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ORIGINAL RESEARCH

Racial and Ethnic and Sex Disparities in the Outcomes and Treatment of In-Hospital Cardiac Arrest: A Nationwide Analysis From the United States

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BACKGROUND: In-hospital cardiac arrest (IHCA) is associated with significant morbidity and mortality. The relationships between race and ethnicity and sex on outcomes and treatment patterns among patients with IHCA remain poorly understood.

METHODS AND RESULTS: We conducted a retrospective study using the National (Nationwide) Inpatient Sample (NIS) database from 2016 to 2020 to identify adult patients with IHCA and examine the associations between in-hospital outcomes and race and ethnicity (White, Black, Hispanic) and sex. The primary outcome was in-hospital mortality. Secondary outcomes included rates of in-hospital procedures. Multivariable logistic regression analysis was used to adjust for potential confounders. Among 207 770 patients with IHCA, 26.6% had ventricular tachycardia/ventricular fibrillation and 73.4% had pulseless electrical activity/asystole. For ventricular tachycardia/ventricular fibrillation arrest, Black men (adjusted odds ratio [aOR], 1.42 [95% CI, 1.21–1.66]), Black women (aOR, 1.25 [95% CI, 1.05–1.50]), and Hispanic women (aOR, 1.30 [95% CI, 1.01–1.66]) had higher odds of mortality compared with White men (corresponding adjusted risk ratios [aRRs], 1.10 [CI, 1.06–1.14], 1.06 [95% CI, 1.02–1.11], and 1.08 [95% CI, 1.01–1.14], respectively). In the pulseless electrical activity/asystole arrest subgroup, Black men (aOR, 1.25 [95% CI, 1.11–1.39]) and Hispanic men (aOR, 1.22 [95% CI, 1.07–1.40]) had higher odds of mortality (corresponding aRRs, 1.04 [95% CI, 1.02–1.06] and 1.04 [95% CI, 1.01–1.06], respectively). Black patients with IHCA were less likely to receive percutaneous coronary intervention, coronary artery bypass grafting, and mechanical circulatory support compared with White men.

CONCLUSIONS: Significant racial and ethnic and sex disparities exist in outcomes and treatment patterns among patients with IHCA. Targeted efforts and further studies are needed to better understand and address these disparities and improve outcomes.

Key Words: cardiac arrest ■ disparities ■ race/ethnic ■ sex

In-hospital cardiac arrest (IHCA) affects over 290 000 patients annually in the United States and is associated with significant morbidity and mortality.[1] Despite advances in resuscitation techniques and postarrest care leading to improved IHCA survival over the past 2 decades, <25% of patients survive to hospital discharge.[2–4] The high rates of mortality associated with IHCA underscore the importance of understanding the factors that influence patient outcomes and identifying potential disparities in care.

Racial and ethnic and sex disparities have been well documented in numerous cardiovascular diseases,

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CLINICAL PERSPECTIVE

What Is New?

- In this large nationwide study of patients with in-hospital cardiac arrest, significant racial and ethnic and sex disparities were observed in outcomes and treatment patterns, with Black and Hispanic patients generally experiencing higher mortality rates and lower rates of coronary interventions and mechanical circulatory support, while also having higher rates of tracheostomy, gastrostomy, and renal replacement therapy, compared with White patients.

What Are the Clinical Implications?

- Clinicians and health systems should be aware of the substantial racial and ethnic and sex disparities associated with in-hospital cardiac arrest outcomes and treatment, and proactively work to ensure equitable high-quality care for all patients.
- Future research is needed to better understand the patient-, provider-, and system-level factors contributing to these disparities in order to develop targeted interventions.

Nonstandard Abbreviations and Acronyms

AHRQ	Agency for Healthcare Research and Quality
aRR	adjusted risk ratio
CCI	Charlson Comorbidity Index
HCUP	Healthcare Cost and Utilization Project
IHCA	in-hospital cardiac arrest
NIS	National (Nationwide) Inpatient Sample
OHCA	out-of-hospital cardiac arrest
PEA	pulseless electrical activity

including out-of-hospital cardiac arrest (OHCA). Studies have shown that Black and Hispanic patients were less likely to receive bystander cardiopulmonary resuscitation and had worse neurological outcomes compared with White patients, while women experience lower rates of bystander cardiopulmonary resuscitation and delayed time to defibrillation compared with men following OHCA.[5–9] Similar disparities extend to other cardiovascular conditions, with minority populations and women experiencing higher incidence and mortality with acute myocardial infarction and heart failure.[10–14]

Despite the growing body of literature on racial and ethnic and sex disparities in OHCA, these relationships remain poorly defined in the case of IHCA.[9] Previous studies have shown mixed results regarding sex differences in IHCA outcomes, with some indicating better survival for women and others showing no difference or worse outcomes.[15–18] In addition, while prior studies have primarily focused on differences between White and Black patients, the outcomes for patients of Hispanic ethnicity have not been well studied in the context of IHCA.[19,20] Furthermore, to our knowledge, no previous study has comprehensively examined both sex and racial and ethnic disparities simultaneously in IHCA outcomes.

Therefore, we analyzed the National (Nationwide) Inpatient Sample (NIS) database to examine the relationships between race and ethnicity, sex, and in-hospital outcomes and treatment of patients with IHCA. We chose in-hospital mortality as our primary outcome because of its critical importance in assessing overall IHCA care quality. We also investigated rates of invasive coronary interventions and mechanical circulatory support (MCS) given prior studies noting racial and sex disparities in these interventions for OHCA, as well as cardiac arrest in the setting of acute myocardial infarction.[21,22] Furthermore, we examined procedures indicative of prolonged intensive care and potentially worse neurological outcomes, including tracheostomy, gastrostomy, and renal replacement therapy.

METHODS

Study Design and Database Description

This study is a cross-sectional retrospective analysis employing data from the NIS from 2016 through 2020. The specific data that support this study's findings are available from the corresponding author upon request. Developed for the Healthcare Cost and Utilization Project (HCUP) of the Agency for Healthcare Research and Quality (AHRQ), the NIS is the largest publicly available all-payer inpatient database in the United States.[23] NIS includes a stratified 20% sample of all hospital discharges in the United States, excluding those from rehabilitation and long-term acute care facilities. Since the NIS database is a public database with deidentified data, Hennepin Healthcare's institutional review board approval was waived.

Study Population

We identified adult patients (aged ≥18 years) who experienced IHCA between January 1, 2016, and December 31, 2020, using *International Classification of Diseases, Tenth Revision, Clinical Modification* (*ICD-10-CM*) codes (Table S1). Patients with OHCA were excluded from the analysis.[24] This *ICD* coding approach used in this study has been previously validated, with a positive predictive value of 83.3% for identifying

IHCA.[25] Patients with ventricular tachycardia/fibrillation (VT/VF) arrest were identified using secondary diagnosis codes (Table S1), while the remaining patients without VT/VF arrest codes were considered to have pulseless electrical activity (PEA) or asystole.[24,26] A recently published paper by Wu et al[27] has also used a similar method to identify IHCA as well as the type of the presenting rhythm. We also excluded patients with postoperative cardiac arrest and those with missing data on race or sex.

The study population was categorized into 6 subgroups based on self-reported race and sex, as recorded in the NIS using predefined variables. The subgroups were: White men, White women, Black men, Black women, Hispanic men, and Hispanic women. The NIS database categorizes a patient's sex as a binary variable, with options limited to man or woman. Patients whose sex was not reported, undetermined, or identified as nonbinary were classified as having missing data. The NIS combines race and ethnicity into a single variable, prioritizing ethnicity over race when both pieces of information are available. For example, if a patient self-identifies as having Black race and Hispanic ethnicity, the patient would be categorized as Hispanic in the NIS database. The race and ethnicity categories available in the NIS include White, Black, Hispanic, Asian or Pacific Islander, Native American, and other.

For this study, because of very small subgroup sample sizes, we excluded patients who identified as Asian or Pacific Islander, Native American, or other. We acknowledge that excluding patients with missing race or sex data, as well as those from smaller racial and ethnic groups, may introduce bias. The characteristics of excluded patients could differ from those included, which might affect the generalizability of our results to those excluded from the study.

Patient Characteristics and Outcome Measures

The primary outcome was in-hospital all-cause mortality. Secondary outcomes included in-hospital procedures including percutaneous coronary intervention (PCI), coronary artery bypass grafting (CABG), MCS, tracheostomy, gastrostomy, and renal replacement therapy (Table S2). We excluded all procedures performed before the day of the cardiopulmonary resuscitation to specifically account for postarrest procedures.

Statistical Analysis

All the generated data are weighted per HCUP guidelines (https://hcup-us.ahrq.gov/tech_assist/tutorials.jsp). $\chi 2$ testing was used to compare categorical variables, which were reported as proportions. All statistical analyses were conducted using Stata version 18.0 (StataCorp LLC). To account for the complex survey design and hospital clustering, we employed Stata's survey commands, setting the hospital identifier (HOSP_NIS) as the primary sampling unit (clustering variable) along with strata (NIS_STRATUM), and sampling weight (DISCWT) as recommended by the AHRQ's methods series.

Multivariable logistic regression analysis was performed to adjust for potential confounders, including demographic characteristics (age, insurance, median household income), hospital characteristics (hospital region, size, teaching status), Charlson Comorbidity Index (CCI), and relevant comorbidities (Table S3). These variables were selected based on their established or potential association with IHCA outcomes, as identified in previous literature and clinical expertise, as well as their clinical significance, which may directly influence in-hospital outcomes. Variables for multivariable adjustment models were chosen in a 2-step process: initially, univariable screening of all variables (Table S3) was performed for each outcome of interest. After that, all variables with a *P* value <0.2 were included in the final multivariable model for that outcome. The results from this model are reported as adjusted odds ratios (aORs) with 95% CIs and *P* values for each outcome.

We also calculated adjusted risk ratios (aRRs) for mortality using a survey-weighted Poisson regression model[28] and used the same variable selection approach as the logistic regression models. The results of this analysis are presented in Table S4. In addition to our primary analysis using White men as the reference group, we conducted a secondary analysis of in-hospital mortality using each cohort of White, Black, and Hispanic patients of each sex as the reference to provide a more comprehensive perspective on mortality differences among groups (results in Table S5).

RESULTS

Patient and Hospital Characteristics

A total of 207 770 patients with IHCA were identified from 2016 to 2020. Of these, 55 340 (26.6%) had VT/VF arrests and 152 430 (73.4%) had PEA/asystole arrests. White men constituted the largest group at 38.7% (80 304), followed by White women at 26.3% (54 702), Black men at 11.9% (24 821), Black women at 11.1% (22 967), Hispanic men at 7.3% (15 154), and Hispanic women at 4.7% (9822). The proportions of those 6 categories in each subgroup of VT/VF and PEA/asystole arrest are shown in Figure 1. White men were more likely to have VT/VF arrest compared with the other groups (31.3% versus 23.4% [White women], 26.5% [Black men], 21.7% [Black women], 25.4% [Hispanic men], and 20.8% [Hispanic women]; all *P*<0.01). In contrast, White men were less likely to have PEA/asystole compared with the other groups (68.7% versus 76.6% [White

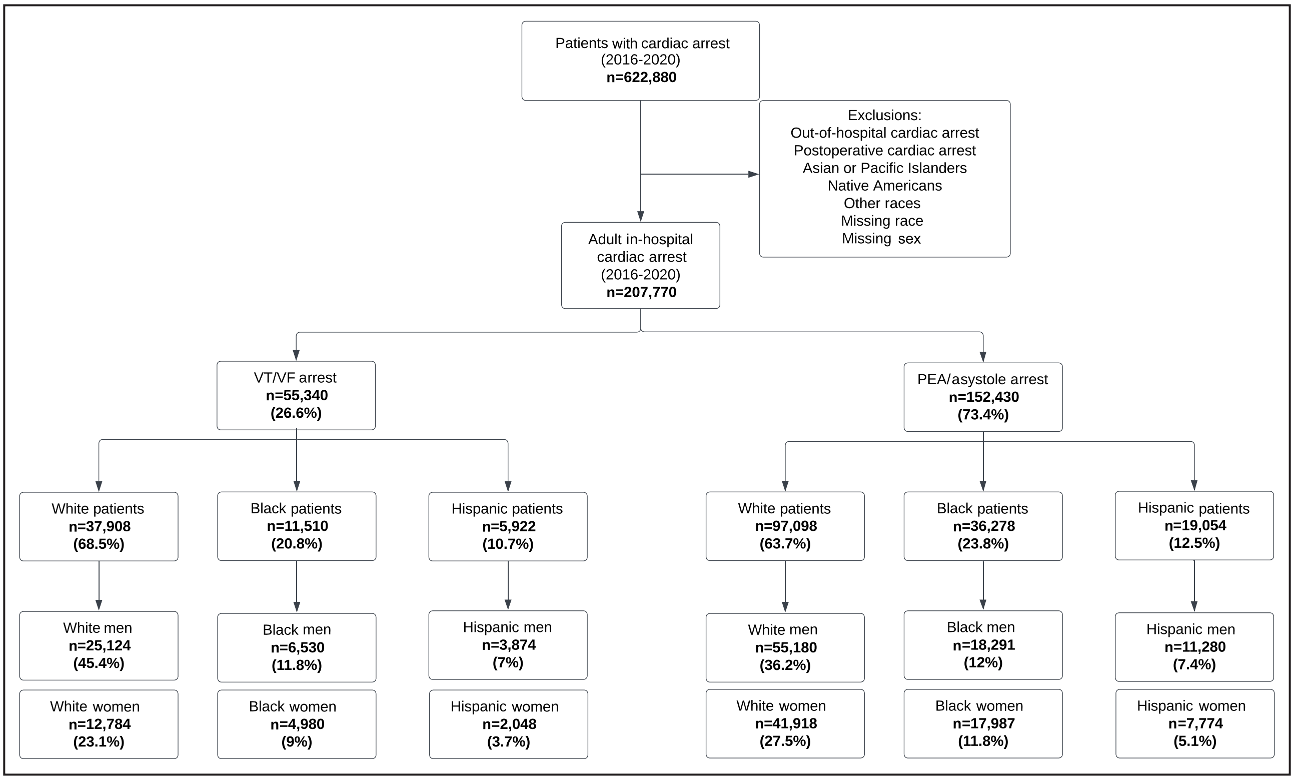

Figure 1. Study flow diagram showing inclusion and exclusion criteria.
PEA indicates pulseless electrical activity; and VT/VF, ventricular tachycardia/ventricular fibrillation.

women], 73.5% [Black men], 78.3% [Black women], 74.6% [Hispanic men], and 79.2% [Hispanic women]; all *P*<0.01) (Figure 2).Significant differences were observed in patient characteristics among racial/ethnic and sex subgroups (Table 1). Black and Hispanic patients were younger compared with White patients. The CCI was highest in Black patients, with 67.2% of Black men and 67.6% of Black women having a score of ≥3 versus 60.5% in White men. Differences in socioeconomic status were also evident, with a higher proportion of Black and Hispanic patients belonging to the lowest income quartile compared with White patients. Medicaid was the primary payer for 37% of Black and 48.5% of Hispanic patients compared with 19.6% of White patients. Most patients were treated in large, urban teaching hospitals among all of the subgroups. The Southern states of the United States had the highest proportion of overall IHCA cases compared with other US regions (Table S6).

Primary Outcome: Mortality

In our study, the overall prevalence of mortality among those with IHCA was 76.3%. Unadjusted mortality rates were significantly higher in Black and Hispanic patients compared with White patients for both VT/VF and PEA/asystole arrests (Table 2; Figure 3). In the multivariable logistic regression analysis controlling for comorbidity and other key variables (Table 3), Black men had the highest adjusted odds of mortality in VT/VF arrests (aOR, 1.42 [95% CI, 1.21–1.66], *P*<0.01), followed by Hispanic women (aOR, 1.30 [95% CI, 1.01–1.66], *P*=0.04) and Black women (aOR, 1.25 [95% CI, 1.05–1.50], *P*=0.01), compared with White men. For PEA/asystole arrests, Black men (aOR, 1.25 [95% CI, 1.11–1.39], *P*<0.01) and Hispanic men (aOR, 1.22 [95% CI, 1.07–1.40], *P*<0.01) had higher odds of mortality, while White women had lower odds of mortality (aOR, 0.88 [95% CI, 0.82–0.94], *P*<0.01), compared with White men (Figure 3).

When using different racial and ethnic and sex groups as reference in the secondary analysis, the observed disparities in mortality remained consistent. For instance, Black men consistently showed higher odds of mortality across both VT/VF and PEA/asystole arrests compared with White patients of either sex (Table S5).

To account for the high prevalence of mortality in IHCA, we also calculated aRRs as shown in Table S4. The patterns of disparities remained consistent with our primary analysis using odds ratios, though the magnitude of associations was attenuated as expected.

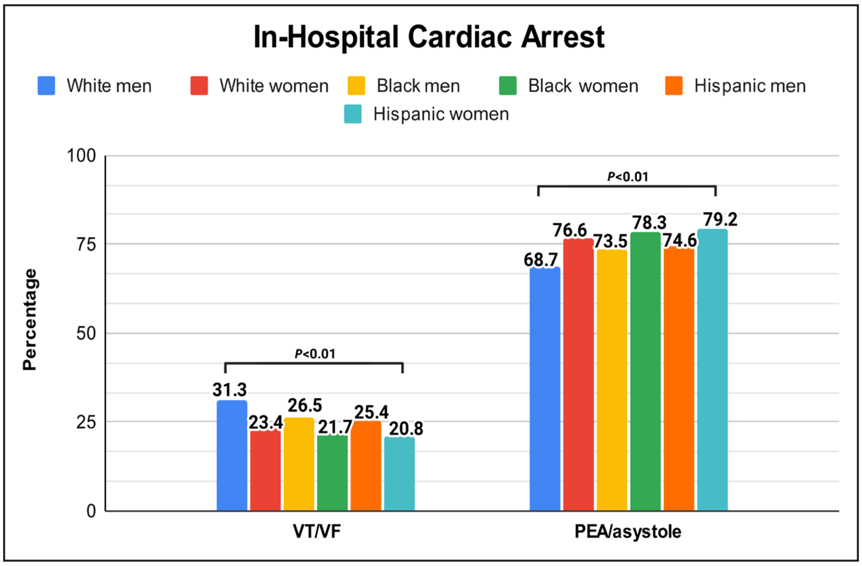

Figure 2. Prevalence of VT/VF arrest and PEA/asystole by race/ethnicity and sex.
PEA indicates pulseless electrical activity; and VT/VF, ventricular tachycardia/ventricular fibrillation.

Secondary Outcomes: Procedure Use

Outcomes of PCI, CABG, and MCS

Rates of in-hospital procedures differed significantly among the racial and ethnic groups (Table 2). White men consistently had the highest rates of coronary interventions, including PCI and CABG, as well as MCS use, for both VT/VF and PEA/asystole arrests (Figure 4). In the adjusted analysis (Table 3; Figure 5), Black patients with VT/VF arrests had significantly lower odds of receiving PCI (Black men: aOR, 0.53 [95% CI, 0.43–0.66]; Black women: aOR, 0.54 [95% CI, 0.42–0.69]) and CABG (Black men: aOR, 0.50 [95% CI, 0.30–0.82]; Black women: aOR, 0.47 [95% CI, 0.27–0.81]) compared with White men. Similar trends were observed for PEA/asystole arrests (Figure 6). Hispanic men had lower odds of receiving PCI or CABG in PEA/asystole arrest compared with White men (aORs 0.70 [95% CI, 0.54–0.91] and 0.62 [95% CI, 0.40–0.96], respectively). White women were also noted to have ≈30% lower odds of receiving CABG compared with White men in VF/VT arrest (aOR, 0.71 [95% CI, 0.54–0.94]).

Outcomes of Tracheostomy, Gastrostomy, and Renal Replacement Therapy

Following adjustment, Black patients had higher odds of tracheostomy in PEA/asystole and gastrostomy in both VT/VF and PEA/asystole compared with White men. Both Hispanic men and women had higher odds of tracheostomy and Hispanic women had higher odds of gastrostomy in VT/VF arrest compared with White men. Renal replacement therapy was more common in Black and Hispanic patients, with Black men having the highest adjusted odds of renal replacement therapy in VT/VF arrests (aOR, 1.47 [95% CI, 1.21–1.80]) and Hispanic men having the highest adjusted odds of renal replacement therapy in PEA/asystole arrests (aOR, 1.49 [95% CI, 1.27–1.74]) compared with White men (Table 3; Figures 5 and 6).

DISCUSSION

Using a large, national data set, our study reveals significant racial and ethnic and sex disparities in outcomes and treatment patterns among patients with IHCA. The main findings of our study include the following: (1) notable differences were observed in the presenting rhythm of cardiac arrest among racial and ethnic and sex groups, with White men more likely to present with VT/VF arrests compared with other groups; (2) Black and Hispanic patients generally experienced higher mortality rates compared with White men, particularly in VT/VF arrests; and (3) substantial disparities were evident in the use of postarrest interventions, with Black patients consistently receiving lower rates of PCI, CABG, and MCS compared with White men.

VT/VF Versus PEA/Asystole

When stratifying by sex, we found that men were more likely to present with VT/VF, while women were more likely to present with PEA/asystole within each racial and ethnic group.[28] Meaney et al[29] partially accounted for the overall racial and ethnic disparity in IHCA outcomes by highlighting the difference in the proportion of VT/VF

Table 1. Patient Characteristics of IHCA by Race and Ethnicity and Sex

Patient characteristics	White men, n=80 304 (%)	White women, n=54 702 (%)	Black men, n=24 821 (%)	Black women, n=22 967 (%)	Hispanic men, n=15 154 (%)	Hispanic women, n=9822 (%)	*P* value
Age, y							<0.01
18–34	2248 (2.8)	1860 (3.4)	1489 (6)	1102 (4.8)	909 (6)	638 (6.5)	
35–64	27 384 (34.1)	17 614 (32.2)	11 989 (48.3)	9577 (41.7)	7062 (46.6)	3801 (38.7)	
>65	50 672 (63.1)	35 228 (64.4)	11 343 (45.7)	12 288 (53.5)	7183 (47.4)	5383 (54.8)	
CCI							<0.01
0	6505 (8.1)	5525 (10.1)	1886 (7.6)	1493 (6.5)	1455 (9.6)	903 (9.2)	
1	11 644 (14.5)	9628 (17.6)	2755 (11.1)	2710 (11.8)	2182 (14.4)	1277 (13)	
2	13 571 (16.9)	9846 (18)	3500 (14.1)	3238 (14.1)	2137 (14.1)	1562 (15.9)	
≥3	48 584 (60.5)	29 703 (54.3)	16 680 (67.2)	15 526 (67.6)	9380 (61.9)	6080 (61.9)	
Median annual income by zip code*							<0.01
First quartile	21 602 (26.9)	15 317 (28)	13 726 (55.3)	12 747 (55.5)	6259 (41.3)	3890 (39.6)	
Second quartile	21 602 (26.9)	15 152 (27.7)	5039 (20.3)	4731 (20.6)	3773 (24.9)	2573 (26.2)	
Third quartile	19 755 (24.6)	13 293 (24.3)	3773 (15.2)	3330 (14.5)	3273 (21.6)	2161 (22)	
Fourth quartile	17 345 (21.6)	10 940 (20)	2283 (9.2)	2159 (9.4)	1849 (12.2)	1198 (12.2)	
Insurance type							<0.01
Medicare	53 563 (66.7)	38 127 (69.7)	14 570 (58.7)	14 906 (64.9)	7850 (51.8)	5441 (55.4)	
Medicaid	7870 (9.8)	5361 (9.8)	4840 (19.5)	4019 (17.5)	3501 (23.1)	2495 (25.4)	
Private	15 739 (19.6)	9518 (17.4)	3971 (16)	3353 (14.6)	2500 (16.5)	1365 (13.9)	
Uninsured	3132 (3.9)	1696 (3.1)	1440 (5.8)	689 (3)	1303 (8.6)	521 (5.3)	
Hospital region							<0.01
Northeast	14 134 (17.6)	9792 (17.9)	3996 (16.1)	3675 (16)	2152 (14.2)	1208 (12.3)	
Midwest	17 747 (22.1)	12 253 (22.4)	4567 (18.4)	4180 (18.2)	879 (5.8)	540 (5.5)	
South	32 282 (40.2)	22 537 (41.2)	13 503 (54.4)	12 586 (54.8)	5637 (37.2)	3821 (38.9)	
West	16 141 (20.1)	10 120 (18.5)	2755 (11.1)	2526 (11)	6486 (42.8)	4253 (43.3)	
Hospital bed size							<0.01
Small	13 652 (17)	9682 (17.7)	4145 (16.7)	3652 (15.9)	2531 (16.7)	1768 (18)	
Medium	22 886 (28.5)	15 590 (28.5)	6975 (28.1)	6844 (29.8)	4970 (32.8)	3231 (32.9)	
Large	43 766 (54.5)	29 430 (53.8)	13 701 (55.2)	12 471 (54.3)	7653 (50.5)	4823 (49.1)	
Hospital teaching status							<0.01
Nonteaching	22 244 (27.7)	16 301 (29.8)	4989 (20.1)	4731 (20.6)	3591 (23.7)	2524 (25.7)	
Teaching	58 060 (72.3)	38 401 (70.2)	19 832 (79.9)	18 236 (79.4)	11 563 (76.3)	7298 (74.3)	
Comorbidities							
Hypertension	52 920 (65.9)	35 775 (65.4)	12 024 (69.6)	16 858 (73.4)	9835 (64.9)	6640 (67.6)	<0.01
Diabetes	29 632 (36.9)	18 708 (34.2)	10 102 (40.7)	10 496 (45.7)	7577 (50)	5166 (52.6)	<0.01
Hyperlipidemia	30 917 (38.5)	19 419 (35.5)	7099 (28.6)	6982 (30.4)	4728 (31.2)	3173 (32.3)	<0.01
Chronic pulmonary diseases	22 887 (28.5)	17 176 (31.4)	5907 (23.8)	6775 (29.5)	2607 (17.2)	2072 (21.1)	<0.01
Liver disease	15 900 (19.8)	9737 (17.8)	5560 (22.4)	4433 (19.3)	3819 (25.2)	2033 (20.7)	<0.01
Tobacco use	28 588 (35.6)	15 590 (28.5)	7198 (29)	5168 (22.5)	3576 (23.6)	1405 (14.3)	<0.01
Alcohol use	6023 (7.5)	2024 (3.7)	1663 (6.7)	551 (2.4)	1288 (8.5)	177 (1.8)	<0.01
Drug use	4176 (5.2)	2626 (4.8)	2011 (8.1)	919 (4)	955 (6.3)	354 (3.6)	<0.01
Obesity	13 009 (16.2)	10 229 (18.7)	3301 (13.3)	4961 (21.6)	2500 (16.5)	1974 (20.1)	<0.01
OSA	8271 (10.3)	3774 (6.9)	1862 (7.5)	1677 (7.3)	667 (4.4)	403 (4.1)	<0.01
History of coagulopathy	17 024 (21.2)	10 940 (20)	6354 (25.6)	5719 (24.9)	4016 (26.5)	2505 (25.5)	<0.01

(*Continued*)

Table 1. Continued

Patient characteristics	White men, n=80304 (%)	White women, n=54702 (%)	Black men, n=24821 (%)	Black women, n=22967 (%)	Hispanic men, n=15154 (%)	Hispanic women, n=9822 (%)	*P* value
History of malignancy	5943 (7.4)	3774 (6.9)	2135 (8.6)	1929 (8.4)	955 (6.3)	550 (5.6)	<0.01
History of malnutrition	10279 (12.8)	7330 (13.4)	4493 (18.1)	4088 (17.8)	2303 (15.2)	1444 (14.7)	<0.01
History of dementia	6665 (8.3)	4923 (9)	2383 (9.6)	2618 (11.4)	1167 (7.7)	1090 (11.1)	<0.01
History of depression	6665 (8.3)	7658 (14)	1291 (5.2)	1860 (8.1)	879 (5.8)	972 (9.9)	<0.01
Family history of CAD	3614 (4.5)	2298 (4.2)	918 (3.7)	942 (4.1)	424 (2.8)	324 (3.3)	<0.01
History of CAD	38947 (48.5)	19419 (35.5)	7620 (30.7)	6592 (28.7)	5577 (36.8)	2986 (30.4)	<0.01
History of PAD	7950 (9.9)	4869 (8.9)	1911 (7.7)	1700 (7.4)	1031 (6.8)	688 (7)	<0.01
Dialysis dependent	4015 (5)	2188 (4)	3128 (12.6)	2848 (12.4)	1697 (11.2)	1139 (11.6)	<0.01
Previous MI	9958 (12.4)	4157 (7.6)	1936 (7.8)	1654 (7.2)	1167 (7.7)	491 (5)	<0.01
Previous stroke	5059 (6.3)	4048 (7.4)	1812 (7.3)	1837 (8)	803 (5.3)	629 (6.4)	<0.01
Previous PCI	8833 (11)	3884 (7.1)	1415 (5.7)	1171 (5.1)	1091 (7.2)	472 (4.8)	<0.01
Previous CABG	8994 (11.2)	2735 (5)	1142 (4.6)	781 (3.4)	1106 (7.3)	481 (4.9)	<0.01
History of ICD	3694 (4.6)	985 (1.8)	1365 (5.5)	666 (2.9)	606 (4)	147 (1.5)	<0.01
History of PPM	3212 (4)	1969 (3.6)	521 (2.1)	574 (2.5)	409 (2.7)	295 (3)	<0.01

CABG indicates coronary artery bypass graft; CAD, coronary artery disease; CCI, Charlson Comorbidity Index; IHCA, in-hospital cardiac arrest; ICD, implantable cardioverter-defibrillator; MI, myocardial infarction; OSA, obstructive sleep apnea; PAD, peripheral artery disease; PCI, percutaneous coronary intervention; and PPM, permanent pacemaker.

*Estimated median household incomes are zip code–specific, updated annually, and classified into 4 quartiles indicating poorest to wealthiest.

compared with PEA/asystole between racial and ethnic groups. They reported that Black and Hispanic patients were less likely to have a VT/VF arrest compared with their White counterparts. Our study also found that White men were more likely to present with a VT/VF arrest compared with other racial and sex subgroups. Despite women being more likely to present with PEA/asystole arrest, White women had a lower prevalence of mortality than White men, while Black and Hispanic women had similar mortality rates as White men. These observations suggest that sex differences may have a greater influence on the disparity in in-hospital mortality than the presenting rhythm alone.

Mortality

In the VT/VF arrest subgroup, both sexes of Black patients and Hispanic women had higher odds of mortality compared with White men. This finding is consistent with prior studies that have reported lower survival rates and worse neurological outcomes among Black and Hispanic patients compared with White patients.[4,20,30] However, White women showed no statistical difference in mortality compared with White men in the VT/VF subgroup, suggesting that sex disparities may be less pronounced among White patients with VT/VF. In the PEA/asystole subgroup, both Black and Hispanic men had higher odds of mortality compared with White men, while White women had lower odds of mortality compared with White men.

In-Hospital Procedures

Our study revealed significant disparities in the rates of in-hospital procedures among race and ethnicity and sex. Black patients and White women with any IHCA and Hispanic men with PEA/asystole were less likely to receive coronary interventions and MCS compared with White men. These findings align with prior studies reporting lower rates of cardiac interventions among women and minority groups.[31–33] The underlying causes of these disparities are complex, with some research suggesting not only the underuse of revascularization procedures for minority groups and women, but also potential overuse among White men.[34,35] White men in the present study were more likely to be older and had the highest prevalence of cardiovascular diseases, which likely contributed to these findings. However, there were no differences in MCS use between both sexes of Hispanic patients and White men.

Racial and sex disparities were also observed in the utilization of tracheostomy and gastrostomy. Regardless of sex, Hispanic patients were more likely to receive tracheostomy in VT/VF arrest, while Black patients were

Table 2. Unadjusted Primary and Secondary In-Hospital Outcomes of IHCA Based on Their Associations With Race and Ethnicity and Sex

Variables	White men, n=80 304 (%)	White women, n=54 702 (%)	Black men, n=24 821 (%)	Black women, n=22 967 (%)	Hispanic men, n=15 154 (%)	Hispanic women, n=9822 (%)	*P* value
Primary outcome							
Mortality							
Overall	59 666 (74.3)	40 698 (74.4)	20 105 (81)	18 305 (79.7)	12 093 (79.8)	7602 (77.4)	<0.01
VT/VF	54 205 (67.5)	38 237 (69.9)	19 063 (76.8)	17 685 (77)	11 153 (73.6)	7445 (75.8)	<0.01
PEA/asystole	62 236 (77.5)	41 464 (75.8)	20 477 (82.5)	18 488 (80.5)	12 411 (81.9)	7642 (77.8)	<0.01
Procedures							
PCI							
Overall	8191 (10.2)	4103 (7.5)	918 (3.7)	758 (3.3)	1061 (7)	550 (5.6)	<0.01
VT/VF	17 667 (22)	9682 (17.7)	2408 (9.7)	1883 (8.2)	2758 (18.2)	1493 (15.2)	<0.01
PEA/asystole	3855 (4.8)	2011 (4.4)	372 (1.5)	459 (2)	485 (3.2)	295 (3)	<0.01
CABG							
Overall	1686 (2.1)	602 (1.1)	124 (0.5)	138 (0.6)	197 (1.3)	108 (1.1)	<0.01
VT/VF	2730 (3.4)	1203 (2.2)	223 (0.9)	299 (1.3)	409 (2.7)	196 (2)	<0.01
PEA/asystole	1205 (1.5)	438 (0.8)	75 (0.3)	92 (0.4)	121 (0.8)	79 (0.8)	<0.01
MCS							
Overall	6665 (8.3)	2954 (5.4)	943 (3.8)	712 (3.1)	985 (6.5)	540 (5.5)	<0.01
VT/VF	13 009 (16.2)	6455 (11.8)	2035 (8.2)	1608 (7)	2258 (14.9)	1277 (13)	<0.01
PEA/asystole	3855 (4.8)	1860 (3.4)	546 (2.2)	482 (2.1)	546 (3.6)	344 (3.5)	<0.01
Tracheostomy							
Overall	964 (1.2)	602 (1.1)	496 (2)	482 (2.1)	227 (1.5)	187 (1.9)	<0.01
VT/VF	964 (1.2)	602 (1.1)	521 (2.1)	459 (2)	273 (1.8)	216 (2.2)	0.02
PEA/asystole	964 (1.2)	602 (1.1)	496 (2)	482 (2.1)	212 (1.4)	177 (1.8)	<0.01
Gastrostomy							
Overall	1285 (1.6)	821 (1.5)	794 (3.2)	666 (2.9)	333 (2.2)	236 (2.4)	<0.01
VT/VF	1124 (1.4)	821 (1.5)	794 (3.2)	666 (2.9)	333 (2.2)	285 (2.9)	<0.01
PEA/asystole	1365 (1.7)	821 (1.5)	794 (3.2)	666 (2.9)	333 (2.2)	226 (2.3)	<0.01
Renal replacement therapy							
Overall	5541 (6.9)	3173 (5.8)	3128 (12.6)	2549 (11.1)	1773 (11.7)	1031 (10.5)	<0.01
VT/VF	6424 (8)	3720 (6.8)	3401 (13.7)	3147 (13.7)	1728 (11.4)	1464 (14.9)	<0.01
PEA/asystole	5140 (6.4)	3009 (5.5)	3053 (12.3)	2389 (10.4)	1773 (11.7)	923 (9.4)	<0.01

CABG indicates coronary artery bypass graft; IHCA, in-hospital cardiac arrest; MCS, mechanical circulatory support; PCI, percutaneous coronary interventions; PEA, pulseless electrical activity; and VT/VF, ventricular tachycardia/ventricular fibrillation.

more likely to receive tracheostomy in PEA/asystole arrest compared with White men. In addition, Black patients were more likely to receive gastrostomy in both VT/VF and PEA/asystole arrest compared with White men, while Hispanic women had higher rates of gastrostomy in VT/VF arrest. These findings may suggest that Black and Hispanic patients were more likely to have longer intubation periods and worse neurological outcomes, requiring tracheostomy and/or gastrostomy, compared with their White counterparts.[4] Woo et al[36] reported similar findings in patients admitted with OHCA, where minority patients received fewer guideline-recommended postresuscitation treatments, including cardiac catheterization for suspected cardiac causes, while also undergoing tracheostomy and gastrostomy procedures at higher rates compared with White patients.

Renal replacement therapy was more common in Black and Hispanic patients, with Black men having the highest adjusted odds in VT/VF arrests and Hispanic men in PEA/asystole arrests compared with White men. These findings support previous literature that Black patients were more likely to have acute kidney injury compared with White patients, attributed to higher rates of comorbidities among Black patients. However, there is a paucity of data focusing on comparisons between Hispanic and White patients.[37–39]

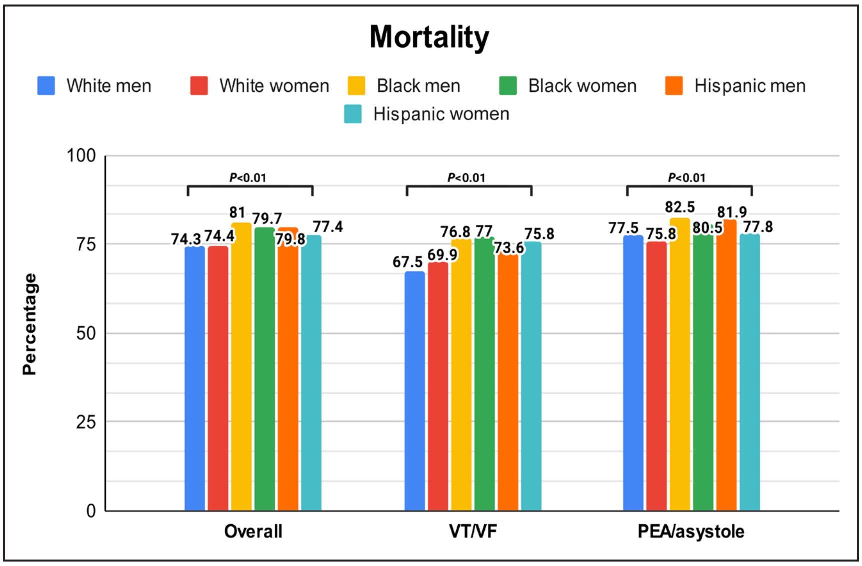

Figure 3. Unadjusted in-hospital mortality differences based on their association with race and ethnicity and sex.
PEA indicates pulseless electrical activity; and VT/VF, ventricular tachycardia/ventricular fibrillation.

Causes of Disparities

The disparities in outcomes and treatment patterns observed in our study may be attributed to a complex interplay of patient-, provider-, and system-level factors. At the patient level, our study showed that Black and Hispanic patients had a higher prevalence of comorbidities, as evidenced by a higher CCI, hypertension, diabetes, liver diseases, malignancy, and dialysis dependence, despite being younger than their White counterparts. This is consistent with prior studies that reported despite Black patients being younger, their overall higher burden of poorly controlled comorbidities may have contributed to their worse outcomes.[22,40] Moreover, in a survey of Medicare beneficiaries, Black and Hispanic patients were reported to have a preference for intensive treatments during critical illness and near the end-of-life compared with White patients.[41]

At the provider level, although implicit bias and stereotyping may contribute to disparities in clinical decision-making and the utilization of life-sustaining interventions, Razi et al[19] reported that racial disparity is less likely to be due to Black and Hispanic patients receiving less aggressive resuscitation. They also noted that, on average, Black patients were 8 years younger than their White counterparts during the onset of IHCA, and thus may add to the lower likelihood of an end-of-life discussion, which is consistent with their findings of lower rates of do-not-resuscitate orders in the Black patients. Furthermore, multiple other studies[42–44] have shown that Black patients were more likely to receive life-prolonging interventions and less likely to receive comfort-focused care or hospice enrollment, with some studies noting underutilization of do-not-resuscitate orders in Black patients. These trends are felt to be tied, in part, to less access to information regarding advanced directives by Black patients and their families along with differences in culture.[19,45] Muni et al[46] reported that racial and ethnic minorities who were in the intensive care unit had lower rates of advance directives and families of those patients received fewer discussions with clinicians about the patient's wishes or preferences, thus were more likely to die while receiving life-sustaining measures.

At the system level, structural inequities in access to high-quality care, resource allocation, and post-resuscitation care may perpetuate disparities in IHCA outcomes, as discussed in another analysis from the NIS sample by Rachoin et al[47] in 2021, which combined OHCA and IHCA and focused mainly on Black patients compared with White patients. Prior studies have reported substantial variation in outcomes for IHCA among different healthcare institutions, with risk-adjusted survival rates ranging from 12.4% in the bottom decile to 22.7% in the top decile of hospitals.[48] Although a prior study[49] noted that being a Black patient was found to be a predictor of delayed time of defibrillation response in the acute resuscitation period, Chan et al[50] reported that adjusting for defibrillation response time within hospitals did not reduce racial disparity after accounting for the hospital where the patient was treated, implying that Black patients were more likely to have IHCA in hospitals with higher rates of delays in defibrillation time. A study by Joseph et al[20] looked into the trend of racial gap changes in

Table 3. Multivariable Logistic Regression Models Assessing Associations Between race and ethnicity, Sex, and In-Hospital Outcomes Among Patients With IHCA

Outcomes*	Race and ethnicity and sex	IHCA			
		VT/VF (n=55 340, 26.6%)		PEA/asystole (n=152 430, 73.4%)	
		Adjusted OR† (95% CI)	*P* value	Adjusted OR† (95% CI)	*P* value
Mortality	White women	1.04 (0.93–1.16)	0.6	0.88 (0.82–0.94)	<0.01
	Black men	1.42 (1.21–1.66)	<0.01	1.25 (1.11–1.39)	<0.01
	Black women	1.25 (1.05–1.50)	0.01	1.03 (0.93–1.15)	0.5
	Hispanic men	1.20 (1.00–1.45)	0.05	1.22 (1.07–1.40)	<0.01
	Hispanic women	1.30 (1.01–1.66)	0.04	0.90 (0.78–1.04)	0.1
PCI	White women	0.96 (0.84–1.11)	0.6	1.09 (0.95–1.26)	0.2
	Black men	0.53 (0.43–0.66)	<0.01	0.52 (0.40–0.68)	<0.01
	Black women	0.54 (0.42–0.69)	<0.01	0.55 (0.42–0.71)	<0.01
	Hispanic men	0.94 (0.75–1.17)	0.6	0.70 (0.54–0.91)	<0.01
	Hispanic women	0.88 (0.65–1.20)	0.4	0.79 (0.59–1.06)	0.1
CABG	White women	0.71 (0.54–0.94)	0.02	0.57 (0.44–0.74)	<0.01
	Black men	0.50 (0.30–0.82)	<0.01	0.41 (0.26–0.65)	<0.01
	Black women	0.47 (0.27–0.81)	<0.01	0.24 (0.14–0.40)	<0.01
	Hispanic men	0.88 (0.56–1.38)	0.6	0.62 (0.40–0.96)	0.03
	Hispanic women	0.76 (0.39–1.46)	0.4	0.84 (0.53–1.31)	0.4
MCS	White women	0.81 (0.70–0.94)	<0.01	0.87 (0.76–1.01)	0.07
	Black men	0.58 (0.47–0.72)	<0.01	0.67 (0.53–0.85)	<0.01
	Black women	0.59 (0.46–0.76)	<0.01	0.62 (0.49–0.79)	<0.01
	Hispanic men	0.99 (0.78–1.26)	0.9	0.86 (0.67–1.09)	0.2
	Hispanic women	0.98 (0.71–1.35)	0.9	0.86 (0.65–1.14)	0.3
Tracheostomy	White women	0.96 (0.62–1.47)	0.8	0.90 (0.71–1.14)	0.4
	Black men	1.56 (0.97–2.51)	0.07	1.51 (1.16–1.97)	<0.01
	Black women	1.27 (0.76–2.11)	0.4	1.40 (1.08–1.82)	0.01
	Hispanic men	1.90 (1.11–3.24)	0.02	1.37 (0.97–1.93)	0.08
	Hispanic women	2.16 (1.08–4.33)	0.03	1.45 (1.00–2.10)	0.05
Gastrostomy	White women	1.10 (0.76–1.59)	0.6	0.83 (0.68–1.02)	0.08
	Black men	1.98 (1.37–2.86)	<0.01	1.54 (1.23–1.93)	<0.01
	Black women	1.74 (1.14–2.66)	0.01	1.28 (1.02–1.60)	0.03
	Hispanic men	1.51 (0.94–2.43)	0.09	1.26 (0.96–1.67)	0.1
	Hispanic women	2.03 (1.15–3.59)	0.02	1.01 (0.71–1.42)	1.0
Renal replacement therapy	White women	0.85 (0.71–1.02)	0.08	0.80 (0.71–0.89)	<0.01
	Black men	1.47 (1.21–1.80)	<0.01	1.42 (1.24–1.62)	<0.01
	Black women	1.24 (1.00–1.55)	0.05	1.13 (0.99–1.30)	0.07
	Hispanic men	1.30 (1.00–1.68)	0.05	1.49 (1.27–1.74)	<0.01
	Hispanic women	1.45 (1.06–1.99)	0.02	1.11 (0.92–1.34)	0.3

CABG indicates coronary artery bypass graft; IHCA, in-hospital cardiac arrest; MCS, mechanical circulatory support; OR, odds ratio; PCI, percutaneous coronary interventions; PEA, pulseless electrical activity; and VT/VF, ventricular tachycardia/ventricular fibrillation.

*All multivariable logistic regression models were adjusted for all of the following variables that met the inclusion criteria for univariable screening of each outcome as shown in the Methods section (age, insurance, income quartile, hospital location, hospital bed size, teaching status, Charlson Comorbidity Index, and comorbidities shown in Table S3).

†Reference group was White men.

IHCA survival from 2000 to 2014 and found that hospitals with a higher proportion of Black patients initially had lower IHCA survival rates but showed greater improvement over time compared with hospitals with fewer Black patients. This reduction in racial disparities was attributed partly to enhanced acute resuscitation measures in hospitals serving more Black patients. They also reported that racial differences in

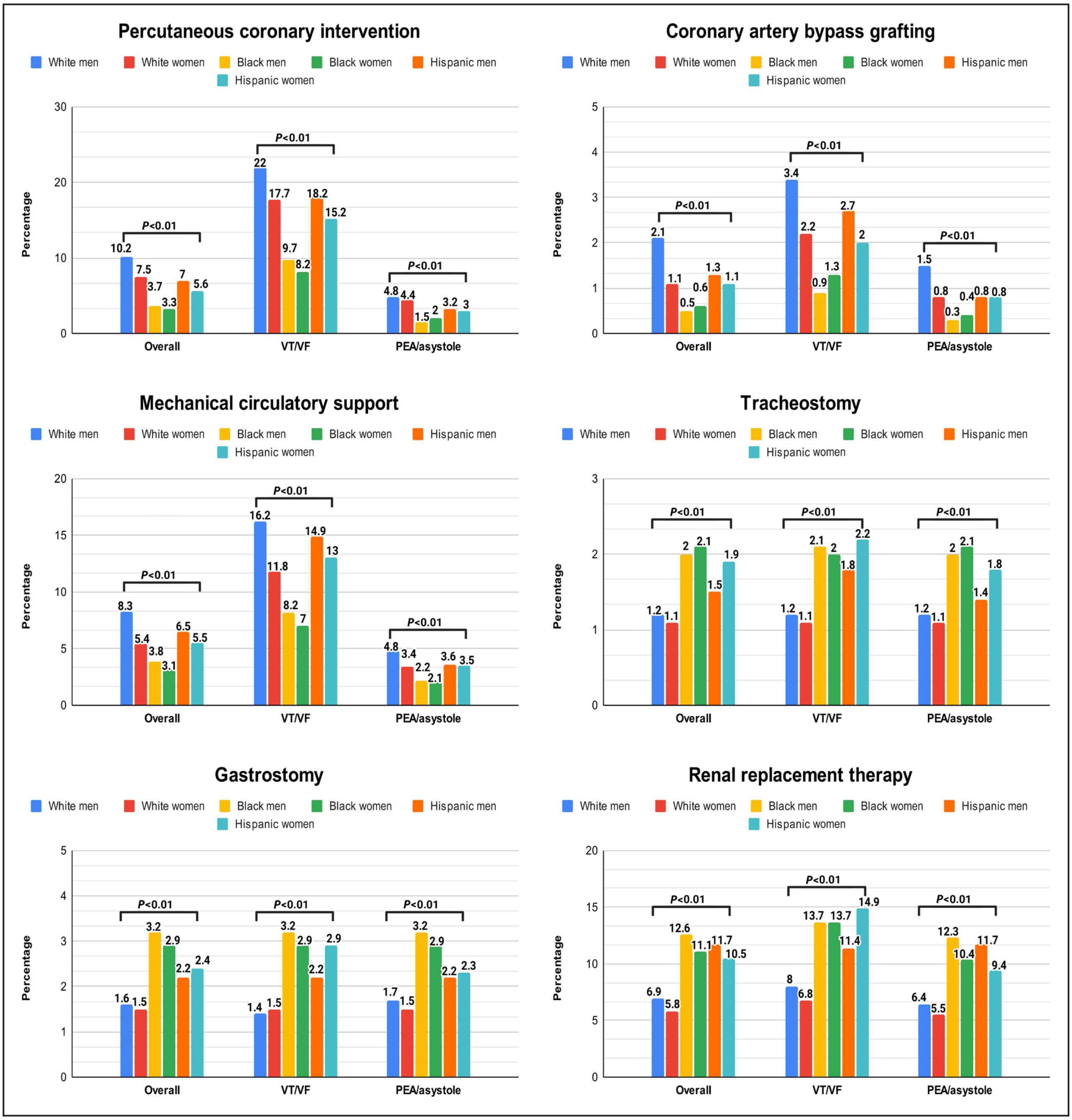

Figure 4. Unadjusted procedure differences based on race and ethnicity and sex.
PEA indicates pulseless electrical activity; and VT/VF, ventricular tachycardia/ventricular fibrillation.

postresuscitation survival between Black and White patients did not change significantly during the course of the study.

Implications and Future Directions

These disparities underscore the need for targeted interventions to address the specific factors contributing to these disparities at the patient, provider, and system levels. At the patient level, efforts should focus on improving health literacy, access to preventive care, and management of chronic conditions to decrease the risk and complications of IHCA. At the provider level, addressing implicit bias and promoting cultural competence may reduce disparities in clinical decision-making and the utilization of life-sustaining interventions. At the system level, ensuring equitable access to high-quality care, resource allocation, and postresuscitation care among different healthcare institutions is crucial to mitigate disparities in IHCA outcomes.

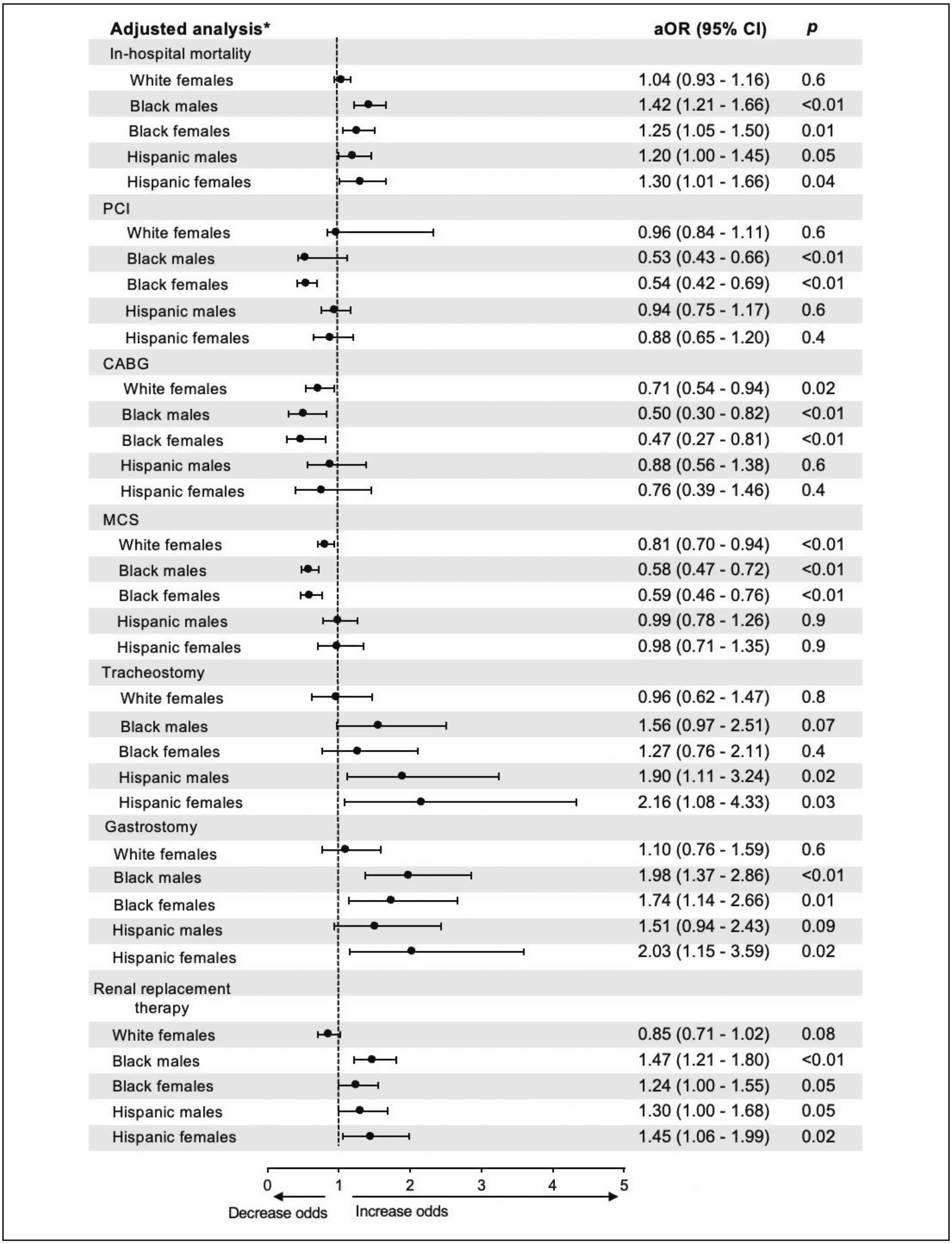

Figure 5. Forest plots for the adjusted outcomes following VT/VF arrest in different race and ethnicity and sex compared with White men (reference).

aOR indicates adjusted odds ratio; CABG, coronary artery bypass graft; MCS, mechanical circulatory support; and PCI, percutaneous coronary interventions. *The multivariable regression model is adjusted for all of the relevant variables shown in Table S3.

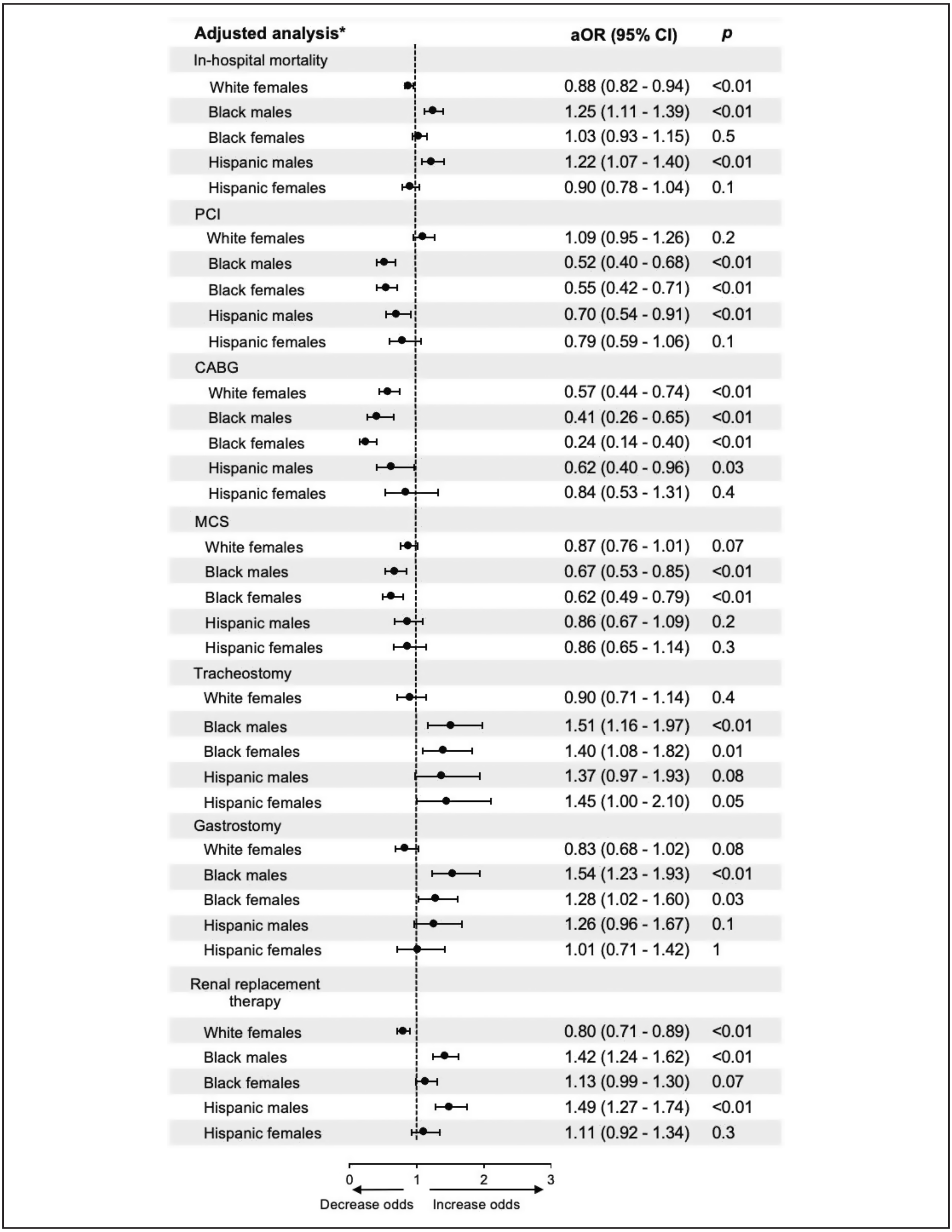

Figure 6. Forest plots for the adjusted outcomes following PEA/asystole arrest in different race and ethnicity and sex compared with White men (reference).

aOR indicates adjusted odds ratio; CABG, coronary artery bypass graft; MCS, mechanical circulatory support; and PCI, percutaneous coronary interventions. *The multivariable regression model is adjusted for all of the relevant variables shown in Table S3.

Future research should focus on understanding the complex factors contributing to these disparities and developing evidence-based strategies to promote equitable, high-quality care for all patients with IHCA, regardless of race and ethnicity or sex.

Strengths and Limitations

Our study has several strengths, including the use of a large, national data set, stratification by presenting rhythm (VT/VF, PEA/asystole), and adjustment for potential confounders using multivariable regression analysis. However, there are important limitations to consider when interpreting the results.

As with any study using administrative data, there is a potential for coding errors and misclassification of diagnoses, procedures, and outcomes, which may impact the accuracy of the outcomes studied. We used a previously validated coding method to identify IHCA cases and comorbidities, minimizing this risk. However, our method of classifying cardiac arrest rhythms has limitations. The accuracy of *ICD* codes for identifying VT/VF has been reported to range from 77% to 100%, but identifying PEA/asystole is more challenging.[51] Furthermore, it is difficult to discern those patients who had both types of rhythm during the IHCA using this database.

Since the NIS database is primarily based on hospital coding, it lacks detailed clinical information and variations in factors such as cardiac arrest characteristics, duration of the arrest, quality of chest compressions, and other resuscitation efforts, as well as adherence to resuscitation guidelines and postarrest care, which could have a significant impact on survival rates and other outcomes. In addition, the database does not provide a chronological sequence of events that occurred during the hospital stay. Consequently, even though we only accounted for those procedures that occurred during the day of the cardiopulmonary resuscitation and thereafter, the observed disparities in procedure utilization among race and ethnicity and sex should be interpreted with caution, as some procedures may have been performed before the cardiac arrest event during that day, and the temporal relationship between procedures and IHCA cannot be definitively established using this database. Furthermore, with this database, we cannot study the long-term outcomes of those discharged to rehabilitation and long-term care facilities. Further research into this specific population would be important to assess whether the observed differences persist.

It is also important to note that since the NIS database prioritizes ethnicity over race when both are available, this limits our ability to capture more granular characteristics, such as distinguishing between Hispanic White and Hispanic Black patients and assessing whether racial differences persist in these subgroups. Moreover, by focusing on White, Black, and Hispanic populations, we excluded other racial and ethnic groups such as Asian Americans, Pacific Islanders, and Native Americans because of small sample sizes. This restricts the generalizability of our findings to these populations and may not accurately represent their experiences. The exclusion of these groups introduces a form of selection bias, as our results may not apply to the entire US population.

Finally, although we adjusted for several potential confounders, unmeasured confounding factors may still influence the observed associations between race and ethnicity, sex, and outcomes.

CONCLUSIONS

Significant racial and ethnic and sex disparities exist in outcomes and treatment patterns among patients with IHCA. Future research should focus on understanding the complex factors contributing to these disparities and developing evidence-based strategies to promote equitable and high-quality care for all patients with IHCA, regardless of race and ethnicity or sex.

ARTICLE INFORMATION

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Supplemental Material

Tables S1–S6

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