3.8 | 0.10 |
| Female | 4.4 | 4.5 | 4.5 | 4.4 | 4.2 | 4.4 | 4.1 | 4.1 | 4.2 | 4.0 | <0.01 |
| Age 30–34 yrs | | | | | | | | | | | |
| Male | 3.8 | 3.3 | 3.8 | 3.7 | 3.6 | 3.6 | 3.4 | 3.5 | 3.7 | 3.5 | 0.30 |
| Female | 4.1 | 4.8 | 4.1 | 4.2 | 3.5 | 4.2 | 4.3 | 3.8 | 3.9 | 4.0 | 0.50 |
| Age 35–39 yrs | | | | | | | | | | | |
| Male | 3.5 | 3.5 | 3.6 | 3.5 | 3.6 | 3.6 | 3.4 | 3.4 | 3.3 | 3.6 | 0.40 |
| Female | 3.8 | 4.1 | 4.1 | 4.1 | 4.0 | 4.1 | 3.8 | 3.9 | 3.7 | 3.6 | 0.60 |
| Age 40–44 yrs | | | | | | | | | | | |
| Male | 3.8 | 3.7 | 3.7 | 3.5 | 3.5 | 3.6 | 3.4 | 3.5 | 3.6 | 3.5 | 0.04 |
| Female | 4.2 | 4.1 | 4.0 | 3.8 | 3.8 | 3.9 | 3.9 | 3.9 | 3.9 | 3.7 | 0.50 |
| Age 45–49 yrs | | | | | | | | | | | |
| Male | 4.0 | 3.9 | 4.0 | 3.9 | 3.7 | 3.8 | 3.7 | 3.8 | 3.8 | 3.7 | 0.10 |
| Female | 4.3 | 4.5 | 4.5 | 4.3 | 3.9 | 4.3 | 3.9 | 4.0 | 4.2 | 4.0 | <0.01 |
| Age 50–54 yrs | | | | | | | | | | | |
| Male | 4.3 | 4.2 | 4.2 | 4.3 | 4.1 | 4.1 | 4.2 | 4.1 | 4.1 | 4.0 | 0.30 |
| Female | 4.6 | 4.8 | 4.8 | 4.8 | 4.7 | 4.7 | 4.4 | 4.3 | 4.5 | 4.2 | <0.01 |

Abbreviation as in Table 1.

population. The National Health and Nutrition Examination Survey reports that although significant reductions were observed in the proportion of the U.S. population having at least 1 of the 3 cardiovascular risk factors (uncontrolled blood pressure, elevated low-density lipoprotein, and current smoking) in the elderly, no significant declines were observed for women younger than 60 years of age and men younger than 40 years of age from 1999 to 2010 (9). In general, coronary heart disease at younger ages is strongly influenced by genetic factors that are harder to modify, resulting in a less impressive decline in hospitalization rates compared with the elderly (10). Moreover, it is possible that young persons who are more likely to survive a hospitalization for AMI, have more admissions for subsequent AMIs. If the rate of these subsequent events is not declining, then it could be responsible for less prominent hospitalization rate declines in this age group.

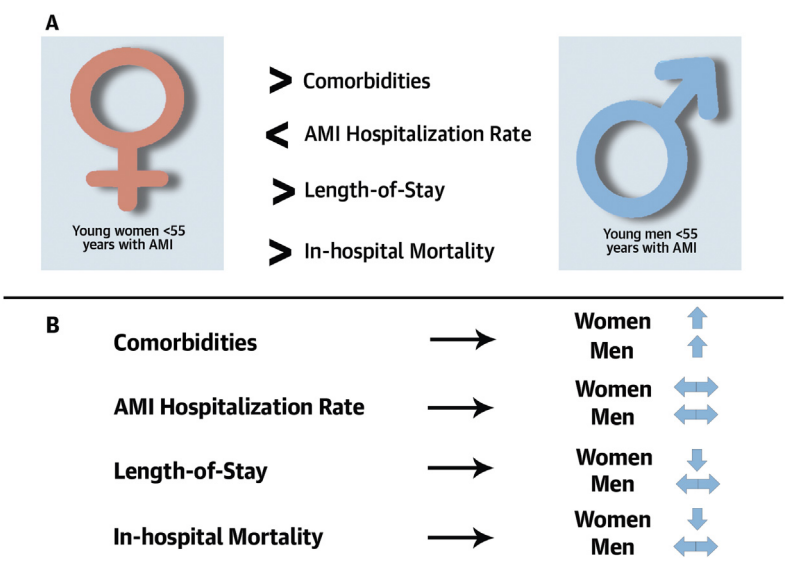
We did observe that subgroups of men ages 40 to 54 years of age showed a trend toward decreasing AMI rates, but women showed either no change or an increasing trend for most age subgroups. This finding is consistent with studies that reported an increasing trend for hospitalization rates among young women <55 years of age, including a recent study from British Columbia (1,11). In the general U.S. population, the 10-year risk for incident cardiovascular disease has not decreased at the same rate in women compared with men, and the Framingham coronary risk score has actually increased in women 35 to 54 years of age (12,13). Also, women belonging to the perimenopausal age group may have abnormal lipid levels that might contribute to the increased risk for AMI in young women (14). In fact, the prevalence of dyslipidemia among women in our study was highest in those ages 50 to 54 years, which is consistent with population-based estimates from the National Health and Nutrition Examination Survey (15). It is also possible that these findings suggest inadequacy of screening and risk factor control (such as hypertension and elevated cholesterol) efforts among women (16,17).

Black women had much higher AMI hospitalization rates than white women, whereas black and white

**TABLE 6** Length of Stay (Days) by Race and Sex Among Patients With AMIs 30 to 54 Years of Age in the United States, 2001 to 2010

| Subgroup | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| Black men | 4.8 | 4.7 | 4.8 | 4.6 | 4.2 | 4.7 | 4.3 | 4.4 | 4.0 | 4.5 |
| White men | 4.1 | 3.8 | 3.9 | 3.9 | 3.7 | 3.8 | 3.6 | 3.7 | 3.7 | 3.6 |
| Black women | 4.7 | 5.3 | 5.4 | 5.0 | 5.0 | 5.3 | 4.8 | 4.6 | 4.7 | 4.4 |
| White women | 4.2 | 4.3 | 4.4 | 4.3 | 4.0 | 4.1 | 4.0 | 3.9 | 4.0 | 3.9 |

Abbreviation as in Table 1.




**CENTRAL ILLUSTRATION** AMI Trends in Young Women and Men, 2001 to 2010

**(A)** Overall comparisons of comorbidities, hospitalization rates, and short-term outcomes in young women with AMIs compared with young men. **(B)** Trends in young women and men with AMIs, 2001 to 2010. Abbreviation as in Figure 1.

men had comparable hospitalization rates. Black women also had the highest prevalence of several comorbidities, including hypertension, diabetes, and heart failure. Our findings are consistent with those of a separate study that demonstrated a markedly higher prevalence of multiple cardiovascular risk factors in black women compared with white women with AMIs (18). In another study, black women were less likely to have optimal blood pressure and cholesterol control compared with white women (19).

We found that young women had higher in-hospital mortality compared with men across all age subgroups. This is consistent with studies reporting a higher likelihood of mortality in young women with AMIs compared with men (11). Women have longer presentation and treatment times after symptom onset compared with men, which may account for their worse in-hospital mortality (20). It is interesting to note that in-hospital mortality declined significantly in almost all age subgroups of young women, but similar declines were not observed among men. Meanwhile, although presentation time continues to be higher in women, there has been a significant reduction in the past decade, which may account for improving in-hospital outcomes as well (21).

**STUDY LIMITATIONS.** First, we did not have detailed clinical data to assess the severity of AMI hospitalization or the quality of care and treatments delivered. Second, "hospitalization rates" do not include all AMIs, because we were unable to account for pre-hospital mortality. Moreover, patients in this dataset are not linked, and as a result we were not able to differentiate first AMIs from subsequent AMIs. In addition, we were not able to assess whether pre-hospital or post-discharge mortality increased to offset declines in in-patient mortality observed among young women. Furthermore, estimates of prevalence of dyslipidemia are based on claims data, and definitions are not standardized. Also, not all HCUP states report ethnicity data, and thus trends in race analyses may not apply to all states. Finally, we relied on administrative data to obtain information on comorbidities.

## CONCLUSIONS

AMI hospitalization rates did not decline for young women and men from 2001 to 2010. Moreover, trends in the frequencies of comorbidities have increased for both women and men hospitalized with AMIs in the past decade, suggesting a greater need for intensive primary prevention efforts in the high-risk young population. Racial differences for AMI hospitalizations in young patients were more pronounced for women compared with men, which requires further study of underlying causes and remedies. Although in-hospital mortality rates are declining for young women, they remain higher than in men. These trends warrant further investigation to identify the biological, clinical, and social factors that contribute to these differences.

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## PERSPECTIVES

**COMPETENCY IN MEDICAL KNOWLEDGE 1:** Hospitalization rates for younger patients with AMI have not declined as they have for older people.

**COMPETENCY IN MEDICAL KNOWLEDGE 2:** Among younger patients hospitalized with AMIs, women have more comorbidities, longer stays, and higher mortality rates than men.

**COMPETENCY IN INTERPERSONAL AND COMMUNICATION SKILLS:** Physicians and other health care professionals should seek opportunities to inform patients, the public, and policy makers about cardiovascular disease risk factors and direct resources toward younger segments of the population for primary prevention.

**COMPETENCY IN PATIENT CARE:** Because of their generally greater burden of comorbidities, young women may gain more benefit from aggressive control of cardiovascular risk factors, including early identification and treatment of hypertension, hyperlipidemia, obesity, smoking, diabetes, and other modifiable risk factors.

**TRANSLATIONAL OUTLOOK 1:** Mechanisms underlying the higher risks associated with AMI in young women than in men warrant further investigation to identify the sex-specific biological, clinical, and social factors responsible.

**TRANSLATIONAL OUTLOOK 2:** Racial differences in hospitalizations for AMI in young patients were more pronounced among women compared with men, warranting further investigation of potential causes.

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**KEY WORDS** acute myocardial infarction, hospitalization, sex differences, trends, young women