Impact of Ethnicity and Gender Differences on Angiographic Coronary Artery Disease Prevalence and In-Hospital Mortality in the American College of Cardiology–National Cardiovascular Data Registry

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Background—Although populations referred for coronary angiography are increasingly diverse, there is limited information on coronary artery disease (CAD) prevalence and in-hospital mortality other than for predominately white male patients.

Methods and Results—We examined gender and ethnic differences in CAD prevalence and in-hospital mortality in a prospective cohort of patients referred for angiographic evaluation of stable angina (n=375 886) or acute coronary syndromes (ACS; unstable angina or myocardial infarction, n=450 329) at 388 US hospitals participating in the American College of Cardiology–National Cardiovascular Data Registry, an angiographic registry. Univariable and multivariable (with covariates that included risk factors, symptoms, and comorbidities) logistic regression models were used to estimate significant CAD, defined as ≥70% stenosis, and in-hospital mortality. Within stable angina and ACS cohorts, 7% of patients were black, 2% were Hispanic, 0.3% were Native American, 1% were Asian, and 90% were white, respectively. In stable angina, the risk-adjusted OR for significant CAD was 0.34 for women compared with men ($P<0.0001$), with black women having the lowest risk-adjusted odds ($P<0.0001$) compared with other females. Among ACS patients, the risk-adjusted OR of significant CAD was 0.47 for women compared with men ($P<0.0001$); similarly, black women had the lowest risk-adjusted odds ($P<0.0001$) compared with other females. Higher in-hospital mortality was reported for white women presenting with stable angina ($P<0.00001$). White women had a 1.34-fold (95% CI 1.21 to 1.48) higher risk-adjusted odds ratio for mortality than white men with stable angina ($P<0.0001$), with higher rates noted for white women who were older or had significant CAD (both $P<0.0001$). Lower utilization of elective coronary revascularization, aspirin, and glycoprotein IIb/IIIa inhibitors (all $P<0.0001$) may have contributed to higher in-hospital mortality for white women. In ACS, higher in-hospital mortality was reported for Hispanic ($P=0.015$) and white ($P<0.0001$) women; however, neither white ($P=0.51$) or Hispanic ($P=0.13$) women had higher in-hospital risk-adjusted mortality.

Conclusions—The likelihood for significant CAD at coronary angiography and for in-hospital mortality varied significantly by ethnicity and gender. Future clinical practice guidelines should be tailored to gender subsets of the population, in particular for black women, to improve the efficient use of angiographic laboratories and to target at-risk populations of women and men. **(*Circulation*. 2008;117:1787-1801.)**

Key Words: ethnicity ■ gender ■ mortality ■ angina ■ coronary disease ■ angiography

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Cardiac catheterization ranks as the most common hospital procedure for patients, with a total of 1 687 000 procedures, and it is performed in 12% of all discharged hospital patients, as reported in 2004.[1,2] Despite an increasingly ethnically diverse US population, our current understanding of ethnic differences in the extent and severity of coronary artery disease (CAD) is based predominantly on white male populations. Population studies and clinical trial data have noted significantly greater coronary disease mortality in women than in men, specifically in black patients.[3–5] Prior studies have noted more cardiac risk factors, including more frequent clustering of risk factors, in blacks, yet a paradoxically lower prevalence of obstructive and subclinical CAD.[6–10] Despite the available evidence,[11–17] few reports have discussed differences in the prevalence of obstructive CAD by ethnicity in a contemporary, geographically diverse coronary angiography registry.[17–20] Therefore, we sought to compare differences in the rate of significant CAD and in-hospital mortality by ethnicity and gender in 2 subsets of patients evaluated for stable and unstable chest pain syndromes and prospectively enrolled in the American College of Cardiology's (ACC) National Cardiovascular Data Registry (NCDR CathPCI Registry).

Clinical Perspective p 1801

Methods

Patient Entry Criteria

Patient entry was limited to 2 distinct patient cohorts: (1) those referred for elective, diagnostic coronary angiography with suspected, yet stable chest pain symptoms (n=375 886) and (2) those referred after admission for an acute coronary syndrome (ACS), including acute myocardial infarction or unstable angina (n=450 329). Patients were enrolled in version 2.0 of the NCDR registry from quarterly consecutive series of patients undergoing coronary angiography from 2000 to 2002. Patients were excluded if they were referred for (1) evaluation before valvular surgery or (2) evaluation of other diseases of the heart, including transplant, congenital disease, or cardiomyopathic abnormalities.

Data Elements and Collection Methods of the NCDR

The NCDR CathPCI Registry captures 142 clinically pertinent and standardized data elements that are needed to detail and assess the quality of care for patients receiving diagnostic coronary angiography. Risk factor and past medical history were derived from patient interview, medical records, or both. Definitions for risk factors and all other data elements within the NCDR registry are available online (http://www.accncdr.com/WebNCDR/elements.aspx; accessed March 13, 2008). Details of the CathPCI Registry and copies of the case report form may be found on the ACC's NCDR Web site.[21] Since 1998, enrollment in the NCDR has grown to >600 participant hospitals, free-standing laboratories, and adult cardiology practices representing ≈20% of all US facilities that perform cardiac catheterization. Participating institutions use ACC-certified commercially available software that is deemed compliant with clinical and coding data standards set forth by the ACC. NCDR-participating institutions collect and submit quarterly patient data using ACC-certified software programs. Within this cohort, ethnicity was recorded as defined by the patient. The present report includes consecutively enrolled patients from 388 US hospitals.

Coronary Angiography Procedures

Coronary angiography was performed and reviewed at the clinical sites according to accepted methods put forth by the ACC.[22] All coronary segments were interpreted visually at each participating site. Percent stenosis in each of the major epicardial coronary arteries was estimated and entered into the ACC case report form. Left ventricular ejection fraction was calculated by the area-length method.[22] These registry data reflect ongoing care of patients undergoing coronary angiography at 388 US hospitals. As such, coronary angiography and the analysis of the presence of significant CAD was not interpreted in a manner blinded to the patient's name, gender, or ethnicity.

Definitions

Major coronary arteries analyzed were the left anterior descending, left circumflex, and right coronary arteries. Significant CAD was defined as ≥70% stenosis in any of the major epicardial coronary arteries.

Statistical Methods

Continuous variables were expressed as mean±SD, and categorical variables were presented as frequencies. Continuous and categorical measures were compared with *t* tests, ANOVA, or χ^2 statistic, as appropriate. Initial analysis included comparisons of the clinical, angiographic, and procedural complication data for each ethnic subset of the population. Additionally, laboratory, hospital, and healthcare payer characteristics were compared within ethnic subsets.

One aim of the present study was to estimate gender and ethnic differences in significant CAD defined at coronary angiography. A second aim was to evaluate the variability of in-hospital mortality by ethnicity and gender. Univariable and multivariable logistic regression models were used to estimate (1) significant CAD and (2) in-hospital mortality. From the models, an OR and 95% CI were calculated. To examine gender and ethnicity effects, we included the main effect terms (ie, gender and separate variables for each ethnic subset), as well as separate gender interaction terms for black, Hispanic, Asian, and Native American women. Risk adjustment included consideration of candidate variables with a univariable $P<0.10$. Risk-adjusted models were chosen a priori to reflect clinically significant variables, including traditional cardiac risk factors and chest pain or dyspnea symptoms. We also included geographic, laboratory, hospital, healthcare payer, and physician characteristics in the multivariable models. Volume measurements, such as the number of hospital beds or full-time employees, were categorized into quartiles. A 2-sided $P<0.05$ was considered statistically significant. Data were analyzed with SPSS version 15.0 (Chicago, Ill).

The authors had full access to the data and take full responsibility for its integrity. All authors have read and agree to the manuscript as written.

Table 1. Clinical Characteristics of the Elective, Diagnostic Coronary Angiography Cohort (n=375 886)

	Black (n=24 998)	Hispanic (n=7823)	Native American (n=1251)	Asian (n=3562)	White, Non-Hispanic (n=338 252)
Age, y	58±13	60±13	58±12	63±12	62±13
Women	59±13	62±12	59±12	64±12	64±13
Men	57±13	59±13	57±12	61±12	61±12
Female gender	54.2	46.5	47.6	44.0	44.0
Risk factors					
Family history of CAD	36.8	36.8	38.0	29.4	42.4
Hypertension	79.1	67.2	66.7	71.9	64.1
Hyperlipidemia	44.1	48.5	52.6	56.9	55.0
Diabetes	36.7	39.9	52.1	33.2	23.6
Insulin	9.2	7.9	11.0	4.9	3.6
Oral	14.2	18.1	19.6	14.8	10.1
Diet	3.4	3.0	5.0	4.3	2.7
Combination	9.3	9.7	15.4	8.6	6.3
No treatment	0.7	1.2	1.2	0.7	0.8
Current smoker	27.4	19.5	33.4	13.1	24.2
Symptoms					
CHF symptoms	11.4	8.8	9.2	8.1	7.2
Anginal symptoms					
None	17.1	15.1	13.3	15.0	16.6
Atypical angina	23.3	18.3	20.3	19.4	18.3
Stable angina	59.6	76.6	66.4	65.6	65.1
Chronic lung disease	13.3	10.1	12.6	8.6	15.1
Renal failure					
Dialysis	4.8	3.4	5.6	3.1	0.8
No dialysis	3.6	2.6	2.6	3.5	1.8
History of peripheral arterial disease	8.8	7.8	7.4	4.9	8.8
History of cerebrovascular disease	8.6	8.1	7.5	7.4	8.1
Body mass index, kg/m^2	31.3±7	30.2±6	30.9±6	26.8±5	29.8±6
Noninvasive ischemia					
Negative	7.7	6.3	7.0	5.9	8.3
Positive	58.7	58.9	56.2	61.4	62.4
Equivocal	3.7	3.6	5.9	2.6	3.4
Arrhythmia	0.9	0.9	0.7	0.8	1.2
None	29.1	30.4	30.2	29.3	24.7

CHF indicates congestive heart failure.

All $P<0.001$ except for cerebrovascular disease ($P=0.037$). Data are presented as frequencies (%), except mean±SD values are used for age and body mass index.

Results

Stable Chest Pain Cohort (n=375 886)

Clinical Characteristics in the Diagnostic Cohort

Compared with white, non-Hispanic patients, ethnic minority patients (except Asians) were on average 2 to 4 years younger ($P<0.0001$) and had higher rates of hypertension and diabetes (all $P<0.001$). Black, Hispanic, and Native American patients had an average body mass index ≥30 kg/m^2, which met criteria for obesity; however, Asian patients had a significantly lower body mass index than other subsets within this cohort. Although higher rates of heart failure symptoms were noted in ethnic minority patients, rates of stable angina varied by ethnicity. Higher rates of renal failure were reported in black, Hispanic, Native American, and Asian patients ($P<0.001$). White, non-Hispanic patients had a greater frequency of stress-induced ischemia ($P<0.0001$). (See Table 1).

Laboratory, Hospital, and Payer Characteristics for Ethnic Subsets

Ethnic minority patients were hospitalized 0.3 to 0.9 days longer than their white, non-Hispanic counterparts ($P<0.0001$). Ethnic minorities (except Asian patients) more often underwent angiography at a teaching hospital ($P<0.0001$). Significant variability in the geographic distribution of ethnic minority patients was noted ($P<0.0001$). Black patients were more often from the Southeast and Great Lakes regions of the United States. Hispanic and Asian patients were more often from the Western states region. Native American patients were more often from the West and Central region. Finally, 5.2% to 8.5% of black, Hispanic, and Native American patients had no healthcare insurance ($P<0.0001$). Information on laboratory, hospital, and payer characteristics is included in the Appendix in the online Data Supplement.

Table 2. Procedural and In-Hospital Complication Rates* (%) for Ethnic Subsets of the Elective, Diagnostic Coronary Angiography Cohort

% With Complications	Black (n=24 998)	Hispanic (n=7823)	Native American (n=1251)	Asian (n=3562)	White, Non-Hispanic (n=338 252)	P
Unplanned CABG	0.08	0.12	0.08	0.03	0.18	<0.0001
Postprocedure emergent PCI	0.29	0.57	0.00	0.34	0.43	<0.0001
Postprocedure arrhythmia	0.99	1.46	0.80	1.88	1.79	<0.0001
Postprocedure CVA	0.17	0.19	0.00	0.28	0.24	0.014
Postprocedure tamponade	0.04	0.04	0.16	0.06	0.08	0.043
Postprocedure renal failure	0.37	0.54	0.80	0.42	0.42	0.13
Vascular bleed	0.50	0.84	0.80	0.87	0.72	<0.0001
Postprocedure CHF	0.25	0.42	0.24	0.70	0.48	0.012
Postprocedure shock	0.18	0.26	0.24	0.34	0.29	<0.0001
Periprocedural MI	0.20	0.27	0.72	0.67	0.42	<0.0001
In-hospital death	0.48	0.41	0.64	0.67	0.52	0.29
Cardiac	0.23	0.26	0.32	0.37	0.30	0.91

PCI indicates percutaneous coronary intervention CVA, cerebrovascular accident; CHF, congestive heart failure; and MI, myocardial infarction.
*Note: The data report the observed rates for each of the listed procedural complications.

Procedural Complication Rates

Unplanned coronary artery bypass surgery rates were low (≤0.4%) but were slightly higher among white, non-Hispanic patients ($P<0.0001$; Table 2). Postprocedure renal failure did not differ by ethnicity ($P=0.13$).

In-Hospital Mortality Rates

Higher in-hospital mortality rates were reported for white women who presented with stable angina (0.6% versus 0.5% for men, $P<0.00001$), with no gender differences noted for other ethnic subsets (all $P>0.15$; Figure 1). Table 3 depicts a multivariable model that examines the impact of gender and ethnicity on in-hospital mortality. Predictors of in-hospital mortality included age, obstructive CAD, history of noncardiac atherosclerosis, and other cardiac risk factors. Patients treated for hyperlipidemia ($P<0.0001$) had lower odds of in-hospital mortality, as did younger obese patients ($P=0.003$).

In a risk-adjusted model, white women had a 1.34-fold (95% CI 1.21 to 1.48) greater OR for mortality than white men ($P<0.0001$). In those with stable chest pain, white women with 1-, 2-, and 3-vessel CAD, respectively, had a 1.67-fold (95% CI 1.10 to 2.53), 1.83-fold (95% CI 1.24 to 2.69), and 2.02-fold (95% CI 1.28 to 3.18) higher OR for in-hospital mortality than white men ($P=0.013$). Moreover, older white women had higher mortality rates. Specifically, higher in-hospital mortality was reported for white women 70 to 79 years old (OR 2.15, 95% CI 1.46 to 3.16, $P<0.0001$) and for those ≥80 years old (OR 3.85, 95% CI 2.22 to 6.70, $P<0.0001$) than for black women. Similarly, white women 80 years of age and older had 6.30-fold (95% CI 2.58 to 15.41) increased OR of in-hospital death compared with similarly aged Asian women ($P<0.0001$).

In-Hospital Coronary Revascularization and Aspirin and Glycoprotein IIb/IIIa Therapy Utilization Rates

For stable chest pain patients, utilization rates for elective and emergent percutaneous coronary intervention and CABG surgery were higher for men than for women across all ethnic subsets; however, the risk-adjusted OR (controlling for variables noted in Table 3) were mostly lower for white women undergoing elective coronary revascularization ($P<0.0001$ for both) and for use of aspirin ($P<0.0001$) and glycoprotein IIb/IIIa inhibitors ($P<0.0001$). With regard to the latter, differences in utilization of IIb/IIIa inhibitors were largely due to lower in-laboratory use in women than in men of diverse ethnicity (all $P<0.0001$).

Frequency of Significant CAD by Gender and Ethnicity

Of the 375 886 patients, 58.7% had significant CAD. The rate of significant CAD was 48.8% for women and 66.7% for men ($P<0.0001$; Figure 2A), which resulted in an unadjusted OR of 0.37 (95% CI 0.366 to 0.38) in women compared with men ($P<0.0001$).

Of the 207 564 men enrolled in the ACC-NCDR registry, black men had the lowest prevalence of disease, with only 52.2% having obstructive CAD. By comparison, 64.2% and 67.6% of Hispanic and white men and nearly 75% of Native American and Asian males had significant CAD at angiography. For each ethnic subset, the overall rate of significant CAD was higher for men than for women ($P<0.0001$).

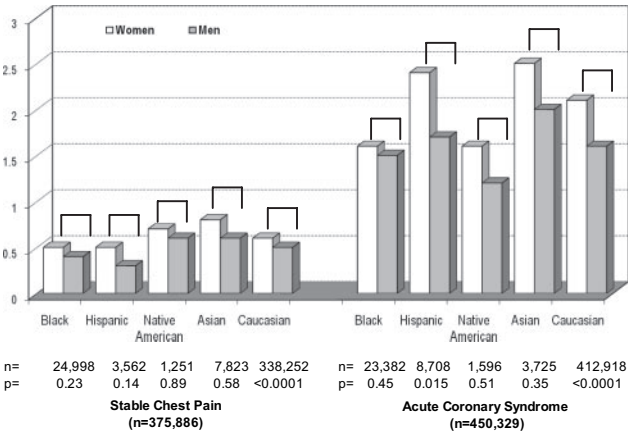

Figure 1. Gender and ethnic differences in (unadjusted) in-hospital mortality rates after coronary angiography in stable chest pain and ACS patients.

Table 3. Multivariable Predictors of In-Hospital Death (n=1785 Deaths) in a Suspected CAD Cohort Referred for Elective, Diagnostic Coronary Angiography, With Examination of Gender and Ethnicity Interactions

				95% CI	
	Wald χ^2 Statistic	*P*	OR	Lower	Upper
Female gender	20	<0.0001	1.25	1.14	1.39
Ethnicity					
Black	<1	0.58	0.83	0.43	1.60
Hispanic	2	0.19	0.45	0.14	1.49
Asian	<1	0.92	0.93	0.24	3.59
Native American	<1	0.75	1.44	0.15	2.63
Female gender interaction					
Black	<1	0.54	1.13	0.76	1.67
Hispanic	1	0.32	1.44	0.70	2.96
Asian	<1	0.77	1.14	0.49	2.63
Native American	<1	0.84	0.86	0.21	3.56
Cardiac risk factors					
Age (in deciles)	342	<0.0001	1.64	1.56	1.73
Family history of premature CAD	14	<0.0001	0.82	0.74	0.91
Insulin-dependent diabetes	21	<0.0001	1.39	1.20	1.59
Hyperlipidemia	88	<0.0001	0.64	0.58	0.70
CAD and noncardiac atherosclerosis					
No. of vessels with CAD	526	<0.0001	1.76	1.67	1.84
History of cerebrovascular disease	33	<0.0001	1.42	1.26	1.60
History of peripheral arterial disease	38	<0.0001	1.45	1.29	1.63
Comorbidity					
History of renal failure	174	<0.0001	2.54	2.21	2.92
Body mass index (per 10 kg/m^2)	9	0.003	0.93	0.89	0.98
History of chronic lung disease	78	<0.0001	1.61	1.45	1.79
Symptoms and stress ischemia					
NYHA class	312	<0.0001	1.37	1.32	1.42
CCSC angina class	149	<0.0001	1.46	1.37	1.55
Stress imaging ischemia	19	<0.0001	0.87	0.82	0.93
Nonclinical factors					
Teaching hospital	15	<0.0001	1.20	1.09	1.32
Northeast region	10	0.001	0.81	0.71	0.92
Southeast region	7	0.007	1.17	1.04	1.31
Government insurance	6	0.014	0.72	0.56	0.94
Private insurance	16	<0.0001	0.59	0.45	0.76

NYHA indicates New York Heart Association; CCSC, Canadian Cardiovascular Society Class.

Among the 168 322 women, black women also had the lowest rate of obstructive disease, with only 41.7% having significant CAD at angiography. Similarly, 45.3% of Hispanic women had significant CAD, whereas the rates of obstructive CAD were 55%, 53%, and 50% for Native American, Asian, and white, non-Hispanic women, respectively.

Risk-Adjusted Gender and Ethnic Differences in Significant CAD

In a multivariable model, traditional risk factors, metabolic syndrome risk factors, and noncardiac atherosclerosis were significantly associated with higher OR of significant CAD (Table 5). In addition, typical angina, imaging ischemia, and presentation with heart failure symptoms were also associated with higher odds of significant CAD. Nonclinical factors associated with more frequent significant CAD included being uninsured, performance of angiography at a government or community hospital, and performance of angiography at a larger hospital with more beds and employees.

The risk-adjusted OR for significant CAD was 0.34 for women compared with men ($P<0.0001$). In this multivariable model, the sole gender-by-ethnicity interaction that remained significant was that for black women (OR 0.64, $P<0.0001$). For black women, higher ORs for significant CAD included chronic lung disease (OR 1.3, $P<0.0001$), hyperlipidemia (OR 1.3, $P<0.0001$), insulin-dependent diabetes mellitus (OR 2.4, $P<0.0001$) and non–insulin-dependent diabetes mellitus (OR 1.7, $P<0.0001$), heart failure symptoms (OR 1.6, $P<0.0001$), and typical angina (OR 1.7, $P<0.0001$). Additionally, the OR for significant CAD

Table 4. Risk-Adjusted* OR for Utilization of Elective or Emergent PCI or CABG Surgery and Aspirin or Glycoprotein IIb/IIIa Inhibitor Use in Women and Men of Diverse Ethnicity With Stable Chest Pain

	Observed Utilization Rate, %		Risk-Adjusted OR for Utilization in Women vs Men (95% CI)	*P*
	Women	Men		
Elective PCI				
Black	17.5	22.7	0.93 (0.86–1.01)	0.075
Hispanic	23.0	33.2	0.99 (0.87–1.12)	0.83
Native American	25.0	34.6	0.96 (0.71–1.31)	0.80
Asian	24.5	35.4	0.86 (0.72–1.03)	0.11
White	22.6	31.3	0.90 (0.88–0.92)	<0.0001
Emergent PCI				
Black	0.2	0.3	0.70 (0.43–1.12)	0.14
Hispanic	0.4	0.8	0.70 (0.35–1.39)	0.31
Native American	0.0	0.0	...	...
Asian	0.4	0.3	1.97 (0.58–6.73)	0.28
White	0.4	0.5	0.97 (0.87–1.08)	0.57
Elective CABG				
Black	1.7	2.7	0.82 (0.68–0.99)	0.038
Hispanic	3.5	4.3	1.15 (0.89–1.49)	0.29
Native American	3.0	4.0	0.94 (0.48–1.86)	0.86
Asian	3.9	5.1	0.95 (0.66–1.37)	0.79
White	2.7	4.7	0.75 (0.72–0.78)	<0.0001
Unplanned CABG				
Black	0.1	0.1	1.37 (0.57–3.33)	0.48
Hispanic	0.1	0.2	0.35 (0.07–1.89)	0.22
Native American	0.0	0.1	...	0.99
Asian	0.0	0.1	...	0.99
White	0.2	0.2	1.19 (1.02–1.39)	0.027
Aspirin use				
Black	63.4	66.1	0.95 (0.90–1.01)	0.077
Hispanic	53.9	62.3	0.88 (0.80–0.98)	0.017
Native American	76.9	81.3	0.84 (0.62–1.14)	0.26
Asian	63.2	72.1	0.82 (0.70–0.96)	0.015
White	70.0	74.6	0.88 (0.87–0.90)	<0.0001
Glycoprotein IIb/IIIa inhibitor use				
Black	15.0	19.7	0.90 (0.83–0.98)	0.01
Hispanic	17.2	25.8	0.95 (0.83–1.08)	0.43
Native American	20.2	27.0	1.07 (0.78–1.47)	0.69
Asian	21.3	31.9	0.81 (0.67–0.97)	0.02
White	19.2	27.4	0.86 (0.84–0.88)	<0.0001

PCI indicates percutaneous coronary intervention.
*Risk adjustment includes covariates included in Table 3.

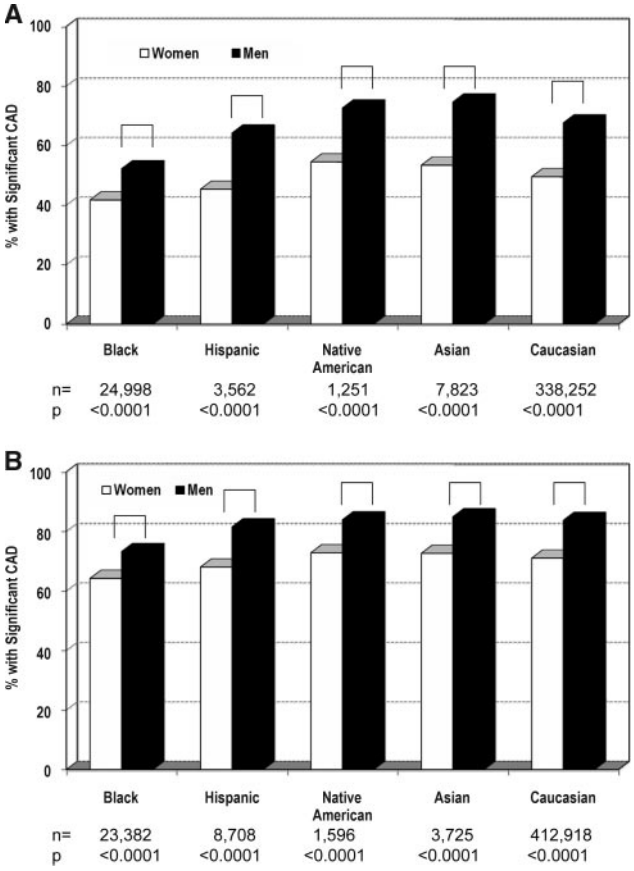

Figure 2. A, Observed frequency of significant CAD (defined as ≥70% stenosis in 1 or more epicardial coronary arteries) by gender and ethnicity in patients presenting with suspected ischemic heart disease with stable chest pain symptoms (n=375 886). B, Observed frequency of significant CAD by gender and ethnicity in patients presenting with ACS (n=450 329).

increased by age decile (Figure 3) such that black women 70 to 79 years of age and 80 to 98 years old had a 3.6- to 5.7-fold higher OR for significant CAD ($P<0.0001$ for both age deciles).

ACS Cohort (n=450 329)

Clinical Characteristics in the Acute Chest Pain Cohort

In the ACS cohort, ethnic minorities (except Asians) were generally younger and had a higher body mass index (Table 6). More than half of Native American patients had diabetes or prior myocardial infarction, and Native Americans were more often referred to catheterization on an urgent basis and more often received preangiography thrombolysis. Asian patients were more often transferred from another facility for the procedure and were more likely to have cardiogenic shock as an indication for angiography. Black patients more often had heart failure and unstable angina as presenting symptoms. Finally, white, non-Hispanic patients more often had a prior revascularization procedure.

Laboratory, Hospital, and Payer Characteristics for Ethnic Subsets

Ethnic minority patients had a longer average length of stay and more often underwent the procedure at an urban location. More than 90% of patients underwent the procedure with onsite surgical backup, although this rate was lowest for black patients. Black patients were also more likely to undergo the procedure at a government hospital. Hispanic, Asian, and Native American patients more often underwent the procedure at lower-volume facilities with fewer hospital beds. Information on laboratory, hospital, and payer characteristics are included in the Appendix in the online Data Supplement.

Table 5. Multivariable Predictors of Significant CAD (ie, ≥70% Coronary Stenosis) in Suspected CAD Cohort Referred for Elective, Diagnostic Coronary Angiography, With Examination of Gender and Ethnicity Interactions

				95% CI	
	Wald χ^2 Statistic	*P*	OR	Lower	Upper
Female gender	13 259	<0.0001	0.34	0.33	0.34
Ethnicity					
Black	823	<0.0001	0.47	0.45	0.50
Hispanic	41	<0.0001	0.76	0.70	0.82
Asian	10	0.001	1.24	1.09	1.42
Native American	2	0.14	1.19	0.95	1.49
Female gender interaction					
Black	184	<0.0001	0.64	0.61	0.68
Hispanic	1	0.47	1.01	0.91	1.12
Asian	2	0.15	1.16	0.99	1.36
Native American	<1	0.82	1.08	0.83	1.40
Cardiac risk factors					
Age (in deciles)	17 829	<0.0001	1.78	1.77	1.80
Family history of premature CAD	88	<0.0001	1.09	1.07	1.11
Hypertension	808	<0.0001	1.31	1.28	1.33
Current smoker	2992	<0.0001	1.82	1.78	1.86
Non–insulin-dependent diabetes mellitus	2003	<0.0001	1.71	1.67	1.75
Insulin-dependent diabetes mellitus	2434	<0.0001	2.48	2.40	2.57
Obesity (body mass index ≥30 kg/m^2)	337	<0.0001	0.85	0.83	0.86
History of chronic lung disease	241	<0.0001	0.82	0.80	0.84
Prior peripheral arterial disease	843	<0.0001	1.65	1.59	1.70
Prior cerebrovascular disease	291	<0.0001	1.34	1.30	1.39
History of renal failure	226	<0.0001	1.55	1.46	1.64
Symptoms and stress ischemia					
Typical angina	10 630	<0.0001	1.78	1.76	1.80
Congestive heart failure symptoms	50	<0.0001	1.14	1.10	1.18
Stress-induced ischemia	973	<0.0001	1.51	1.47	1.55
Nonclinical factors					
Rural setting	30	<0.0001	0.93	0.90	0.95
Uninsured	151	<0.0001	1.33	1.27	1.39
Hospital type					
Government hospital	62	<0.0001	1.41	1.29	1.53
Private–community hospital	64	<0.0001	1.19	1.14	1.25
Volume variables					
Hospital bed quartiles (per quartile)	30	<0.0001	1.03	1.02	1.04
Diagnostic volume (per quartile)	7	0.007	0.98	0.97	0.99
PCI volume (per quartile)	103	<0.0001	1.08	1.06	1.10
No. of physician operators (per quartile)	4	0.047	0.99	0.98	0.995
No. of full-time employees (per quartile)	14	<0.0001	1.02	1.01	1.03
US region					
Southeastern	49	<0.0001	0.92	0.90	0.94
Western	417	<0.0001	1.37	1.33	1.41

PCI indicates percutaneous coronary intervention.

In the above model, comparator groups are those not meeting the defined group (eg, Western US region vs non-Western US region or rural vs nonrural location).

Quartile subsets are as follows: No. of hospital beds: <300, 300–401, 402–550, and >550; diagnostic volume: <1430, 1430–2218, 2219–3683, and >3683; PCI volume: <551, 551–920, 921–1497, and >1497; No. of physician operators: <9, 9–14, 15–24, and >24; and No. of full-time employees: <4, 4–4.95, 5–5.9, and >5.9.

Model information: Nagelkerke r^2=0.26, model χ^2=57 941, classification rate=70.2%.

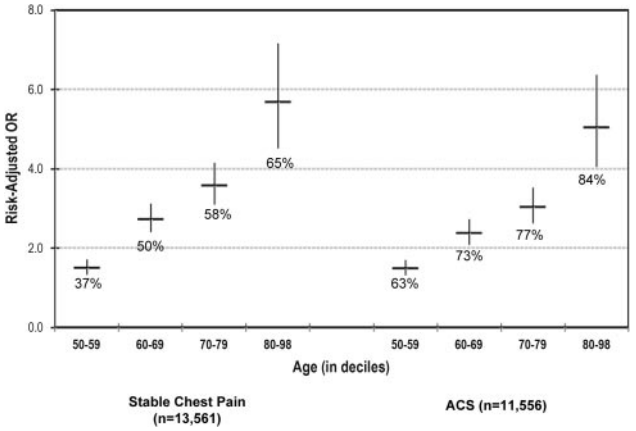

Figure 3. Multivariable OR for each age decile in black women with stable chest pain (n=13 561) and ACS (n=11 556). Below the OR, the observed frequency of significant CAD is reported for both cohorts. Not listed in this figure, 25% and 53% of black women <50 years of age had significant CAD (stable chest pain and ACS, respectively).

Procedural Complication Rates

Ethnic differences were noted across an array of procedural complications, including postprocedure myocardial infarction ($P=0.003$) and unplanned CABG surgery ($P<0.0001$) or emergent percutaneous coronary intervention ($P<0.0001$; Table 7). In general, higher complication rates were observed for white patients, except that postprocedural renal failure and vascular bleeding occurred more frequently in Hispanic, Native American, and Asian patients. Additionally, postprocedural shock and in-hospital death were reported more often in Hispanic and Asian patients.

In-Hospital Mortality Rates

Although the rates of all-cause ($P=0.026$) and cardiac ($P=0.041$) death were significantly different across ethnic subsets, these differences were not significant in a risk-adjusted model that controlled for age, gender, and cardiogenic shock on referral ($P=0.47$ for all-cause death and $P=0.98$ for cardiac death). A multivariable model of significant estimators of in-hospital death is detailed in Table 8. In this model, female gender remained a significant predictor of in-hospital death ($P<0.0001$) after risk adjustment for an array of risk factors, comorbidities, symptoms, and nonclinical factors. In this risk-adjusted model, Hispanic women exhibited a trend toward worsening in-hospital mortality ($P=0.13$).

Higher unadjusted mortality was reported for white women than for men ($P<0.0001$; Figure 1), with these results persisting in a multivariable model that compared in-hospital mortality differences in white women and men (OR 1.32, 95% CI 1.25 to 1.39, $P<0.0001$). In a stepwise model, angiography performed on an urgent or emergent basis (OR 4.09, 95% CI 3.76 to 4.44, $P<0.0001$) and presentation in cardiogenic shock (OR 12.46, 95% CI 11.24 to 13.80, $P<0.0001$) were the single greatest estimators of in-hospital mortality for white women. After these, each decile of age for white women was associated with a 1.79-fold (95% CI 1.72 to 1.85) higher OR of in-hospital death ($P<0.0001$). In-hospital death rates ranged from 3.0% for white women <50 years of age to 33.9% and 37.4% for women 70 years old and ≥80 years of age, respectively ($P<0.0001$). Additionally, white women with angiographic CAD had higher odds of in-hospital mortality; for white women, each vessel with a ≥70% stenosis was associated with a 1.57-fold (95% CI 1.51 to 1.64) higher OR of in-hospital mortality ($P<0.0001$). For white women, in-hospital mortality rates were 7.7%, 22.4%, 31.8%, and 38.0% for <70% stenosis and 1-, 2-, and 3-vessel CAD, respectively ($P<0.0001$).

In-Hospital Coronary Revascularization and Aspirin and Glycoprotein IIb/IIIa Therapy Utilization Rates

For ACS patients, utilization rates for elective and emergent percutaneous coronary intervention and coronary bypass surgery were higher for men than for women across all ethnic subsets (Table 8); however, the risk-adjusted OR (controlling for variables noted in Table 8) were mostly lower for white women undergoing elective coronary revascularization ($P<0.0001$ for both) and for use of aspirin ($P<0.0001$) and glycoprotein IIb/IIIa inhibitors ($P<0.0001$). With regard to the latter, differences in utilization of IIb/IIIa inhibitors were largely due to lower in-laboratory use in women than in men of diverse ethnicity (all $P<0.0001$).

Frequency of Significant CAD by Gender and Ethnicity

Similar to the diagnostic cohort, women of diverse ethnicities had a lower frequency of significant CAD ($P<0.0001$; Figure 2B). Only 64.2% and 68% of black and Hispanic women, respectively, had significant CAD, rates that were significantly less than for other women in the present ACS cohort. The unadjusted OR for significant CAD was 0.59 for black women ($P<0.0001$), 0.86 for Hispanic women ($P<0.0001$), 1.04 for Native American women ($P=0.53$), and 1.09 for Native American women ($P=0.028$) compared with white, non-Hispanic females, respectively.

Risk-Adjusted Gender and Ethnic Differences in Significant CAD

In the present cohort of 450 329 patients presenting with ACS, a number of clinical and nonclinical factors were associated with significant CAD (Table 10). Clinical predictors included diabetes, noncardiac atherosclerosis, renal failure, and a prior history of CAD. Patients presenting with non–ST-segment and ST-segment myocardial infarction had a 3.4-fold ($P<0.0001$) and 6.9-fold ($P<0.0001$) elevated OR of significant CAD. Nonclinical factors associated with a higher OR of significant CAD included being uninsured ($P=0.001$) or undergoing the procedure at a community hospital ($P<0.0001$) with a higher percentage of Medicare patients ($P<0.0001$), higher percutaneous coronary intervention volume ($P=0.044$), and onsite coronary bypass surgery ($P<0.0001$).

Similar to the diagnostic cohort, the risk-adjusted OR of significant CAD was 0.47 for women compared with men ($P<0.0001$). Only black women had a lower OR (0.67, $P<0.0001$) for significant CAD after controlling for other clinical and nonclinical covariates. Among the 11 556 black women, those with a higher OR for significant CAD included those with chronic lung disease (OR 1.3, $P<0.0001$), hyperlipidemia (OR 1.4, $P<0.0001$), and diabetes therapy with (OR 2.1, $P<0.0001$) or without (OR=1.5, $P<0.0001$) insulin

Table 6. Clinical Characteristics of the Acute Chest Pain Cohort Undergoing Coronary Angiography (n=450 329)

	Black (n=23 382)	Hispanic (n=8708)	Native American (n=1596)	Asian (n=3725)	White, Non-Hispanic (n=412 918)
Age, y	59.4±13	61.3±13	58.7±12	63.7±12	63.9±13
Female gender	50.2	39.1	37.6	39.4	38
Risk factors					
Family history of CAD	37.8	37.3	41.6	28.2	42.2
Hypertension	81.3	71.0	70.2	74.9	68.6
Hyperlipidemia	54.1	57.9	62.6	63.0	64.3
Diabetes					
Insulin	10.8	10.0	12.6	5.3	4.9
Oral	14.2	19.0	19.6	15.5	11.0
Diet	3.5	2.9	4.7	4.2	2.8
Combination	10.7	11.0	15.1	11.3	8.1
No treatment	0.9	1.2	1.7	0.9	0.9
Current smoker	30.7	21.8	38.2	16.1	25.8
Urgency of catheterization					
Urgent	37.0	33.8	52.6	42.8	35.3
Emergent/stable	12.2	15.0	13.1	16.9	13.9
Salvage	0.1	0.2	0.1	0.2	0.2
Admission status					
Referred	35.5	37.2	35.8	31.9	39.8
Emergency department	48.3	39.8	19.5	41.1	34.4
Transfer	14.0	21.0	23.3	23.3	24.0
Cardiogenic shock	1.3	2.0	1.9	2.7	1.7
Acute MI (within 6 h)	16.2	15.2	15.6	19.2	17.0
Remote MI (7 to 21 d)	25.0	25.0	28.8	21.6	27.7
History of CAD	39.5	41.0	45.2	37.8	47.0
Prethrombolysis	1.9	3.4	6.1	4.1	3.5
CHF symptoms	14.7	11.5	11.0	11.3	10.4
NYHA class III–IV	14.7	11.5	11.0	11.3	10.4
Angina class IV	35.5	38.4	40.5	38.8	37.5
Unstable angina	56.7	56.7	54.1	51.4	57.1
Non–ST-elevation MI	18.9	19.6	20.7	20.9	18.4
ST elevation MI	10.3	13.9	16.7	16.5	12.7
Prior MI	25.0	25.0	28.8	21.6	27.7
Prior PCI	23.9	25.0	30.2	22.0	30.0
Prior CABG	11.1	14.3	14.3	13.3	18.4
Chronic lung disease	14.9	10.5	14.6	9.7	17.0
Renal failure					
Dialysis	5.3	3.2	4.3	3.3	1.1
No dialysis	4.9	3.6	3.3	4.6	3.1
History of peripheral arterial disease	12.2	10.6	7.0	9.6	12.3
History of cerebrovascular disease	11.7	10.0	9.4	10.2	11.2
BMI, kg/m^2	30.6±6	29.7±6	30.5±6	26.3±5	29.3±6
Obese (BMI ≥30 kg/m^2)	50.6	43.7	52.7	20.4	41.7

CHF indicates congestive heart failure; NYHA, New York Heart Association class; MI, myocardial infarction; PCI, percutaneous coronary intervention; and BMI, body mass index.

All $P<0.001$. Data are presented as frequencies (%), except mean±SD values are used for age and body mass index.

or combination diabetes therapy (OR=1.7, $P<0.0001$). Additionally, the OR for significant CAD increased by age decile (Figure 3) such that black women 70 to 79 years old and 80 to 98 years old had a 3.05- to 5.06-fold higher OR for significant CAD, respectively ($P<0.0001$ for both age deciles).

Discussion

Within the last decade, the lack of gender-specific evidence prompted an upsurge in research focusing on clinical differences in cardiovascular disease between women and men.[23–27] In a similar manner, our current knowledge about differences in CAD and clinical outcomes by ethnicity is notably inadequate

Table 7. Procedural and In-Hospital Complication Rates* (%) for Ethnic Subsets of the Acute Chest Pain Cohort Undergoing Coronary Angiography

% With Complications	Black (n=23 382)	Hispanic (n=8708)	Native American (n=1596)	Asian (n=3725)	White, Non-Hispanic (n=412 918)	P
Unplanned CABG	0.24	0.31	0.13	0.35	0.39	<0.0001
Postprocedure emergent PCI	0.42	0.70	0.25	0.54	0.68	<0.0001
Postprocedure arrhythmia	2.46	2.96	2.19	4.70	3.67	<0.0001
Postprocedure CVA	0.35	0.31	0.25	0.51	0.39	0.35
Postprocedure tamponade	0.06	0.10	0.13	0.16	0.14	0.004
Postprocedure renal failure	0.85	1.31	1.32	1.32	0.91	<0.0001
Vascular bleed	0.93	1.39	1.25	1.48	1.12	0.001
Postprocedure CHF	0.67	1.03	0.56	1.42	1.07	<0.0001
Postprocedure shock	0.78	1.29	0.81	1.44	0.99	<0.0001
Periprocedural MI	0.51	0.60	0.88	0.72	0.72	0.003
In-hospital death	1.54	1.95	1.38	2.17	1.77	0.014
Cardiac	1.07	1.36	1.00	1.51	1.28	0.021

PCI indicates percutaneous coronary intervention; CVA. cerebrovascular accident; CHF, congestive heart failure; and MI, myocardial infarction.
*Note: The data report the observed rates for each of the listed procedural complications.

given the recent population shifts in Hispanic, Asian, and other diverse patient cohorts.[6,8,9,28–33] The current catheterization data set from the ACC-NCDR, given its nationwide coverage, is uniquely suited to provide insight into differences across gender and ethnic patient subsets referred for coronary angiography.[21] From 2 large angiographic cohorts of patients with stable chest pain (n=375 886) and ACS (n=450 329), in-hospital mortality rates varied by gender and ethnicity, with the highest event rates noted for older white women with obstructive CAD. Moreover, black women had significantly lower rates of obstructive CAD (ie, risk-adjusted OR ≈0.65). We believe that this evidence should prompt the development of predictive models for in-hospital mortality and significant CAD that are guided by the unique risk factors within each gender and ethnically diverse cohort.

Role of Gender and Ethnicity in In-Hospital Mortality

Since the mid-1980s, the total number of deaths related to cardiovascular disease has been greater for women than for men.[20] For example, in 2002, ≈50 000 more women than men died of cardiovascular disease. It has been reported that cardiovascular death rates have not declined as much for women of diverse racial subsets as for white women and men.[34,35] In stable chest pain patients in the present study, crude in-hospital death rates were higher for women than for men, but this failed to reach statistical significance for all but white women ($P<0.0001$). These data extend prior reports that have focused on ACS populations[25,35–39] but provide insight into lower-risk, stable chest pain patients. White patients were at least 2 years older than ethnic minority patients, which may be a principal driver for outcome differences across population subsets in the present study. The present results reveal that elderly white women had an elevated OR of in-hospital death, as much as 6.3-fold higher, compared with similarly aged black and Asian women ($P<0.0001$).

Furthermore, in stable chest pain patients, white women with angiographic CAD were also at higher risk of in-hospital mortality. Among patients with stable chest pain, white women with 1- to 3-vessel CAD had 1.67- to 2.02-fold higher in-hospital mortality than white men ($P=0.013$). In particular, for white women, lower utilization of aspirin and glycoprotein IIb/IIIa inhibitor therapies may have contributed to mortality differences. These data support an expanding evidence base, indicating that women with significant atherosclerosis have a worsening clinical outcome.[24,25] Recent reports also note that higher-risk women with extensive coronary calcification have higher mortality rates than men.[40,41]

For higher-risk women presenting with ACS, a similar pattern was noted in which only white women had higher in-hospital mortality. Certainly, the advanced age at presentation for white women played a key role in clinical outcome, with nearly one third of white females 70 years of age and older dying in the hospital ($P<0.0001$). However, in a stepwise model, the greatest predictors of in-hospital mortality for white women were angiography performed on an urgent or emergent basis (OR 4.09, $P<0.0001$) and presentation in cardiogenic shock (OR 12.46, $P<0.0001$). Of the more than 1 million hospitalizations for acute myocardial infarction, more men are admitted annually[19,20]; however, 1-year death rates are consistently higher for women, particularly for black women.[19,20,24] The present report did not highlight an early hazard for black women, and it remains possible that less intensive postdischarge care may place these women at risk for near- and long-term postdischarge death.

Role of Gender and Ethnicity in Obstructive CAD

Despite cardiovascular disease being the leading killer of women at all ages, the prevalence of obstructive CAD in women is low. From the present report, when we controlled for an array of clinical and nonclinical factors, including insurance coverage and laboratory volume, the OR for significant CAD was reduced by >50% in women compared with men presenting with stable chest pain symptoms and for those with ACS. This pattern of a lower frequency of

Table 8. Multivariable Predictors of In-Hospital Death (n=8112 Deaths) in an ACS Cohort Referred for Elective, Diagnostic Coronary Angiography, With Examination of Gender and Ethnicity Interactions

				95% CI	
	Wald χ^2 Statistic	*P*	OR	Lower	Upper
Female gender	61	<0.0001	1.24	1.17	1.31
Ethnicity					
Black	1	0.22	1.27	0.87	1.86
Hispanic	1	0.21	0.71	0.42	1.23
Asian	3	0.11	0.54	0.25	1.15
Native American	<1	0.83	0.85	0.20	3.69
Female gender interaction					
Black	1	0.22	0.86	0.68	1.10
Hispanic	3	0.08	1.37	0.97	1.95
Asian	2	0.13	1.47	0.90	2.41
Native American	<1	0.69	0.81	0.30	2.20
Cardiac risk factors					
Age (in deciles)	856	<0.0001	1.51	1.47	1.55
Family history of premature CAD	24	<0.0001	0.87	0.82	0.92
Diabetes mellitus					
Non–insulin-dependent	5	0.021	1.08	1.01	1.15
Insulin-dependent	32	<0.0001	1.28	1.18	1.40
Current smoker	21	<0.0001	0.86	0.80	0.92
Hyperlipidemia	213	<0.0001	0.68	0.65	0.72
CAD and noncardiac atherosclerosis					
No. of vessels with CAD (/vessel)	297	<0.0001	1.28	1.24	1.32
LVEF (/decile)	1119	<0.0001	0.32	0.13	0.59
Known CAD	22	<0.0001	1.16	1.09	1.23
Prior PCI	60	<0.0001	0.74	0.69	0.80
History of cerebrovascular disease	54	<0.0001	1.28	1.20	1.37
History of peripheral arterial disease	60	<0.0001	1.29	1.21	1.38
Comorbidity					
History of renal failure	571	<0.0001	2.46	2.29	2.65
Body mass index (per 10 kg/m^2)	14	<0.0001	0.95	0.93	0.98
History of chronic lung disease	113	<0.0001	1.38	1.30	1.47
Prior valve surgery	14	<0.0001	1.49	1.21	1.83
Symptoms and stress ischemia					
NYHA class (/class)	605	<0.0001	1.25	1.23	1.27
CCSC angina class (/class)	56	<0.0001	1.23	1.16	1.29
Acute myocardial infarction	458	<0.0001	1.53	1.47	1.59
Urgent/emergent catheterization	526	<0.0001	2.24	2.09	2.40
Nonclinical factors					
No. of MD operators (/quartile)	7	0.01	1.04	1.01	1.07
Northeast region	29	<0.0001	0.82	0.77	0.88
Southeast region	10	0.001	1.11	1.04	1.19
Private insurance	92	<0.0001	0.73	0.68	1.86

LVEF indicates left ventricular ejection fraction; PCI, percutaneous coronary intervention; NYHA, New York Heart Association; CCSC, Canadian Cardiovascular Society class; and MD, medical doctor.

significant CAD in the setting of stable chest pain and ACS has been reported previously.[24,42,43] Recent data from the National Institutes of Health–National Heart, Lung-and Blood Institute–sponsored Women's Ischemia Syndrome Evaluation reported that nearly two thirds of females undergoing elective coronary angiography had nonobstructive CAD.[44] Similarly, women enrolled in the Thrombolysis In Myocardial Infarction-18 and Global Utilization of Streptokinase and t-PA for occluded arteries randomized trials had 47% and 57% lower frequencies of significant CAD, respectively, compared with men.[42] A recent synthesis of ACS trials reveals that on average, 23% of women and 13% of men had nonobstructive CAD.[45]

Although this consistent pattern of a lower frequency of significant CAD has been reported for several decades, what is yet to be defined is how ethnicity may alter this gender relationship to angiographic CAD. The present results further revealed that black and Hispanic patients had a lower prev-

Table 9. Risk-Adjusted* OR for Utilization of Elective or Emergent PCI or CABG Surgery and Aspirin and Glycoprotein IIb/IIIa Inhibitor Use in Women and Men of Diverse Ethnicity With ACS

	Observed Utilization Rate, %		Risk-Adjusted OR for Utilization in Women vs. Men (95% CI)	*P*
	Women	Men		
Elective PCI				
Black	37.4	42.9	1.02 (0.96–1.09)	0.51
Hispanic	41.5	52.9	0.70 (0.88–1.09)	0.70
Native American	46.7	51.2	1.16 (0.90–1.49)	0.24
Asian	43.6	54.0	0.96 (0.81–1.13)	0.59
White	41.0	48.9	0.95 (0.93–0.96)	<0.0001
Emergent PCI				
Black	0.4	0.5	0.87 (0.57–1.32)	0.50
Hispanic	0.5	0.8	0.75 (0.40–1.39)	0.36
Native American	0.3	0.2	1.81 (0.66–5.00)	0.25
Asian	0.7	0.5	1.05 (0.99–1.97)	0.99
White	0.6	0.7	1.04 (0.96–1.13)	0.294
Elective CABG				
Black	2.5	3.1	0.89 (0.76–1.05)	0.177
Hispanic	4.1	4.1	1.04 (0.82–1.32)	0.77
Native American	2.8	4.2	0.67 (0.35–1.30)	0.24
Asian	3.4	3.6	0.81 (0.55–1.21)	0.31
White	3.4	4.5	0.77 (0.74–0.80)	<0.0001
Unplanned CABG				
Black	0.2	0.3	0.92 (0.53–1.62)	0.78
Hispanic	0.2	0.4	0.81 (0.31–2.07)	0.65
Native American	0.0	0.2	. . .	0.99
Asian	0.1	0.5	0.69 (0.13–3.76)	0.67
White	0.4	0.4	1.11 (0.99–1.24)	0.053
Aspirin use				
Black	75.1	76.8	1.01 (0.95–1.08)	0.79
Hispanic	69.3	75.7	0.96 (0.86–1.06)	0.40
Native American	86.7	89.6	0.82 (0.58–1.15)	0.25
Asian	77.4	82.0	0.99 (0.83–1.19)	0.92
White	80.1	83.3	0.92 (0.90–0.93)	<0.0001
Glycoprotein IIb/IIIa inhibitor use				
Black	32.5	38.5	0.95 (0.89–1.01)	0.096
Hispanic	32.4	43.6	0.92 (0.82–1.02)	0.10
Native American	36.6	41.8	1.02 (0.80–1.29)	0.90
Asian	37.8	50.4	0.80 (0.69–0.94)	0.007
White	35.5	43.8	0.89 (0.88–0.90)	<0.0001

PCI indicates percutaneous coronary intervention.
*Risk adjustment includes covariates included in Table 8.

alence of CAD than their white, non-Hispanic counterparts when referred for evaluation of stable and unstable chest pain symptoms. These results were similar to a prior report in 311 men referred to coronary angiography after a positive nuclear imaging study.[46] In that report by Whittle et al[46] from a cohort of male veterans, blacks had a 17% lower rate of significant CAD.

However, within these 2 large cohorts, black women had the lowest observed frequency of significant CAD, with only 42% and 64% presenting with stable and unstable chest pain symptoms, respectively. Our test for interaction revealed that black women had an OR for significant CAD of 0.64 ($P<0.0001$) with stable chest pain and 0.67 with ACS ($P<0.0001$). These results in ethnic minorities, notably for black women, may be the result of a limited knowledge base in important diverse subsets of the patient population.[28] A less abundant evidence base may contribute to precatheterization pathways that are less efficient or care pathways that may be based on physician indecision. A prior report by Barnhart and Bernstein[47] noted that among patients who met appropriate clinical criteria for coronary angiography, blacks and Hispanics were less likely to be referred to cardiac catheterization. In a similar report, guidelines oriented toward black post–myocardial infarction patients resulted in a similar yield in identifying patients with significant CAD,[48] thus supporting the concept that tailored pathways may improve detection of patients at risk for significant CAD.

Evidence reported herein further identifies subsets of black women with a higher OR for significant CAD. In both the stable and unstable cohorts, black women with diabetes, chronic lung disease, or hyperlipidemia consistently had a higher OR for significant CAD. The presence of a higher risk of CAD with diabetic and hyperlipidemic blacks has been reported in several prior series[49]; however, data specific to women are ill-defined. Significant CAD also increased with age, with elderly black women having a 3- to 6-fold higher OR. Observed frequencies revealed that nearly 60% and >75% of elderly black women with stable chest pain or ACS, respectively, had significant CAD, rates that more closely approximated those of their male counterparts.

Study Limitations

Given the present large cohort of patients undergoing coronary angiography, statistical differences are frequently observed but may not be clinically meaningful. For example, in large cohorts such as this, even 1% to 2% differences in the prevalence of risk factors or other comorbidities may be statistically significant yet insignificant from a clinical perspective. Although data are available from population samples, one cannot draw inferences from the present study registry and apply them to noncatheterized patients owing to referral bias.[23] A major limitation of the present data is that participation in the NCDR is voluntary and not without selection bias. We included only hospitals that provide consecutive patient series on a quarterly basis to minimize selection bias. Moreover, our prognostic models only considered the dichotomous occurrence of in-hospital death, because of the largely short observation time period, and the models did not consider a differential timing of this event.

The registry contains a limited depth of information on risk factors and other measured risk factor data, as well as about the reason and timing of referral and may underestimate clinical risk prediction. We used in-hospital all-cause mortality as an end point in an attempt to minimize event misclas-

Table 10. Multivariable Predictors of Significant CAD (ie, ≥70% Coronary Stenosis) in ACS Patients Referred for Coronary Angiography, With Examination of Gender and Ethnicity Interactions

				95% CI	
	Wald χ^2 Statistic	*P*	OR	Lower	Upper
Female gender	7494	<0.0001	0.47	0.47	0.48
Ethnicity					
Black	15	<0.0001	0.91	0.87	0.96
Hispanic	42	<0.0001	0.76	0.70	0.82
Asian	0	0.94	0.99	0.87	1.14
Native American	0	0.99	0.99	0.82	1.22
Female gender interaction					
Black	141	<0.0001	0.67	0.63	0.72
Hispanic	1	0.40	1.05	0.94	1.18
Asian	1	0.36	0.92	0.76	1.11
Native American	1	0.40	0.89	0.68	1.17
Cardiac risk factors					
Age (in deciles)	9396	<0.0001	1.48	1.47	1.49
Family history of premature CAD	13	<0.0001	1.03	1.01	1.05
Current smoker	1783	<0.0001	1.55	1.52	1.58
Hypertension	250	<0.0001	1.16	1.14	1.18
Hyperlipidemia	1769	<0.0001	1.46	1.43	1.48
Non–insulin-dependent diabetes mellitus	1023	<0.0001	1.45	1.42	1.48
Insulin-dependent diabetes mellitus	1200	<0.0001	1.76	1.70	1.81
Obesity (body mass index ≥30 kg/m^2)	67	<0.0001	0.93	0.92	0.95
History of chronic lung disease	362	<0.0001	0.81	0.79	0.82
Prior peripheral arterial disease	396	<0.0001	1.36	1.32	1.40
Prior cerebrovascular disease	34	<0.0001	1.09	1.06	1.12
History of renal failure	43	<0.0001	1.17	1.12	1.23
Symptoms and CAD history					
Known CAD	316	<0.0001	1.41	1.36	1.47
Prior MI	69	<0.0001	1.13	1.10	1.16
Prior PCI	264	<0.0001	1.30	1.26	1.34
Prior CABG surgery	1498	<0.0001	1.90	1.84	1.96
Non–ST-segment MI	9410	<0.0001	3.35	3.27	3.43
ST-segment MI	12 054	<0.0001	6.87	6.64	7.11
Congestive heart failure symptoms	80	<0.0001	0.88	0.85	0.90
Urgent catheterization	68	<0.0001	1.08	1.06	1.10
Nonclinical factors					
ED admission	18	<0.0001	0.96	0.95	0.98
Uninsured	10	0.001	1.06	1.02	1.10
Suburban hospital	147	<0.0001	0.89	0.87	0.91
Hospital type					
Government hospital	9	0.003	0.91	0.86	0.97
Private–community hospital	288	<0.0001	1.37	1.32	1.42
On-site CABS	46	<0.0001	1.16	1.11	1.21
% of Medicare patients (in quartiles)	14	<0.0001	1.02	1.01	1.03
PCI volume (per quartile)	4	0.044	1.02	1.01	1.03
No. of cardiology groups (per quartile)	181	<0.0001	1.06	1.05	1.07
No. of full-time employees (per quartile)	205	<0.0001	1.06	1.05	1.07
US region					
Southeastern region	29	<0.0001	0.93	0.91	0.96
Great Lakes region	470	<0.0001	0.80	0.78	0.82
Western US region	76	<0.0001	1.15	1.11	1.18

MI indicates myocardial infarction; ED, emergency department.

In the above model, comparator groups are those not meeting the defined group (eg, Western US region vs non-Western US region or rural vs nonrural location).

Quartile subsets are as follows: PCI volume: <551, 551–920, 921–1497, % Medicare patients: <45, 45–51.9, 52–59, and >59; No. of cardiology groups: 1, 2, 3–5, and >5; and No. of full-time employees: <4, 4–4.95, 5–5.9, and >5.9.

Model information: Nagelkerke r^2=0.224, model χ^2=66 412, classification rate=82.3%.

sification. Results for cardiac-specific mortality may be different from the presented results. These data also represent patients referred for coronary angiography, and as such, the present results are in part due to selection bias. Moreover, risk factor and additional medical history were often derived from patient self-reports and are therefore subject to bias. We believe that this may explain, for example, why patients with chronic lung disease had lower odds of CAD. Finally, the use of visual angiographic interpretation may differentially bias the present results for gender and ethnic subsets of these 2 cohorts. The exclusion of measured arterial diameters may have resulted in differential bias across gender and ethnic patient subsets.

Conclusions

The present report provides an exploration of differential in-hospital mortality and angiographic CAD rates in 2 large, ethnically diverse cohorts of 375 886 and 450 329 patients referred to coronary angiography for evaluation of stable and unstable chest pain syndromes. The present study was the first to evaluate in-hospital death rates in lower-risk patients with stable chest pain symptoms and revealed generally similar outcomes for women and men of diverse ethnicity. However, white women with stable and unstable chest pain symptoms, particularly those with angiographic CAD, had higher in-hospital mortality. Similarly, white women presenting with ACS who required angiography on an urgent or emergent basis and those presenting in cardiogenic shock were particularly at risk of in-hospital death.

Substantial ethnic and gender-related differences were also notable across the present registry, including a lower (risk-adjusted) OR of significant CAD in black women. Of clinical importance, elderly black women had significantly higher CAD rates, and it was possible to identify subsets of these women with higher disease prevalence that approached the rate of their male counterparts. This evidence illustrates the prominent role of ethnicity and gender in defining diagnostic strategies for significant CAD detection and may be helpful in updating the expected rates of significant CAD for women and men of diverse ethnicity referred for diagnostic coronary angiography. The present mortality and CAD predictive models have important implications for clinical practice and support the need for individualized gender- and ethnicity-based risk profiles in clinical care algorithms.

Disclosures

None.

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CLINICAL PERSPECTIVE

Dramatic population shifts have made the United States ever more ethnically diverse. Its healthcare centers reflect this ethnic "melting pot," yet our understanding of diverse healthcare needs and differences in disease prevalence and outcomes between male and female ethnic subsets remains poor. The American College of Cardiology's National Cardiovascular Data Registry (NCDR) for cardiac catheterization, with data collection in >600 US hospitals, is well suited to track national patterns of disease prevalence and clinical outcomes. The present report focused on patients referred for diagnostic coronary angiography and revealed significant gender and ethnic differences in coronary disease prevalence and in-hospital mortality rates. Our results reveal higher risk-adjusted in-hospital mortality for white, non-Hispanic women referred for evaluation of stable and unstable chest pain syndromes. One driver for higher in-hospital mortality for white, non-Hispanic women was their advanced age at presentation. An additional risk driver could relate to lower use of elective coronary revascularization procedures and lower glycoprotein IIb/IIIa inhibitor use. Moreover, in this registry, black women had a consistently lower prevalence of obstructive coronary disease than other patient subsets. A key finding was higher disease prevalence, similar to that of men, in higher-risk black women, including those who were older, diabetic, or hyperlipidemic or who had lung disease. We believe the NCDR data can be invaluable as an aid in the development of clinical practice guidelines tailored to gender subsets of the population to improve the efficient use of angiographic laboratories and to target at-risk populations of women and men.

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