Heart Failure Hospitalization by Race/Ethnicity, Gender and Age in California: Implications for Prevention

Baqar A. Husaini, PhD[1]; Robert S. Levine, MD[2]; Keith C. Norris, MD, PhD[3]; Van Cain, MA[1]; Mohsen Bazargan, PhD[4]; Majaz Moonis, MD[5]

Objective: We examined variation in rates of hospitalization, risk factors, and costs by race/ethnicity, gender and age among heart failure (HF) patients.

Methods: We analyzed California hospital discharge data for patients in 2007 (n=58,544) and 2010 (n=57,219) with a primary diagnosis of HF (ICD-9 codes: 402, 404, 428). HF cases included African Americans (Blacks; 14%), Hispanic/Latinos (21%), and non-Hispanic Whites (65%). Age-adjusted prevalence rates per 100,000 US population were computed per CDC methodology.

Results: Four major trends emerged: 1) Overall HF rates declined by 7.7% from 284.7 in 2007 to 262.8 in 2010; despite the decline, the rates for males and Blacks remained higher compared with others in both years; 2) while rates for Blacks (aged ≤54) were 6 times higher compared with same age Whites, rates for Hispanics were higher than Whites in the middle age category; 3) risk factors for HF included hypertension, chronic heart disease, chronic kidney disease, atrial fibrillation, and chronic obstructive pulmonary disease; and 4) submitted hospitalization costs were higher for males, Blacks, and younger patients compared with other groups.

Conclusion: Health inequality in HF persists as hospitalization rates for Blacks remain higher compared with Whites and Hispanics. These findings reinforce the need to determine whether increased access to providers, or implementing proven hypertension and diabetes preventive programs among minorities might reduce subsequent hospitalization for HF in these populations. *Ethn Dis.*2016;26(3):345-354; doi:10.18865/ed.26.3.345

Introduction: Previous Findings

Heart failure (HF) is a growing epidemic and likely to impact 9 million US adults by 2030. The lifetime risk of developing HF at age 40 is one in five with no gender differences.[1-3] However, with advances in treatment and management, a decline in hospitalization for HF has been recently observed.[4-10] Data distinguishing trends according to race/ethnicity, gender and age are sparse, but available evidence supports a higher burden of HF among Blacks and Hispanics.[6-23] Moreover, Blacks with HF tend to be younger and have higher readmission rates compared with Whites.[9,11-14,21-23] Similarly, Hispanic patients were reported to be younger, had higher readmission rates, and they tended to be under-insured.[11] These trends are important, in part, because as Black and Hispanic populations age, their early burden of HF may translate into high costs for the Medicare program. Only 14% of Medicare patients have HF, yet HF patients consume approximately 43% of annual Medicare spending.[24] Since prior studies have not provided hospital cost variations relative to primary diagnosis of HF, this article examines variations by gender, age and race/ethnicity in: 1) prevalence of HF and associated risk factors; and 2) hospital cost for patients discharged with a primary diagnosis of HF.

Methods

Sample

We examined 2007 and 2010 California Hospital Discharge Data (HDDS, obtained from the California Office of Statewide Health Planning and Development [OSHPD]) on patients (aged ≥20 years)

Keywords: Heart Failure; Ethnicity; Gender; Age; Hospital Costs

[1]Center for Prevention Research, Tennessee State University, Nashville, TN
[2]Baylor College of Medicine, Houston, TX
[3]David Geffen School of Medicine, UCLA, Los Angeles, CA
[4]Charles R. Drew University of Medicine and Science, Los Angeles, CA
[5]University of Massachusetts Medical School, Worcester, MA

Address correspondence to Baqar A. Husaini, PhD; professor, Center for Prevention Research, Tennessee State University; 3500 John Merritt Blvd; Nashville, TN 37209; 615.210.1132; bhusaini@tnstate.edu

discharged with a primary diagnosis of HF (ICD-9 codes 402, 404, 428). Numbers of HF cases were 58,544 in 2007 and 57,219 in 2010.

Data Characteristics

HDDS files are administrative files that provide patients' basic demographics such as: age; gender; county and zip code of residence; ICD-9 diagnostic codes (both primary and secondary diagnoses) for which a hospital in-patient was treated; race/ethnicity (White, Black, Hispanic/Latinos, Pacific Islanders/Asians, Native American, and others); the number of admissions; days in hospital; and charges (US$) for the stay. Only the attending physicians gave primary and secondary diagnoses. Secondary diagnoses were used as co-morbidities of HF.

this article examines variations by gender, age and race/ethnicity in: 1) prevalence of HF and associated risk factors; and 2) hospital cost for patients discharged with a primary diagnosis of HF.

While 12% of California's population is composed of Asians (eg, Chinese, Japanese, East Indians), no such data on ethnic sub-groups are available in the OSHPD administrative files. Hence, we focused on comparing HF rates, risk factors, and estimated costs across African American (Black), Hispanic, and White groups. Two indices of co-morbidity were computed: 1) a simple count of all secondary diagnoses for each patient; and 2) Charlson Index of co-morbidity,[25] which measures severity of co-morbidity for each patient. Since OSHPD files do not provide actual reimbursed dollars for services, we used the submitted charges as an estimated cost of HF for the year. We computed two types of hospital costs for the entire year: 1) costs/charges for HF alone (HF cost $), the amount associated with a patient discharged with HF as a primary diagnosis during the year; and 2) total hospital cost/charges for the year (Total cost $) that included HF cost plus the cost for the same patient when he/she was re-admitted with diagnoses other than HF. Physicians' charges were not included in the hospital costs/charges.

Statistical Analysis

Age-adjusted HF rates per 100,000 US adults (2010 Census) were developed per CDC methodology.[26] Additionally, we estimated age-specific prevalence for each age category (20–34, 35-44, 45–54, 55–64, 65–74, 75-84, and ≥85 years), gender, and age-specific prevalence ratios (PR) of HF for each sub-group. Differences in the prevalence of HF risk factors by gender, race/ethnicity and age were evaluated with the Pearson $\chi 2$ and the Fisher's Exact Tests. Group differences in cost and other continuous variables were examined by ANOVA or t-tests. To examine the likelihood of HF association with each risk factor, logistic models were used on the total sample first and then for each gender and race/ethnic sub-groups separately.

Results

HF Rates and Changes in Rates (2007-2010) by Race/Ethnicity and Gender

The mean age was 73 across both time periods and both periods included almost equal numbers of males and females; race/ethnicity breakdown was Blacks (14%), Hispanics (21%) and Whites (65%). Age differences at both times were statistically significant by race/ethnicity, whereby White patients (2010) were older (mean age + standard deviation = 76 ± 13.5 years), followed by Hispanics (69 ± 15.0 years) and Blacks (64 ± 15.3 years) (Table 1, columns 2,4,6).

Table 2 (column 4) shows that the overall HF rate per 100,000 adult (aged 20 - 85+ years) population, declined by 7.7% from 284.7 in 2007 to 262.8 in 2010. Further, the decline was uneven in that prevalence of HF among Whites declined by 7.88% (250.1 in 2007, to 230.4 in 2010), Hispanics by 7.04% (316.7 to 294.4), and Blacks by 5.43% (653.4 to 617.9). Despite the overall decline, rates for Blacks relative to Whites and Hispanics, have remained more than two times higher (2:1) both in 2007 and 2010 (Table 2, columns 8-9).

Similarly, rates for males were nearly 1.5:1 higher than female rates (Table 2, column 7). Further, Black-to-White (B/W) rate ratios among the younger age category (≤54 years) remained higher, namely, 6:1 in both time periods (Table 2, columns 8-9).

Table 1: Demographic and clinical characteristics of HF patients in California, 2007 and 2010

	Black		Hispanic		White		Total Sample				All Male		All Female	
Factors	**2007**	**2010**	**2007**	**2010**	**2007**	**2010**	**2007 HF**	**2007 Non-HF**	**2010 HF**	**2010 Non-HF**	**2010 HF**	**2010 Non-HF**	**2010 HF**	**2010 Non-HF**
n	8,400	8,279	11,769	12,762	38,375	36,178	58,544	13,241	57,219	21,071	29,090	7,824	28,129	13,241
Col. →	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Female %	51.7	50.0	50.3	49.3	50.3	48.9	50.5	54.4	49.2	50.7	50.8	48.7	49.2	51.3
Age Mean	63	64	69	69	76	76	73	72	73	66	70	64	76	68
Age SD	15.46	15.3	14.94	15.0	13.50	13.6	14.2	14.5	14.9	16.3	15.0	15.8	14.2	16.6
HTN %	92	93	89	90	82	84	85[a]	77	87[a]	70	86[a]	69	88[a]	72
DM %	51	51	64	64	41	40	47[a]	39	47[a]	30	48[a]	30	46[a]	30
CHOL %	14	10	6	13	14	11	14[a]	11	11	7	10	7	11	8
CHD %	53	51	61	60	64	60	62[a]	40	60[a]	41	65[a]	45	55[a]	37
MI %	9	9	11	10	11	10	10[a]	4	10	8	10	8	9	7
STRK %	13	13	13	11	12	11	13	14	12	12	11	12	12	12
AFib %	44	45	47	47	62	63	56[a]	51	57[a]	43	58[a]	46	55[a]	39
CKD %	49	56	49	54	40	48	43[a]	22	50[a]	21	53[a]	22	47[a]	19
COPD %	38	37	31	30	41	39	38[a]	24	37[a]	17	37[a]	17	36[a]	17

a. differences between HF and non-HF cases are significant at P<.001.
SD, standard deviation; HTN, hypertension; DM, diabetes mellitus; CHOL, high cholesterol; CHD, coronary heart disease; MI, myocardial infarction; STRK, stroke; AFib, atrial fibrillation; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease.
Non-HF category excluded all patients with any diagnosis of HF.

These ratios begin to decline at age 65 onwards. Similar trends emerged for younger adults (≤54) when Black-to Hispanic (B/H) rate ratios were examined (Table 2, column 9). Here, younger Blacks (≤54) had significantly higher rates compared with Hispanics. Briefly, these data show that younger Blacks have higher HF hospitalization rates compared with their White and Hispanic peers. In contrast, Hispanic-to-White (H/W) ratios were different from those for B/W rate ratios. For example, the H/W ratios in 2007 were nearly 1:1 among Hispanics aged ≤45 years; in 2010 the ratios were slightly higher for each age group except in age group ≥85 years.

HF Risk Factors by Race/ Ethnicity, Gender and Age

Associations of HF risk factors were examined two ways: 1) comparing the patient cohorts in each race/ethnic and gender category on the existing percentage (%) of each risk factor (Table 1, columns 1-14); and 2) using multiple-logistical regressions to compute odds ratios (OR) and 95% CI of risk factors associated with HF in 2007 and 2010 (Table 3, columns 1-2). Overall, more than 50% of HF patients in 2007 and 2010 (Table 1, columns 7,9) had hypertension (HTN 85%; in 2007, OR=1.03; in 2010, OR=1.24, Table 3, columns 1-2), coronary heart disease (CHD 62%; in 2007, OR = 1.63; in 2010, OR =1.27, Table 3), atrial fibrillation (56%; in 2007, OR =2.31; in 2010, OR =1.16), and chronic kidney disease (CKD 43%; in 2007, OR =1.83; in 2010, OR =2.10).

An association of hypertension and kidney dysfunction is noticeable in the early ages (aged 35-44 years), as CKD existed in >40% of younger patients with HF (Table 4). Moreover, the prevalence of CKD rose with advancing age. Specifically, a majority (54.6%) of these patients had kidney dysfunction between Stage-III and Stage-V. Other risk factors impacting more than one-third (>33%) of the patients across all three groups (Table 1, columns 7,9; Table 3, columns 1-2) included conditions such as COPD (38%; 2007 OR=1.69; 2010 OR=2.12), and DM (47%; 2007 OR=1.09; 2010 OR=1.50). While MI showed a strong relationship to HF both in 2007 and 2010 (OR=2.18 and OR=1.80 respectively), stroke remained unrelated to HF. Finally, little variation by ethnicity and gender emerged as risk factors except for DM and HTN. Hypertension was more prevalent and started at a younger age (aged 20-34 years) in Blacks than other groups, while diabetes was more prevalent among Hispanics (starting at aged 35 years (Table 4, columns 1-2).

Table 2. California heart failure rate per 100,000 and rate ratios by age and ethnicity in 2007 and 2010

Age		Black	Hispanic	White	Total Sample	All Male	All Female	M/F Ratio Col 5/6	B/W Ratio Col. 1/3	B/H Ratio Col. 1/2	H/W Ratio Col. 2/3
	Col →	1	2	3	4	5	6	7	8	9	10
All Ages	2007	653.4	316.7	250.1	284.7	333.6	246.7	1.36	2.61	2.06	1.27
	2010	617.9	294.4	230.4	262.8	313.1	223.4	1.40	2.68	2.10	1.28
20-34	2007	49.9	7.9	7.9	10.9	12.9	8.0	1.60	6.32	6.32	1.00
	2010	47.5	7.6	7.0	9.9	12.1	7.4	1.64	6.78	6.25	1.08
35-44	2007	186.8	30.8	29.8	40.4	52.6	27.8	1.89	6.27	6.06	1.03
	2010	169.0	30.2	26.1	36.9	49.3	24.0	2.05	6.47	5.60	1.16
45-54	2007	551.0	113.3	88.4	121.8	155.7	88.7	1.76	6.23	4.86	1.29
	2010	480.5	101.7	83.2	110.6	146.6	75.1	1.95	5.77	4.72	1.22
55-64	2007	1,010.1	352.8	218.7	287.7	351.2	228.8	1.53	4.62	2.86	1.61
	2010	977.7	317.9	196.3	262.8	327.0	202.9	1.61	4.98	3.08	1.62
65-74	2007	1,558.7	816.7	558.6	658.6	763.9	569.4	1.34	2.79	1.91	1.46
	2010	1,469.6	758.7	523.6	615.3	723.0	524.0	1.38	2.81	1.94	1.45
75-84	2007	2,240.4	1,692.1	1,287.9	1,398.8	1,582.8	1,270.6	1.25	1.74	1.32	1.31
	2010	2,157.9	1,561.3	1,175.6	1,291.3	1,479.3	1,160.2	1.28	1.84	1.38	1.33
≥85	2007	4,307.4	3,071.5	3,210.6	3,252.6	3,749.3	3,013.0	1.24	1.34	1.40	.96
	2010	4,290.7	2,961.2	2,983.6	3,003.3	3,524.9	2,743.8	1.29	1.44	1.45	.99
18-64	2007	361.0	97.3	67.9	90.8	113.2	69.3	1.63	5.32	3.71	1.43
	2010	334.2	88.3	61.5	82.8	105.9	60.5	1.75	5.43	3.78	1.44
≥65	2007	2,048.0	1,323.3	1,058.9	1,155.8	1,326.0	1,038.6	1.28	1.93	1.55	1.25
	2010	1,967.6	1,236.0	979.3	1,070.9	1,246.2	949.9	1.31	2.01	1.59	1.26

B, Blacks; W, Whites; H, Hispanics.

Hospital Costs by Race/ Ethnicity and Gender

Overall Costs

We examined three factors that impact submitted hospitalization costs: 1) number of co-morbidities and Charlson Comorbidity Index; 2) number of admissions; and 3) length of hospital stay (in days). We first examined cost differences for the total 2007 and 2010 samples (Table 5, columns 4, 8) and then cost variations by ethnicity, gender and age categories (aged ≤64 vs ≥65 years). Significant findings included a 6.7% increase in cost of HF alone from $71,995 in 2007 to $76,839 in 2010 (Table 5, columns 4, 8). Similarly, the total annual cost increased by 4.01% from $143,270 in 2007 to $149,020 in 2010. It may be noted here that more than 50% of the readmissions and the total costs for the year included the costs for HF alone. Thus, the higher total costs of the year reflect all cost factors including the number of readmissions (more than 2), number of co-morbidities (more than 3), and length of hospital stay (14+ days; Table 5, columns 4, 8).

Costs by Race/Ethnicity and Gender

Submitted costs also varied significantly by race/ethnicity and by gender (Table 5, columns. 1-3, 5-7, 9-10). Black patients had significantly *(P*<.001) more hospital readmissions, longer hospitalizations (15-18 days) and higher costs compared with Hispanics and Whites. In both years, costs for HF alone were higher for Blacks compared with Hispanics and Whites (in 2007: $83,858 vs $69,430 vs $70,315, P<.001; in 2010: $82,929 vs $80,981 vs $73,985, P<.001). Further, Blacks had higher total costs compared with Hispanic and White cohorts (Table 5, columns 1-3, 5-7). Similar gender differences also emerged whereby higher cost for both HF alone and the total cost for the year existed for males compared with females (Table 5, columns 9-10). These data suggest that higher cost among males and Blacks reflected greater severity of co-morbidities (see Charlson Index of condition severity score of 3.58 and 3.8, respectively), resulting in more services and longer hospitalization compared with other groups.

Table 3. Odds ratio and 95% CI interval predicting heart failure in 2007 and 2010

Risk Factors		Total		Black	Hispanic	White	All Male	All Female
Year		2007	2010	2010	2010	2010	2010	2010
Col. →		1	2	3	4	5	6	7
HTN	OR	1.03	1.24	1.47	1.16	1.21	1.23	1.23
	CI	1.01-1.06	1.19-1.29	1.29-1.69	1.04-1.28	1.15-1.27	1.16-1.30	1.15-1.32
DM	OR	1.09	1.50	1.46	1.45	1.53	1.51	1.49
	CI	1.06-1.11	1.44-1.56	1.31-1.63	1.33-1.58	1.45-1.61	1.44-1.60	1.40-1.59
CHOL	OR	.96	1.03	1.04	1.08	1.01	1.07	.97
	CI	.94-.99	.96-1.22	.85-1.28	.93-1.26	.93-1.10	.98-1.18	.87-1.07
CHD	OR	1.63	1.27	1.27	1.17	1.31	1.36	1.16
	CI	1.59-1.66	1.22-1.33	1.13-1.43	1.07-1.28	1.25-1.38	1.30-1.44	1.09-1.24
MI	OR	2.17	1.25	1.03	1.38	1.25	1.31	1.16
	CI	2.08-2.27	1.6-1.34	.84-1.28	1.18-1.62	1.15-1.36	1.19-1.43	1.04-1.30
STRK	OR	.96	.90	.76	.87	.94	.91	.88
	CI	.93-.98	.85-.95	.66-.87	.77-.98	.88-1.01	.81-.98	.81-.96
AFib	OR	2.31	1.16	1.30	1.13	1.15	1.12	1.22
	CI	2.27-2.36	1.11-1.20	1.16-1.45	1.04-1.23	1.10-1.20	1.06-1.17	1.15-1.29
CKD	OR	1.83	2.10	1.86	2.27	2.06	2.11	2.09
	CI	1.79-1.99	2.00-2.10	1.66-2.08	2.06-2.51	1.94-2.18	1.99-2.24	1.94-2.25
COPD	OR	1.69	2.12	2.23	2.13	2.14	2.10	2.17
	CI	1.65-1.73	2.02-2.22	1.95-2.55	1.89-2.41	2.02-2.26	1.98-2.23	2.02-2.33

B, Blacks; W, Whites; H, Hispanics; CI, confidence interval; HTN, hypertension; DM, diabetes mellitus; CHOL, high cholesterol; CHD, coronary heart disease; AFib, atrial fibrillation; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease.

Table 4. Percentage of risk factors among HF patients by age and ethnicity in 2007 and 2010

Age		20-34	34-44	45-54	55-64	65-74	75-84	≥85	All Ages	Total Sample
Ethnic Group		B/H/W	B/H/W	B/H/W	B/H/W	B/H/W	B/H/W	B/H/W	B/H/W	
Col. →		1	2	3	4	5	6	7	8	9
HTN	2007	80/60/62	88/79/66	91/85/76	93/90/80	94/92/84	94/91/84	93/89/82	92/89/82	85
	2010	83[a]/72/60	88[a]/82/66	91[a]/86/76	94[a]/90/82	95[a]/92/85	94[a]/92/87	94[a]/90/85	93[a]/90/84	87
DM	2007	26/30/19	36/41/33	45/63/44	55/75/56	61/75/56	57/64/44	38/44/26	51/64/41	47
	2010	29[a]/27/21	34/44[a]/31	45/62[a]/40	55/75[a]/53	62/76[a]/55	54/65[a]/43	40/45[a]/26	51/64[a]/40	47
CHOL	2007	6/4/5	10/10/7	12/16/11	16/18/16	16/19/17	16/16/15	12/14/12	14/16/14	14
	2010	3/4/2	8/6/6	9/11[b]/8	9/13[b]/11	13/14/11	11/14/12	10/12/9	10/13[a]/11	11
CHD	2007	18/19/15	32/30/28	42/47/47	56/61/61	62/70/70	63/70/70	58/64/61	53/62/64	62
	2010	24/22/20	30/30/31	43/47/44	50/57/58	58/66/67	63/70[a]/68	59/63/60	51/60/62[a]	60
MI	2007	3/3/4	5/5/5	7/7/8	9/11/11	10/12/12	11/12/11	10/11/11	9/11/11	10
	2010	7/4/3	6/6/5	6/8/8	7/10/9	10/11/10	11/12/10	11/11/9	9/10/10	10
STK	2007	6/4/4	6/4/4	8/8/7	12/11/9	16/15/13	18/16/14	18/15/13	13/13/12	13
	2010	4/5/3	7/5/4	9/8/7	12/9/8	14[a]/12/11	18[a]/14/13	20[a]/12/12	13[a]11/11	12
AFib	2007	31/31/35	38/25/37	34/30/43	40/39/49	50/49/60	57/56/58	57/29/68	44/47/62	56
	2010	29/32/33	29/28/36[a]	37/30/42[a]	43/37/48[a]	48/46/60[a]	54/57/69[a]	59/58/69[a]	45/47/63[a]	57
CKD	2007	42/36/32	43/40/21	42/43/28	47/52/36	55/53/43	53/51/44	52/43/40	49/49/40	43
	2010	46[a]/39/27	42[a]/39/24	47/48[a]/30	54[a]/54/40	60[a]/60/50	64[a]57/53	63[a]/52/50	56[a]/54/48	50
COPD	2007	19/15/15	24/15/25	34/21/37	41/27/44	44/33/48	41/31/43	36/37/35	38/31/41	38
	2010	19/17/31[a]	17/20/30[a]	20/20/27[a]	20/20/29[a]	17/21/26[a]	14/20/22	12/19/19	37/30/39	37

a. Differences between ethnic groups within the age category are significant at P≤.001.
b. Differences between ethnic groups within the age category are significant at P<.01.
B, Blacks; W, Whites; H, Hispanics; HTN, hypertension; DM, diabetes mellitus; CHOL, high cholesterol; CHD, coronary heart disease; MI, myocardial infarction; STRK, stroke; AFib, atrial fibrillation; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease.

Table 5. Average hospitalization costs of heart failure by ethnicity in 2007 and 2010

Factors			2007				2010					
			Black	Hispanic	White	Total Sample	Black	Hispanic	White	Total Sample	All Males	All Females
Cols. →			1	2	3	4	5	6	7	8	9	10
# Co-morbid			2.7	2.6	2.9	2.8	3.64	3.79	3.67	3.69	3.58	3.38
Charlson Index			3.9	3.9	3.6	3.7	3.8	3.8	3..5	3.6	3.70[a]	3.50
# HF adm			1.5	1.4	1.3	1.4	1.6[a]	1.4	1.3	1.4	1.40[a]	1.33
Total # re-adm.			3.2	2.9	2.6	2.8	2.8[a]	2.4	2.2	2.3	2.36[a]	2.31
HF LOS			7.7[a]	7.4	7.6	7.6	7.6	7.9[a]	7.0	7.3	7.31[a]	7.19
Total LOS			18.4[a]	17.3	16.8	17.1	15.4[a]	14.8	13.3	13.9	13.7	14.2
HF Cost Alone $	All Ages	M	83,858[a]	69,430	70,315	71,995	82,929[a]	80,981	73,985	76,839	83,341	70,116
		SD	137,304	101,971	114,953	115,866	166,922	141,089	148,332	149,654	178,691	111,572
	Age ≤64	M	87,152	70,970	87,570	82,995	93,929	84,673	96,735	92,580	98,245[a]	83,063
		SD	160,009	105,589	169,348	152,364	204,144	165,798	245,742	214,650	246,731	145,148
	Age ≥65	M	79,896	68,557	66,003	67,667	71,013	78,996	68,436	70,803	75,302[a]	66,666
		SD	102,256	998,617	962,161	975,052	112,400	125,782	111,732	114,825	129,329	218,732
Total Cost $	All Ages	M	159,690[a]	148,860	137,960	143,270	165,393[a]	158,355	141,980	149,020	156,730[a]	141,050
		SD	253,579	213,449	206,667	215,507	292,440	245,190	235,834	247,053	271,427	218,732
	Age ≤64	M	166,200	156,580	173,440	167,040	178,982	159,545	181,379[a]	174,590	176,080	172,080
		SD	272,493	235,533	274,008	264,148	327,600	262,495	340,670	317,016	338,946	276,287
	Age ≥65	M	152,360	144,550	129,380	134,220	150,672	157,716	132,370	139,210	146,680	132,780
		SD	230,220	199,967	185,747	193,046	124,800	235,376	201,019	213,439	100,479	100,826

a. differences by ethnicity and gender significant at P<.001.
comorbid, number of comorbidities; Charlson Index, Charlson Index of Severity of Comorbid Conditions; # HF Adm., number of heart failure admissions; Total # re-adm., total number of readmissions; HF LOS, length of stay in days associated with heart failure; Total LOS, total days in hospital; HF Cost Alone $, hospital cost for heart failure; Total Cost $, total cost for year for any admission with at least one admission for HF; M, mean; SD, standard deviation.

Costs by Age

Since previous studies had pointed to higher hospitalization cost for younger (aged ≤64 years) compared with older HF patients (≥65),[27] we examined cost differentials between these two groups of patients (Table 5). Here, the cost for HF alone was 30% higher for younger patients (aged ≤64 years) compared with the older (aged ≥65 years) patients ($82,995 vs $67,667, *P*<.001 in 2007; $92,580 vs $70,803, *P*<.001 in 2010; Table 5, columns. 4,8). Further, among the younger patients (aged ≤64 years), HF costs varied by ethnicity in that younger Blacks had significantly higher HF costs (in both 2007 and 2010) compared with younger Hispanics ($87,152 vs $70,970, *P*<.001 in 2007; $93,925 vs $84,673, *P*<.001 in 2010; Table 5, columns. 1-2, 5-6). Interestingly, the higher HF cost among younger Whites in 2010 ($96,735) occurred largely due to higher costs among the youngest patients (aged 20-44 years). Further, the total annual costs showed similar trends favoring Black patients as was found for HF cost alone (Table 5, columns 1-3, 5-7).

In summary, the hospital costs (charges) varied by gender; race/ethnicity and age were higher for males and younger Black patients (aged ≤64 years). These higher costs largely reflect a higher prevalence of severe chronic conditions that afflict minority populations in general. The lower costs among the older patients (aged ≥65 years) may reflect a higher rate of mortality, which affects both the number of admissions and length of hospital stay of older patients.

Discussion

Our study is the first to our knowledge to examine both HF rates and costs across three racial/ethnic groups (Blacks, Hispanics, and Whites) from a large administrative dataset. We found both Black and Hispanic

HF patients were younger (aged 64 and 69 years, respectively) than their White peers (aged 76 years). This age finding supports previously reported lower age of minority HF patients compared with Whites.[9-23,28] Further, we noted a decline of 7.7% in California HF rates (284.7 in 2007; 262.8 in 2010). This decline is consistent with previous reports of decline in HF hospitalization.[6,10] Interestingly, while hospitalization for HF declined in California, the decline for Blacks was smaller (5.43%) compared with Whites (7.88%) and Hispanics (7.04%). The burden of HF for Blacks in California has remained high since Alexander and colleagues[15] reported their findings in 1999. Now it appears worse for Blacks (aged ≤54 years) whose HF rates in California were more than six times (6:1) higher compared with same age Whites. In sum, for Blacks, the burden of HF starts at an early age, and it remains higher (45% to 50% higher) in older Blacks than Whites. These findings are consistent with those previously reported,[28-30] calling for proven preventive programs to focus on minority groups who are at greater risk for HF starting at younger ages.[6]

We examined several clinical factors and found five factors, namely coronary heart disease (CHD), chronic kidney disease (CKD), atrial fibrillation (AFib), chronic obstructive pulmonary disease (COPD), and hypertension (HTN), as significant predictors of HF (Table 3). Hypertension, which is a precursor of HF (see the 20-year follow-up of Framingham study),[31] existed in more than 80% of patients across all three groups and it started at an early age (35-40 years). Given the higher prevalence of hypertension (>85% in our samples), it is not surprising to find higher prevalence of kidney disease in stages-III-V. The association of hypertension with CKD was especially noticeable among Blacks where kidney damage started at an early age (aged 35-44 years) and became progressively worse with increasing age (Table 4). Similarly, diabetes, which existed in almost half of our patients (highest among Hispanics), had a strong contributory role, not only in HF but also in kidney dysfunction and other cardiovascular events such as heart attacks and stroke.[32,33]

With regard to hospitalization costs of HF patients, two comments need to be acknowledged. First, reported hospital costs for HF vary considerably depending on whether studies used regional, state, Medicare, or private insurance data. Secondly, while some studies reported Medicare costs (for elderly patients only), others focused on reimbursed cost, and still others have reported hospital charges for patients aged 18-64.[34] The average Medicare hospitalization cost for HF in 2008 was estimated at $10,000.[35] This cost is much lower than the cost reported for HF patients aged 18-64 years ($23,077),[34] the cost of $18,086 in 2008 reported by Titler,[36] or the hospital charges of Tennessee HF patients discharged in 2008 ($36,912).[23]

Finally, California hospital costs in 2007 and 2010 are charges (submitted for payment) for all patients (aged ≥20 years) discharged with a primary diagnosis of HF. These are not reimbursed costs but merely the charges submitted by a composite of California hospitals that included small rural hospitals and large urban hospitals, as well as those that were for profit vs those for non-profit. The higher cost in California reflects this variation in size and type of services provided by the health care facility. The costs simply reflect higher administrative and other costs that are generally higher in California compared with other states. However, given the high cost of living on the West coast, one would expect that the hos-

The clinical significance of our findings is two-fold: 1) that Blacks and Hispanics are more likely than Whites to manifest cardiovascular diseases … at an early age (aged 30-40 years);[43] and 2) from a health equity perspective, proven clinical/preventive programs should be implemented on younger minority groups to test their ability to reduce morbidity, mortality, and health care cost associated with HF.[6, 27]

pital charges would be similar across gender and racial/ethnic groups in the California samples. Nonetheless, this was not the case. The higher costs among males and Blacks, compared with other groups, may have occurred due in part to the greater number of complex co-morbidities, which required more readmissions and longer hospitalization for Blacks. The higher costs for Blacks compared with Whites in California are similar to those reported for Black HF patients in Tennessee.[23] In addition to complexity of medical conditions, the higher costs among minority patients may also occur due to several other factors such as: 1) low health literacy/lower recognition of disease symptoms; 2) poor access to health care providers; 3) distrust of providers; 4) patients' perceived neglect by the providers resulting in longer waiting time; and 5) lower referral to specialists for treatment.[37-42] Such factors, affecting minority patients in all age categories, require further research as they may affect hospitalization costs.

The clinical significance of our findings is two-fold: 1) that Blacks and Hispanics are more likely than Whites to manifest cardiovascular diseases (eg, hypertension, diabetes, CHD) at an early age (aged 30-40 years);[43] and 2) from a health equity perspective, proven clinical/preventive programs should be implemented on younger minority groups to test their ability to reduce morbidity, mortality, and health care cost associated with HF.[6, 27]

Limitations

Our findings are limited, in part, since hospital discharge files (HDDS) do not include patients from Veterans Affairs hospitals (VA) or patients from mental institutions. Further, the HDDS data are administrative files, which do not provide reimbursed costs. Moreover, these files do not provide data pertaining to patients' marital status, education or annual income. No clinical data are provided regarding medications used, tests performed, test results, severity or duration of illness or symptom indices used in arriving at clinical judgments/diagnoses. For the sake of maintaining confidentiality of records, patients' assigned identification numbers change every year and hence it is not possible to follow a patient in the hospital discharge data beyond a given year. Since these potential confounding factors might affect the magnitude of observed racial/ethnic differences, there is a need for caution in interpreting the results. Even though there are some limitations as pointed above, the data remain robust and support the hypothesis that minorities and gender should be an area of focused research. Despite these limitations, however, we believe the present data provide useful insights about the impact of gender and race/ethnicity and age on hospitalization and costs of HF in California that may have application nationally.

Conclusion

We found HF rates have declined in California but they remain higher among males and Blacks compared with Whites and Hispanics. These higher rates for males, and particularly Black males, represent a higher prevalence of comorbidities, which become manifest at younger ages and which may contribute progressively to more readmissions and longer hospitalizations. These findings call for renewed emphasis on aggressive prevention, treatment and control of HF and related risk factors in these at-risk young and middle-aged groups of vulnerable populations. Future research is needed to determine whether hospitalizations for HF can be reduced among minority individuals through increased access to providers, or by implementing proven preventive programs relative to comorbidities (such as hypertension, diabetes) among at-risk young and middle-aged groups of vulnerable populations to reduce subsequent hospitalization for HF.

Conflict of Interest

No conflicts of interest to report.

Author Contributions

Research concept and design: Husaini, Moonis; Acquisition of data: Husaini, Cain; Data analysis and interpretation: Husaini, Levine, Norris, Cain, Bazargan, Moonis; Manuscript draft: Husaini, Levine, Norris, Moonis; Statistical expertise: Husaini, Levine, Cain, Bazargan; Acquisition of funding: Husaini; Administrative: Levine, Norris, Cain; Supervision: Husaini

References

1. Lloyd-Jones D, Adams RJ, Brown TM, et al; WRITING GROUP MEMBERS; American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Heart disease and stroke statistics--2010 update: a report from the American Heart Association. *Circulation*. 2010;121(7):e46-e215. http://dx.doi.org/10.1161/CIRCULATIONAHA.109.192667. PMID:20019324.
2. Go AS, Mozaffarian D, Roger VL, et al; American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Heart disease and stroke statistics--2013 update: a report from the American Heart Association. *Circulation*. 2013;127(1):e6-e245. http://dx.doi.org/10.1161/CIR.0b013e31828124ad. PMID:23239837.
3. Lloyd-Jones DM, Larson MG, Leip EP, et al; Framingham Heart Study. Lifetime

risk for developing congestive heart failure: the Framingham Heart Study. *Circulation*. 2002;106(24):3068-3072. http://dx.doi.org/10.1161/01.CIR.0000039105.49749.6F. PMID:12473553.

4. Heidenreich PA, Trogdon JG, Khavjou OA, et al; American Heart Association Advocacy Coordinating Committee; Stroke Council; Council on Cardiovascular Radiology and Intervention; Council on Clinical Cardiology; Council on Epidemiology and Prevention; Council on Arteriosclerosis; Thrombosis and Vascular Biology; Council on Cardiopulmonary; Critical Care; Perioperative and Resuscitation; Council on Cardiovascular Nursing; Council on the Kidney in Cardiovascular Disease; Council on Cardiovascular Surgery and Anesthesia, and Interdisciplinary Council on Quality of Care and Outcomes Research. Forecasting the future of cardiovascular disease in the United States: a policy statement from the American Heart Association. *Circulation*. 2011;123(8):933-944. http://dx.doi.org/10.1161/CIR.0b013e31820a55f5. PMID:21262990.
5. Blecker S, Paul M, Taksler G, Ogedegbe G, Katz S. Heart failure–associated hospitalizations in the United States. *J Am Coll Cardiol*. 2013;61(12):1259-1267. http://dx.doi.org/10.1016/j.jacc.2012.12.038. PMID:23500328.
6. Will JC, Valderrama AL, Yoon PW. Preventable hospitalizations for congestive heart failure: establishing a baseline to monitor trends and disparities. *Prev Chronic Dis*. 2012;9:E85. http://dx.doi.org/10.5888/pcd9.110260. PMID:22498036.
7. Hall MJ, Levant S, DeFrances CJ. Hospitalization for congestive heart failure: United States, 2000-2010. NCHS Data Brief No 108. Hyattsville, MD: National Center for Health Statistics. October, 2012:1-7.
8. Chen J, Normand SL, Wang Y, Krumholz HM. National and regional trends in heart failure hospitalization and mortality rates for Medicare beneficiaries, 1998-2008. *JAMA*. 2011;306(15):1669-1678. http://dx.doi.org/10.1001/jama.2011.1474. PMID:22009099.
9. Chen J, Normand SL, Wang Y, Drye EE, Schreiner GC, Krumholz HM. Recent declines in hospitalizations for acute myocardial infarction for Medicare fee-for-service beneficiaries: progress and continuing challenges. *Circulation*. 2010;121(11):1322-1328. http://dx.doi.org/10.1161/CIRCULATIONAHA.109.862094. PMID:20212281.
10. Chen J, Dharmarajan K, Wang Y, Krumholz HM. National trends in heart failure hospital stay rates, 2001 to 2009. *J Am Coll Cardiol*. 2013;61(10):1078-1088. http://dx.doi.org/10.1016/j.jacc.2012.11.057. PMID:23473413.
11. Vivo RP, Krim SR, Cevik C, Witteles RM. Heart failure in Hispanics. *J Am Coll Cardiol*. 2009;53(14):1167-1175. http://dx.doi.org/10.1016/j.jacc.2008.12.037. PMID:19341856.
12. Vivo RP, Krim SR, Krim NR, et al. Care and outcomes of Hispanic patients admitted with heart failure with preserved or reduced ejection fraction: findings from get with the guidelines-heart failure. *Circ Heart Fail*. 2012;5(2):167-175. http://dx.doi.org/10.1161/CIRCHEARTFAILURE.111.963546. PMID:22414939.
13. Demirovic J, Prineas R, Rudolph M. Epidemiology of congestive heart failure in three ethnic groups. *Congest Heart Fail*. 2001;7(2):93-96. http://dx.doi.org/10.1111/j.1527-5299.2001.00230.x. PMID:11828144.
14. Bui AL, Horwich TB, Fonarow GC. Epidemiology and risk profile of heart failure. *Nat Rev Cardiol*. 2011;8(1):30-41. http://dx.doi.org/10.1038/nrcardio.2010.165. PMID:21060326.
15. Alexander M, Grumbach K, Remy L, Rowell R, Massie BM. Congestive heart failure hospitalizations and survival in California: patterns according to race/ethnicity. *Am Heart J*. 1999;137(5):919-927. http://dx.doi.org/10.1016/S0002-8703(99)70417-5. PMID:10220642.
16. Okin PM, Kjeldsen SE, Dahlöf B, Devereux RB. Racial differences in incident heart failure during antihypertensive therapy. *Circ Cardiovasc Qual Outcomes*. 2011;4(2):157-164. http://dx.doi.org/10.1161/CIRCOUTCOMES.110.960112. PMID:21304095.
17. Loehr LR, Rosamond WD, Chang PP, Folsom AR, Chambless LE. Heart failure incidence and survival (from the Atherosclerosis Risk in Communities study). *Am J Cardiol*. 2008;101(7):1016-1022. http://dx.doi.org/10.1016/j.amjcard.2007.11.061. PMID:18359324.
18. Bahrami H, Kronmal R, Bluemke DA, et al. Differences in the incidence of congestive heart failure by ethnicity: the multiethnic study of atherosclerosis. *Arch Intern Med*. 2008;168(19):2138-2145. http://dx.doi.org/10.1001/archinte.168.19.2138. PMID:18955644.
19. Bibbins-Domingo K, Pletcher MJ, Lin F, et al. Racial differences in incident heart failure among young adults. *N Engl J Med*. 2009;360(12):1179-1190. http://dx.doi.org/10.1056/NEJMoa0807265. PMID:19297571.
20. Brown DW, Haldeman GA, Croft JB, Giles WH, Mensah GA. Racial or ethnic differences in hospitalization for heart failure among elderly adults: Medicare, 1990 to 2000. *Am Heart J*. 2005;150(3):448-454. http://dx.doi.org/10.1016/j.ahj.2004.11.010. PMID:16169322.
21. Sampson UKA, Husaini BA, Cain VA, Samad Z, Jahangir EC, Levine RS. Short-term trends in heart failure-related hospitalizations in a high-risk state. *South Med J*. 2013;106(2):147-154. http://dx.doi.org/10.1097/SMJ.0b013e3182804fa4. PMID:23380751.
22. Husaini BA, Mensah GA, Sawyer D, et al. Race, sex, and age differences in heart failure-related hospitalizations in a southern state: implications for prevention. *Circ Heart Fail*. 2011;4(2):161-169. http://dx.doi.org/10.1161/CIRCHEARTFAILURE.110.958306. PMID:21178017.
23. Husaini BA, Levine RS, Novotny ML, Cain VA, Sampson UK, Moonis M. Depression and race affect hospitalization costs of heart failure patients. *Fam Med & Comm Health.* 2015;3(2):39-47. http://dx.doi.org/10.15212/FMCH.2015.0118.
24. Dall TM, Blanchard TD, Gallo PD, Semilla AP. The economic impact of Medicare Part D on congestive heart failure. *Am J Manag Care*. 2013;19(6)(suppl):s97-s100. PMID:23725537.
25. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis*. 1987;40(5):373-383. http://dx.doi.org/10.1016/0021-9681(87)90171-8. PMID:3558716.
26. Klein RJ, Schoenborn CA. Age adjustment using the 2000 projected U.S. population. Healthy People 2010 Stat Notes. 2001;(20):1-10.
27. Korves C, Eldar-Lissai A, McHale J, Lafeuille MH, Hwa Ong S, Sheng Duh M. Resource utilization and costs following hospitalization of patients with chronic heart failure in the US. *J Med Econ*. 2012;15(5):925-937. http://dx.doi.org/10.3111/13696998.2012.685136. PMID:22502902.
28. Sangaralingham LR, Shah ND, Yao X, Roger VL, Dunlay SM. Incidence and early outcomes of heart failure in commercially insured and Medicare Advantage patients, 2006 to 2014. *Circ Cardiovasc Qual Outcomes*. 2016;9(3):332-337. http://dx.doi.org/10.1161/CIRCOUTCOMES.116.002653. PMID:27166206.
29. Gerber Y, Weston SA, Redfield MM, Chamberlain AM, Manemann SM, Jiang R, Killian JM, Roger VL. A contemporary appraisal of the heart failure epidemic in Olmsted County, Minnesota, 2000 to 2010. *JAMA Intern Med*. 2015;175:996-1004. doi;http://dx.doi.org/10.1001/jamainternmed.2015.0924..
30. Joynt KE, Orav EJ, Jha AK. Thirty-day readmission rates for Medicare beneficiaries by race and site of care. *JAMA*. 2011;305(7):675-681. http://dx.doi.org/10.1001/jama.2011.123. PMID:21325183.
31. Levy D, Larson MG, Vasan RS, Kannel WB, Ho KKL. The progression from hyperten-

sion to congestive heart failure. *JAMA*. 1996;275(20):1557-1562. http://dx.doi.org/10.1001/jama.1996.03530440037034. PMID:8622246.
32. Kannel WB, Hjortland M, Castelli WP. Role of diabetes in congestive heart failure: the Framingham study. *Am J Cardiol*. 1974;34(1):29-34. http://dx.doi.org/10.1016/0002-9149(74)90089-7. PMID:4835750.
33. Cavender MA, Steg PG, Smith SC Jr, et al; REACH Registry Investigators. Impact of diabetes mellitus on hospitalization for heart failure, cardiovascular events, and death: outcomes at 4 years from the Reduction of Atherothrombosis for Continued Health (REACH) Registry. *Circulation*. 2015;132(10):923-931. http://dx.doi.org/10.1161/CIRCULATIONAHA.114.014796. PMID:26152709.
34. Wang G, Zhang Z, Ayala C, Wall HK, Fang J. Costs of heart failure-related hospitalizations in patients aged 18 to 64 years. *Am J Manag Care*. 2010;16(10):769-776. PMID:20964473.
35. Linden A, Adler-Milstein J. Medicare disease management in policy context. *Health Care Financ Rev*. 2008;29(3):1-11. PMID:18567239.
36. Titler MG, Jensen GA, Dochterman JM, et al. Cost of hospital care for older adults with heart failure: medical, pharmaceutical, and nursing costs. *Health Serv Res*. 2008;43(2):635-655. http://dx.doi.org/10.1111/j.1475-6773.2007.00789.x. PMID:18370971.
37. Resneck J Jr, Pletcher MJ, Lozano N. Medicare, Medicaid, and access to dermatologists: the effect of patient insurance on appointment access and wait times. *J Am Acad Dermatol*. 2004;50(1):85-92. http://dx.doi.org/10.1016/S0190-9622(03)02463-0. PMID:14699371.
38. Devoe JE, Baez A, Angier H, Krois L, Edlund C, Carney PA. Insurance + access not equal to health care: typology of barriers to health care access for low-income families. *Ann Fam Med*. 2007;5(6):511-518. http://dx.doi.org/10.1370/afm.748. PMID:18025488.
39. Karve SJ, Balkrishnan R, Mohammad YM, Levine DA. Racial/ethnic disparities in emergency department waiting time for stroke patients in the United States. *J Stroke Cerebrovasc Dis*. 2011;20(1):30-40. http://dx.doi.org/10.1016/j.jstrokecerebrovasdis.2009.10.006. PMID:20538484.
40. Cass A, Cunningham J, Snelling P, Ayanian JZ. Late referral to a nephrologist reduces access to renal transplantation. *Am J Kidney Dis*. 2003;42(5):1043-1049. http://dx.doi.org/10.1016/j.ajkd.2003.07.006. PMID:14582048.
41. Hsia AW, Castle A, Wing JJ, et al. Understanding reasons for delay in seeking acute stroke care in an underserved urban population. *Stroke*. 2011;42(6):1697-1701. http://dx.doi.org/10.1161/STROKEAHA.110.604736. PMID:21546471.
42. Greenlund KJ, Neff LJ, Zheng ZJ, et al. Low public recognition of major stroke symptoms. *Am J Prev Med*. 2003;25(4):315-319. http://dx.doi.org/10.1016/S0749-3797(03)00206-X. PMID:14580633.
43. Juarez DT, Davis JW, Brady SK, Chung RS. Prevalence of heart disease and its risk factors related to age in Asians, Pacific Islanders, and Whites in Hawai'i. *J Health Care Poor Underserved*. 2012;23(3):1000-1010. http://dx.doi.org/10.1353/hpu.2012.0103. PMID:24212153.