Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.

RESUSCITATION 179 (2022) 29–35

Available online at ScienceDirect

Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation

Clinical paper

Racial/ethnic and gender disparities of the impact of the COVID-19 pandemic in out-of-hospital cardiac arrest (OHCA) in Texas

Summer Chavez[a,b,*], *Ryan Huebinger*[a,b], *Hei Kit Chan*[a,b], *Kevin Schulz*[a,b], *Micah Panczyk*[a,b], *Normandy Villa*[a,b], *Renee Johnson*[a,b], *Robert Greenberg*[c], *Veer Vithalani*[d], *Rabab Al-Araji*[e], *Bentley Bobrow*[a,b]

Abstract

Introduction: Prior research shows a greater disease burden, lower BCPR rates, and worse outcomes in Black and Hispanic patients after OHCA. Female OHCA patients have lower rates of BCPR compared to men and other survival outcomes vary. The influence of the COVID-19 pandemic on OHCA incidence and outcomes in different health disparity populations is unknown.

Methods: We used data from the Texas Cardiac Arrest Registry to Enhance Survival (CARES). We determined the association of both prehospital characteristics and survival outcomes with the pandemic period in each study group through Pearson's χ^2 test or Fisher's exact tests. We created mixed multivariable logistic regression models to compare odds of cardiac arrest care and outcomes between 2019 and 2020 for the study groups.

Results: Black OHCA patients (aOR = 0.73; 95% CI: 0.65 – 0.82) had significantly lower odds of BCPR compared to White OHCA patients, were less likely to achieve ROSC (aOR = 0.86; 95% CI: 0.74 – 0.99) or have a good CPC score (aOR = 0.47; 95% CI: 0.29 – 0.75). Compared to White patients with OHCA, Hispanic persons were less likely to have a field TOR (aOR = 0.86; 95% CI: 0.75 – 0.99) or receive BCPR (aOR = 0.78; 95% CI: 0.69 – 0.87). Female OHCA patients had higher odds of surviving to hospital admission compared to males (aOR = 1.29; 95% CI: 1.15 – 1.44).

Conclusion: Many OHCA outcomes worsened for Black and Hispanic patients. While some aspects of care worsened for women, their odds of survival improved compared to males.

Keywords: Cardiac arrest, Out-of-hospital cardiac arrest, Prehospital care, COVID-19, Disparities, Healthcare disparities, Minority health, Vulnerable populations

Introduction

In the United States (US), nearly 1,000 people daily suffer from non-traumatic out-of-hospital cardiac arrest (OHCA), with 90% of cases fatal, making this a significant public health issue.[1] Although the overall US death rate has decreased over the last few decades, this has been offset by recent increases in racial and ethnic disparities.[2] Even before the coronavirus disease 2019 (COVID-19) pandemic, there was 21% a higher cardiac disease death rate in Black persons than in White persons.[2] During the early phases of the pandemic in the US, health disparity populations experienced a disproportionate increase in deaths from heart disease and strokes.[3] In addition to disparities in the prevalence of cardiac arrest, focus must also be placed on the inequities that exist in cardiac arrest care and outcomes.

Timely bystander cardiopulmonary resuscitation (BCPR) and automated external defibrillator use (AED) are two interventions demonstrating the greatest impact on OHCA outcomes.[4–7] Overall, approximately half of OHCA patients receive BCPR while estimates of public AED use vary from 9-12%.[8–11] Compared to White patients, Black and Hispanic patients are less likely to have a witnessed arrest, be in a shockable rhythm, or receive bystander CPR.[12] Females are less likely to receive BCPR with other outcomes

* Corresponding author at: Department of Emergency Medicine, McGovern Medical School of UTHealth at Houston, 6431 Fannin Street, JJL 475, Houston, TX 77030, United States.

E-mail address: schavez3@uth.tmc.edu (S. Chavez).

https://doi.org/10.1016/j.resuscitation.2022.07.040

Received 21 April 2022; Received in Revised form 12 July 2022; Accepted 28 July 2022

0300-9572/Published by Elsevier B.V.

varying.[13–15] Prior research analyzing differences in OHCA care and outcomes in Texas shows persistently lower rates of AED use, BCPR and survival to discharge in Black- and Hispanic- majority neighborhoods.[16] Interventions targeting the prehospital cardiac arrest chain of survival can play important roles in reducing disparities.

The COVID-19 pandemic has again highlighted disparities in at-risk populations.[17] Black and Hispanic patients have been disproportionately burdened in terms of hospitalizations, morbidity and mortality compared to non-Hispanic Whites.[18,19] While the death rates from COVID-19 were highest in Hispanic populations, the greatest mortality increases were seen in the Black population and largely attributed to heart disease and diabetes rather than COVID-19.[19] Compared to female patients with COVID-19, men have higher case fatality rates and recently lowered life expectancies to levels not seen in two decades.[17,20] As we transition into a new phase of the COVID-19 pandemic, it is imperative to examine how OHCA has been affected and to what extent, as this is a current gap in the literature. This study examined the impact of COVID-19 on racial/ethnic and gender disparities in Texas OHCA before the pandemic and the first year of the COVID-19 pandemic.

Methods

Data source

We examined adult OHCAs in Texas using data from the Cardiac Arrest Registry to Enhance Survival (CARES) from March 11 – December 31 in 2019 and 2020. The CARES database utilizes OHCA data to improve cardiac arrest outcomes. Roughly 167 million people, or half of the US population is captured by the national CARES database.[21,22] Hospitals and EMS agencies voluntarily report data to CARES, which uses standardized quality measures to benchmark cardiac arrest care and support quality improvement initiatives.[21,22] The study was approved by the University of Texas Health Science Center at Houston Institutional Review Board (HSC-MS-19-0601).

Selection of subjects

The subjects were divided into two study periods: pre-COVID-19 (March 11, 2019 to December 31, 2019) and COVID-19 period (March 11, 2020 to December 31, 2020). On March 11, 2020, the World Health Organization declared COVID-19 a pandemic and thus designated as the start date for data inclusion in this study.[23] These two time frames were identified to best represent the widespread emergence of COVID-19 with a matched period from the prior year. We excluded observations where the arrest was witnessed by 911 responders, <18 years of age, occurring at a healthcare facility and EMS agencies with an incomplete participation period. (Fig. 1).

Study variables and outcomes

We defined patient cardiac arrest characteristics as age, gender (male/female), race/ethnicity (Non-Hispanic White, Non-Hispanic Black, Hispanic, Other), witnessed arrest, location type (home/residence, public), and initial rhythm type (shockable, non-shockable). The disparity groups of interest were race/ethnicity and gender. Prehospital outcomes were BCPR, PAD, sustained ROSC, and prehospital termination of resuscitation (TOR). The hospital survival outcomes were survival to hospital admission, survival to hospital discharge, good neurologic outcomes (CPC score 1 or 2), and Utstein bystander survival rate (OHCA patients surviving to hospital discharge with a witnessed arrest by bystander, initial rhythm that was shockable and received BCPR and/or AED interventions).[24]

Statistical analysis

We examined patient characteristics, prehospital outcomes and hospital survival outcomes through descriptive statistics stratified by year. For age, we determined the medians and interquartile ranges between the two years. We evaluated the age difference between the two groups using two-sample Wilcoxon rank sum (Mann-Whitney) test. For examining association of other categorical variables with the two groups, we used Pearson's χ^2 test and Fisher's exact tests (for variables with expected frequencies < 5). Subsetting the data by race/ethnic group and gender, we determined the association of both prehospital characteristics and survival outcomes with the pandemic period in each disparity group through Pearson's χ^2 test or Fisher's exact tests.

We created mixed multivariable logistic regression models to compare odds of cardiac arrest care and outcomes between 2019 and 2020. We analyzed the dependent variable of interest (bystander CPR, bystander AED, sustained ROSC, TOR, survival to admission, survival to discharge, good CPC score, Utstein bystander survival) for the pre-pandemic and pandemic periods with race, ethnicity and gender as covariates adjusting for other arrest characteristics (i.e. location type, shockable rhythm, witnessed arrest), modeling EMS agency as the random intercept. We constructed mixed multivariable logistic regression models to study the association of disparity groups (gender and race/ethnicity) with our outcomes of interest (bystander CPR, bystander AED, sustained ROSC, TOR, survival to admission, survival to discharge, good CPC score, Utstein bystander survival), adjusting for the pandemic and other arrest characteristics (i.e. location type, shockable rhythm, witnessed arrest) and modeling EMS agency as the random intercept. We obtained adjusted odds ratios of the pandemic year and the disparity groups on both prehospital arrest care and hospital survival outcomes of interest with 95% confidence intervals. All analyses were conducted with STATA 16.1.

Results

The total sample included 8,037 instances of OHCA. (Fig. 1) In 2019, there were 3,619 (45.0%) cases which increased in 2020 (4,418; 55.0%). The distribution of gender and race/ethnicity remained consistent both years. (Table 1) When comparing prehospital characteristics and survival outcomes between 2019 and 2020 in White OHCA patients, we found an association with pandemic year, worsening from 2019 to 2020: BCPR (48.7% in 2019 vs 44.8% in 2020; P = 0.02), bystander AED (15.9% in 2019 vs 8.1% in 2020; P < 0.01), sustained ROSC (28.8% in 2019 vs 22.4% in 2020; P < 0.01), field TOR (39.0% in 2019 vs 50.2%; P < 0.01) and survival to hospital admission (27.2% in 2019 vs 21.7% in 2020; P < 0.01). Similarly, there were worse outcomes for Black OHCA patients including sustained ROSC (27.0% in 2019 vs 19.0% in 2020; P < 0.01), field TOR (32.6% in 2019 vs 38.4% in 2020; P < 0.01), survival to hospital admission (27.6% in 2019 vs 20.6% in 2020; P < 0.01), and survival to hospital discharge (10.2% in 2019 vs 7.2% in 2020; P = 0.02) were associated with the pandemic year. For Hispanic patients, we found BCPR (42.6% in 2019 vs 37.8% in 2020; P = 0.03), sustained ROSC (30.5% in 2019 vs 22.0% in

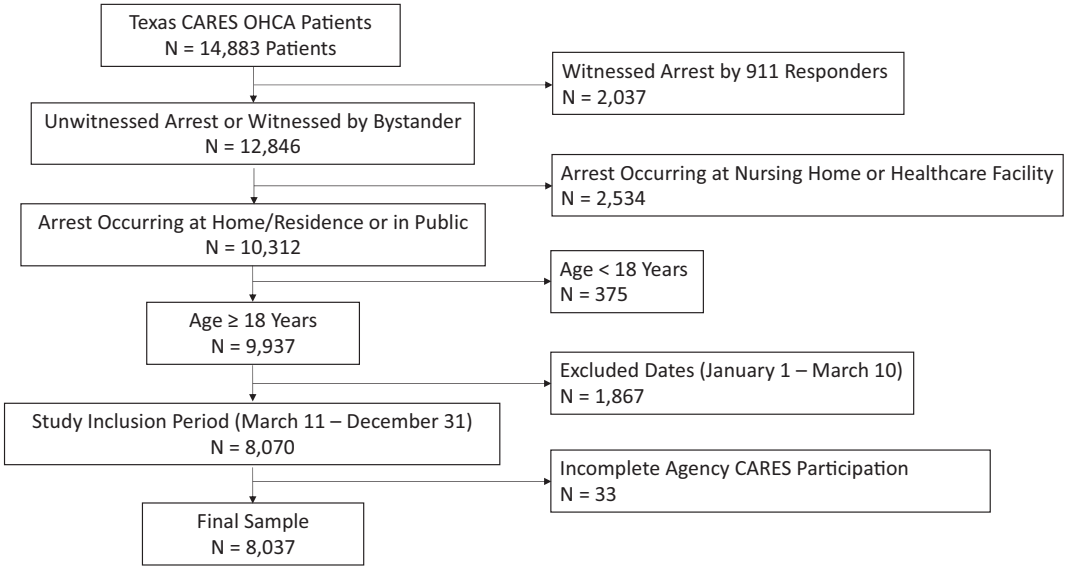

Fig. 1 – Study Flowchart for Patient Inclusion and Exclusion.

Table 1 – Patient Cardiac Arrest Characteristics, Stratified by Year.

	2019 N = 3,619 (45.0%)	2020 N = 4,418 (55.0%)	P-Value
Age (Years)[1], median (IQR[2])	63 (51 – 74)	63 (51 – 74)	0.70
Gender[3], n (%)			
Male	2,307 (63.8%)	2,781 (62.9%)	0.50
Female	1,312 (36.3%)	1,637 (37.1%)	
Race & Ethnicity[3], n (%)			
White	1,591 (44.0%)	1,857 (42.0%)	0.20
Black/African-American	901 (24.9%)	1,128 (25.5%)	
Hispanic/Latino	935 (25.8%)	1,217 (27.6%)	
Other	192 (5.3%)	216 (4.9%)	

[1] P-value determined using two-sample Wilcoxon rank-sum (Mann-Whitney) test.
[2] IQR stands for inter-quartile range.
[3] P-value determined using Pearson's χ^2 test.

2020; P < 0.01), TOR (39.8% in 2019 vs 50.0% in 2020; P < 0.01), survival to admission (26.2% in 2019 vs 21.1% in 2020; P < 0.01), and survival to discharge (8.3% in 2019 vs 5.9% in 2020; P = 0.03) were associated with pandemic year and worsened. For patients of Other race/ethnicity, we also found BCPR (55.7% in 2019 vs 43.1% in 2020; P = 0.01), sustained ROSC (30.7% in 2019 vs 17.6% in 2020; P < 0.01), survival to hospital admission (29.3% in 2019 vs 15.3% in 2020; P < 0.01), and survival to hospital discharge (11.0% in 2019 vs 5.1% in 2020; P = 0.03) were significantly associated with the pandemic year and worsened.

We examined the same set of outcomes by gender, finding significant associations with the pandemic year in male OHCA patients for nearly all outcomes: BCPR (46.7% in 2019 vs 42.1% in 2020; P < 0.01), bystander AED (15.0% in 2019 vs 7.1% in 2020; P < 0.01), sustained ROSC (27.3% in 2019 vs 20.4% in 2020; P < 0.01), TOR (36.5% in 2019 vs 45.7% in 2020; P < 0.01), survival to hospital admission (27.1% in 2019 vs 20.5% in 2020; P < 0.01), survival to hospital discharge (10.9% in 2019 vs 7.6% in 2020; P < 0.01), and Utstein bystander survival (39.1% in 2019 vs 27.8% in 2020; P = 0.01). Female OHCA patients had much fewer worsened outcomes with significant associations to the pandemic years: sustained ROSC (31.7% in 2019 vs 22.5% in 2020; P < 0.01), and survival to hospital admission (27.2% in 2019 vs 21.8% in 2020; P < 0.01). All health disparity population groups had lower rates of sustained ROSC in 2020. Black, Hispanic and Other persons all had increased rates of TOR, decreased survival to hospital admission and discharge. The proportion of OHCA patients with good neurologic outcomes remained consistent from 2019 to 2020 for all study groups. While the Utstein bystander survival rate had a notable decrease only in males, it remained consistent for all other study groups (Table 2).

In our first series of regression models, we compared the odds of prehospital cardiac arrest care and outcomes between the pre-pandemic and pandemic periods. The overall odds of receiving BCPR was less during the COVID-19 period than before (aOR = 0.87; 95% CI: 0.79 – 0.95). In general, OHCA patients were half as likely to receive bystander AED (aOR = 0.53; 95% CI: 0.36 – 0.79) during the COVID-19 period than the pre-COVID-19 period. Odds of TOR was higher during the COVID-19 period than prior (aOR = 1.51; 95% CI: 1.36 –1.68). There was lower odds of sus-

Table 2 – Patient Prehospital Characteristics and Survival Outcomes, Stratified by Disparity Group and Year.

	2019	2020	P-value
Race and Ethnicity			
White	*N = 1,591*	*N = 1,857*	
Bystander CPR[1], n (%)	775 (48.7%)	832 (44.8%)	0.02
Bystander AED[1], n/N (%)	50/315 (15.9%)	21/260 (8.1%)	< 0.01
Sustained ROSC[1], n (%)	458 (28.8%)	416 (22.4%)	< 0.01
Field Termination[1], n (%)	621 (39.0%)	932 (50.2%)	< 0.01
Survival to Hospital Admission[1], n (%)	433 (27.2%)	402 (21.7%)	< 0.01
Survival to Hospital Discharge[1], n (%)	170 (10.7%)	163 (8.8%)	0.06
Good Neurologic Outcome[1], n/N (%)	127/170 (74.7%)	120/163 (73.6%)	0.80
Utstein Bystander Survival[1], n/N (%)	55/160 (34.4%)	46/148 (31.1%)	0.50
Black	*N = 901*	*N = 1,128*	
Bystander CPR[1], n (%)	390 (43.3%)	478 (42.4%)	0.70
Bystander AED[1], n/N (%)	23/186 (12.4%)	10/148 (6.8%)	0.10
Sustained ROSC[1], n (%)	243 (27.0%)	214 (19.0%)	0.01
Field Termination[1], n (%)	294 (32.6%)	433 (38.4%)	< 0.01
Survival to Hospital Admission[1], n (%)	248 (27.6%)	232 (20.6%)	< 0.01
Survival to Hospital Discharge[1], n (%)	92 (10.2%)	81 (7.2%)	0.02
Good Neurologic Outcome[1], n/N (%)	51/89 (57.3%)	42/81 (51.9%)	0.50
Utstein Bystander Survival[1], n/N (%)	32/65 (49.2%)	19/57 (33.3%)	0.08
Hispanic	*N = 935*	*N = 1,217*	
Bystander CPR[1], n (%)	398 (42.6%)	460 (37.8%)	0.03
Bystander AED[1], n/N (%)	10/147 (6.8%)	10/151 (6.6%)	0.95
Sustained ROSC[1], n (%)	285 (30.5%)	268 (22.0%)	< 0.01
Field Termination[1], n (%)	372 (39.8%)	609 (50.0%)	< 0.01
Survival to Hospital Admission[1], n (%)	244 (26.2%)	256 (21.1%)	< 0.01
Survival to Hospital Discharge[1], n (%)	77 (8.3%)	71 (5.9%)	0.03
Good Neurologic Outcome[1], n/N (%)	57/77 (74.0%)	48/71 (67.6%)	0.40
Utstein Bystander Survival[1], n/N (%)	27/71 (38.0%)	18/62 (29.0%)	0.30
Other	*N = 192*	*N = 216*	
Bystander CPR[1], n (%)	107 (55.7%)	93 (43.1%)	0.01
Bystander AED[2], n/N (%)	7/45 (15.6%)	2/28 (7.1%)	0.50
Sustained ROSC[1], n (%)	59 (30.7%)	38 (17.6%)	< 0.01
Field Termination[1], n (%)	62 (32.3%)	89 (41.2%)	0.06
Survival to Hospital Admission[1], n (%)	56 (29.3%)	33 (15.3%)	< 0.01
Survival to Hospital Discharge[1], n (%)	21 (11.0%)	11 (5.1%)	0.03
Good Neurologic Outcome[2], n/N (%)	15/21 (71.4%)	10/11 (90.9%)	0.40
Utstein Bystander Survival[2], n/N (%)	10/26 (38.5%)	4/12 (33.3%)	1.00
Gender			
Male	*N = 2,307*	*N = 2,781*	
Bystander CPR[1], n (%)	1,078 (46.7%)	1,170 (42.1%)	< 0.01
Bystander AED[1], n/N (%)	80/534 (15.0%)	32/454 (7.1%)	< 0.01
Sustained ROSC[1], n (%)	629 (27.3%)	568 (20.4%)	< 0.01
Field Termination[1], n (%)	841 (36.5%)	1,272 (45.7%)	< 0.01
Survival to Hospital Admission[1], n (%)	624 (27.1%)	567 (20.5%)	< 0.01
Survival to Hospital Discharge[1], n (%)	251 (10.9%)	211 (7.6%)	< 0.01
Good Neurologic Outcome[1], n/N (%)	181/249 (72.7%)	152/211 (72.0%)	0.90
Utstein Bystander Survival[1], n/N (%)	97/48 (39.1%)	59/212 (27.8%)	0.01
Female	*N = 1,312*	*N = 1,637*	
Bystander CPR[1], n (%)	592 (45.1%)	693 (42.3%)	0.10
Bystander AED[1], n/N (%)	10/159 (6.3%)	11/133 (8.3%)	0.50
Sustained ROSC[1], n (%)	416 (31.7%)	368 (22.5%)	< 0.01
Field Termination[1] n (%)	508 (38.7%)	791 (48.3%)	0.50
Survival to Hospital Admission[1], n (%)	357 (27.2%)	356 (21.8%)	< 0.01
Survival to Hospital Discharge[1], n (%)	109 (8.3%)	115 (7.0%)	0.20
Good Neurologic Outcome[1], n/N (%)	69/108 (63.9%)	68/115 (59.1%)	0.50
Utstein Bystander Survival[1], n/N (%)	27/74 (36.5%)	28/67 (41.8%)	0.50

[1] P-value determined using Pearson's χ^2 test.

[2] P-value determined using Fisher's exact test.

tained ROSC during COVID-19 than before (aOR = 0.67; 95% CI: 0.60 – 0.75). Survival to hospital admission (aOR = 0.73; 95% CI: 0.65 – 0.82) and odds of survival to hospital discharge worsened during the COVID-19 period (aOR = 0.81; 95% CI: 0.68 – 1.45).

In our second series of regression models, we compared the odds of prehospital cardiac arrest care and outcomes by specific health disparity populations. Black OHCA patients (aOR = 0.73; 95% CI: 0.65 – 0.82) and Hispanic OHCA patients (aOR = 0.78; 95% CI: 0.69 – 0.87) had significantly lower odds of BCPR compared to White OHCA patients. Compared to White OHCA patients, Black OHCA patients were less likely to achieve ROSC (aOR = 0.86; 95% CI: 0.74 – 0.99). Compared to White OHCA patients, Hispanic patients were less likely to have field TOR (aOR = 0.86; 95% CI: 0.75 – 0.99). Black OHCA patients were less likely to have a good CPC score (aOR = 0.47; 95% CI: 0.29 – 0.75) compared to White OHCA patients. Females were less likely to receive bystander AED (aOR = 0.60; 95% CI: 0.37 – 0.98) or experience field TOR (aOR = 0.89; 95% CI 0.8 – 1.06) but had higher odds of surviving to hospital admission compared to males (aOR = 1.29; 95% CI: 1.15 – 1.44) (see Table 3).

Discussion

In this statewide study analyzing changes in prehospital care and OHCA outcomes by race/ethnicity and gender, we found significant associations between year and outcome. Relative to the reference groups, we found worsening odds for several health disparity populations. There is a paucity of literature examining racial, ethnic and gender disparities in OHCA in setting of the COVID-19 pandemic. To our knowledge, this is the first and only statewide analysis comparing racial/ethnic and gender disparity outcomes for OHCA patients.

While there were absolute increases in the incidence of Black and Hispanic OHCA cases with a corresponding decrease in Whites, this did not reach statistical significance. (Table 1) This trend has been demonstrated in a small but growing body of work conducted during the early pandemic, finding increases in OHCA for Black and Hispanic patients relative to 2019.[25,26] Rates of BCPR and PAD worsened in 2020 for the White and male reference groups. However, this trend was not consistent for female and racial/ethnic health disparity populations. We found significant decreases in bystander AED for Black patients only and BCPR for Hispanics and Other persons; no statistically significant difference in these outcomes were noted for females. We found lower odds of BCPR for Black and Hispanic persons compared to White persons. In a study conducted prior to the COVID-19 pandemic in Los Angeles County, Bosson, et. al found rates of BCPR to be lower in Black (37%) and Hispanic (37%) patients compared to White patients (44%); these figures are comparable to our results.[12]

We found significant decreases in odds of bystander AED, sustained ROSC and survival to admission while TOR increased. For all study groups, at least one aspect of prehospital care or OHCA outcomes worsened. This underscores the impact of the pandemic in erasing hard fought gains in improving overall outcomes and disparities that may have been narrower in the past. This also suggests that existing health systems and infrastructure was not sufficient to address this epidemiologic change. Interventions designed to increase BCPR and PAD uptake represents a rich target for future public health interventions.

All study groups had lower rates of sustained ROSC in 2020. This is comparable to other studies which found for all-comers, rates of sustained ROSC decreased from 29.8% in 2019 to 23.0%.[27,28] When stratified by race/ethnicity and gender, the figures were similar for White (22.4%) and Hispanic (22.0%) persons, but worse for Black (19.0%) and Other (17.6%) persons. We found increased rates of field TOR for Black (38.4%), Hispanic (50.0%) and Other (41.2%) OHCA patients in 2020, which were slightly lower compared to overall estimates in the literature (53.9%).[27,28] Rates of survival to hospital admission and hospital discharge decreased for all health disparity populations. Although Black and Hispanic OHCA patients both had lower rates of sustained ROSC, Black, Hispanic and Other groups all had increased rates of TOR and decreased survival to hospital admission and discharge.

Though the proportion of OHCA patients with good neurologic outcomes remained consistent from 2019 to 2020, Black OHCA patients had nearly half the odds of a good CPC score compared to Whites. These findings are consistent with past research by Monlezun, et. al which found Black patients had greater odds of poor neurologic outcomes (OR = 2.21, 95% CI 1.25–3.92) compared to White patients.[29] Whereas the Utstein bystander survival rate had a notable decrease only in males, it remained consistent for all other health disparity populations. (Table 2) We found many survival out-

Table 3 – General Outcomes, Stratified by Pandemic[5] and Disparity Group.[6]

	Pandemic aOR[3] [95% CI[4]]	Female Gender[1] aOR[3] [95% CI[4]]	Black[2] aOR[3] [95% CI[4]]	Hispanic[2] aOR[3] [95% CI[4]]	Other[2] aOR[3] [95% CI[4]]
Bystander CPR	0.87 [0.79, 0.95]	1.02 [0.93, 1.12]	**0.73 [0.65, 0.82]**	**0.78 [0.69, 0.87]**	1.01 [0.82, 1.24]
Bystander AED	**0.53 [0.36, 0.79]**	0.60 [0.37, 0.98]	0.85 [0.54, 1.36]	0.6 [0.34, 1.05]	1.00 [0.47, 2.13]
Sustained ROSC	**0.67 [0.60, 0.75]**	**1.40 [1.26, 1.57]**	0.86 [0.74, 0.99]	1.13 [0.99, 1.30]	0.92 [0.71, 1.18]
Field Termination	**1.51 [1.36, 1.68]**	0.89 [0.8, 0.99]	0.92 [0.8, 1.06]	0.86 [0.75, 0.99]	0.88 [0.69, 1.13]
Survival to Admission	**0.73 [0.65, 0.82]**	**1.29 [1.15, 1.44]**	0.93 [0.81, 1.08]	1.06 [0.92, 1.23]	0.85 [0.65, 1.10]
Survival to Discharge	0.81 [0.68, 0.96]	1.16 [0.96, 1.39]	1.01 [0.81, 1.26]	0.82 [0.65, 1.04]	0.76 [0.50, 1.16]
Good CPC Score	0.99 [0.68, 1.45]	0.91 [0.61, 1.35]	**0.47 [0.29, 0.75]**	1.0 [0.59, 1.69]	0.90 [0.32, 2.53]
Utstein Bystander Survival	0.72 [0.51, 1.02]	1.22 [0.81, 1.82]	1.31 [0.81, 2.1]	1.01 [0.62, 1.63]	1.01 [0.49, 2.09]

[1] Male gender designated as reference group.
[2] White race designated as reference group.
[3] aOR stands for adjusted odds ratio.
[4] CI stands for confidence interval.
[5] Mixed multivariable logistic regression model, adjusting for age, gender, race/ethnicity and other arrest characteristics; EMS agency modeled as a random intercept.
[6] Mixed multivariable logistic regression model, adjusting for pandemic, age and other arrest characteristics; EMS agency modeled as a random intercept.

comes worsened for not just health disparity groups, but also the reference groups, demonstrating worsening health inequities. While this may be linked to poorer prehospital care (i.e. lower rates of BCPR and PAD usage), they are likely multifactorial in nature. Socioeconomic inequities such as health care, community characteristics, economic stability and discrimination contribute to health disparities.[30,31] The impact of this complex interplay of factors has become more significant during the COVID-19 pandemic and requires a multi-level systemic response for meaningful change.[31]

Conflicting evidence exists regarding prehospital care and survival outcomes by sex.[13–15]

In our study, females had better odds of sustained ROSC and survival to admission compared to males. This differs from prior research demonstrating lower rates of BCPR, survival to hospital admission, odds of survival to discharge and good neurologic outcomes for females.[32,33] Although we were unable to control for comorbidities or COVID-19 status, prior studies illustrate already existing gender disparities in COVID-19 patient outcomes, such as higher mortality in males.[34,35] Further study is necessary to characterize this trend long-term.

Results from this analysis provides evidence of the pandemic affecting most aspects of the cardiac chain of survival, including public bystander interventions and survival outcomes. Although all racial/ethnic and gender groups were affected somewhat, persistent disparities exist even when adjusting for the pandemic. Our results also suggest a novel direction for outcomes of OHCA female patients with greater survival odds. Future efforts to improve cardiac arrest care and outcomes during the COVID-19 pandemic transition period necessitates a multi-pronged approach to reduce disparities.

Limitations

Our analysis was limited to 2019 and 2020 so we were unable to analyze for any additional trends beyond this period. As Texas-CARES is continually growing, we wanted to include two years that had a similar number of CARES participating agencies. Including data prior to 2019 would have increased the size of the pre-pandemic group, but there were also fewer participating agencies, making it less comparable to the 2020 Texas-CARES cohort. Because the study was statewide, there may be unaccounted differences on the local level. Our analysis did not include variables related to post-arrest care. Additionally, our data set did not include comorbidities, COVID-19 status or allow clustering by individual hospital or census tract with socioeconomic variables. Socioeconomic status and geographic location, such as neighborhood, have been shown to contribute to OHCA outcomes but were not included as this was outside the scope of the analysis. Other statistical models such as differences-in-differences and time-interrupted analyses were considered for the analysis but given that all groups were exposed to the pandemic, we selected the models we felt would best evaluate the research questions. Variations among EMS agencies and changes in prehospital protocols during the pandemic may have also affected patient outcomes but could not be specifically identified within the data set.

Conclusion

This analysis provides state-wide evidence demonstrating at least one aspect of worsening prehospital cardiac arrest care or outcomes for every studied group. All-comers experienced worsening rates of ROSC and survival to hospital discharge. Disparities worsened for Black and Hispanic patients compared to White patients. Females had higher odds of ROSC and survival to hospital admission compared to males. Survival with good neurologic outcomes did not change for any group. Our study is significant because of its extended study period and catchment size and while adding to health disparities literature.

CRediT authorship contribution statement

S. Chavez: Study conception and design, Data acquisition, Data analysis and Interpretation, Article drafting. **R. Huebinger:** Study conception and design, Data analysis and interpretation, Article drafting. **H.K. Chan:** Data analysis and Interpretation. **K. Schulz:** Data acquisition. **M. Panczyk:** Study conception and design. **V. Villa:** Study conception and design. **R. Johnson:** Data acquisition, Article drafting. **R. Greenberg:** Data acquisition. **V. Vithalani:** Data acquisition. **R. Al-Araji:** Data acquisition. **B. Bobrow:** Study conception and design, Data acquisition.

Prior Presentations

Presented at the Resuscitation Science Symposium Annual Meeting, November 12–14, 2021.

Disclosure Statement

The authors report there are no competing interests to declare.

Data Availability Statement

Data provided by the Cardiac Arrest Registry to Enhance Survival (CARES) Registry.

Funding

This work was funded by the Zoll Foundation.

Conflicts of Interest

None.

Author details

[a]*Texas Emergency Medicine Research Center, McGovern Medical School, Houston, TX, United States* [b]*McGovern Medical School at The University of Texas Health Science Center at Houston (UTHealth), Department of Emergency Medicine, Houston, TX, United States* [c]*Department of Emergency Medicine, Baylor Scott & White Health, United States* [d]*JPS/Medstar, Fort Worth, Tx, United States* [e]*Emory University Rollins School of Public Health, Atlanta, GA, United States*

REFERENCES

1. Tsao CW, Aday AW, Almarzooq ZI, et al. Heart Disease and Stroke Statistics—2022 Update: A Report From the American Heart Association. Circulation 2022;145(8):e153–639. https://doi.org/10.1161/CIR.0000000000001052.
2. Dyke MV. Heart Disease Death Rates Among Blacks and Whites Aged ≥35 Years — United States, 1968–2015. *MMWR Surveill Summ*. 2018;67. doi:10.15585/mmwr.ss6705a1.
3. Wadhera RK, Shen C, Gondi S, Chen S, Kazi DS, Yeh RW. Cardiovascular Deaths During the COVID-19 Pandemic in the United States. J Am Coll Cardiol 2021;77(2):159–69. https://doi.org/10.1016/j.jacc.2020.10.055.
4. Leong BSH. Bystander CPR and survival. Singapore Med J 2011;52(8):573–5.
5. Xu F, Zhang Y, Chen Y. Cardiopulmonary Resuscitation Training in China: Current Situation and Future Development. JAMA Cardiology 2017;2(5):469–70. https://doi.org/10.1001/jamacardio.2017.0035.
6. Yan S, Gan Y, Jiang N, et al. The global survival rate among adult out-of-hospital cardiac arrest patients who received cardiopulmonary resuscitation: a systematic review and meta-analysis. Crit Care 2020;24(1):61. https://doi.org/10.1186/s13054-020-2773-2.
7. Out-of-hospital cardiac arrest: a unique medical emergency - The Lancet. Accessed November 12, 2021. https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(18)30552-X/fulltext.
8. Bystander CPR rates rising, but survival chances worse for women. www.heart.org. Accessed November 12, 2021. https://www.heart.org/en/news/2018/09/24/bystander-cpr-rates-rising-but-survival-chances-worse-for-women.
9. Malta Hansen C, Kragholm K, Pearson DA, et al. Association of Bystander and First-Responder Intervention With Survival After Out-of-Hospital Cardiac Arrest in North Carolina, 2010–2013. JAMA 2015;314(3):255–64. https://doi.org/10.1001/jama.2015.7938.
10. Huebinger R, Jarvis J, Schulz K, et al. Community Variations in Out-of-Hospital Cardiac Arrest Care and Outcomes in Texas. *Prehospital emergency care : official journal of the National Association of EMS Physicians and the National Association of State EMS Directors*. Published online 2021. https://doi.org/10.1080/10903127.2021.1907007.
11. Cardiac Arrest Registry to Enhance Survival. 2020 CARES Annual Report. CARES. Accessed January 4, 2022. https://mycares.net/sitepages/uploads/2021/2020_flipbook/index.html?page=6.
12. Bosson N, Fang A, Kaji AH, et al. Racial and ethnic differences in outcomes after out-of-hospital cardiac arrest: Hispanics and Blacks may fare worse than non-Hispanic Whites. Resuscitation 2019;137:29–34. https://doi.org/10.1016/j.resuscitation.2019.01.038.
13. Mody P, Pandey A, Slutsky AS, et al. Gender-Based Differences in Outcomes Among Resuscitated Patients With Out-of-Hospital Cardiac Arrest. Circulation 2021;143(7):641–9. https://doi.org/10.1161/CIRCULATIONAHA.120.050427.
14. Blom MT, Oving I, Berdowski J, van Valkengoed IGM, Bardai A, Tan HL. Women have lower chances than men to be resuscitated and survive out-of-hospital cardiac arrest. Eur Heart J 2019;40(47):3824–34. https://doi.org/10.1093/eurheartj/ehz297.
15. Kotini-Shah P, Del Rios M, Khosla S, et al. Sex differences in outcomes for out-of-hospital cardiac arrest in the United States. Resuscitation 2021;163:6–13. https://doi.org/10.1016/j.resuscitation.2021.03.020.
16. Huebinger R, Vithalani V, Osborn L, et al. Community disparities in out of hospital cardiac arrest care and outcomes in Texas. Resuscitation 2021;163:101–7. https://doi.org/10.1016/j.resuscitation.2021.03.021.
17. Arias E, Betzaida TV, Ahmad F, Kochanek K. Provisional Life Expectancy Estimates for 2020. In: National Center for Health Statistics (U.S.). https://doi.org/10.15620/cdc:107201.
18. Rodriguez F, Solomon N, de Lemos JA, et al. Racial and Ethnic Differences in Presentation and Outcomes for Patients Hospitalized With COVID-19: Findings From the American Heart Association's COVID-19 Cardiovascular Disease Registry. Circulation 2021;143(24):2332–42. https://doi.org/10.1161/CIRCULATIONAHA.120.052278.
19. Luck AN, Preston SH, Elo IT, Stokes AC. The unequal burden of the Covid-19 pandemic: Capturing racial/ethnic disparities in US cause-specific mortality. SSM - Population Health 2022;17. https://doi.org/10.1016/j.ssmph.2021.101012 101012.
20. Dehingia N, Raj A. Sex differences in COVID-19 case fatality: do we know enough? The Lancet Global Health 2021;9(1):e14–5. https://doi.org/10.1016/S2214-109X(20)30464-2.
21. TX-CARES.com. CARES | TX-CARES. Published 2019. Accessed February 15, 20https://tx-cares.com/cares/.
22. About CARES û MyCares. Accessed November 8, 2020. https://mycares.net/sitepages/aboutcares.jsp.
23. Cucinotta D, Vanelli M. WHO Declares COVID-19 a Pandemic. Acta Biomed 2020;91(1):157–60. https://doi.org/10.23750/abm.v91i1.9397.
24. May S, Zhang L, Foley D, et al. Improvement in Non-Traumatic, Out-Of-Hospital Cardiac Arrest Survival in Detroit From 2014 to 2016. Journal of the American Heart Association 2018;7(16):e009831.
25. Fothergill RT, Smith AL, Wrigley F, Perkins GD. Out-of-Hospital Cardiac Arrest in London during the COVID-19 pandemic. Resusc Plus 2020;5. https://doi.org/10.1016/j.resplu.2020.100066 100066.
26. Lai PH, Lancet EA, Weiden MD, et al. Characteristics Associated With Out-of-Hospital Cardiac Arrests and Resuscitations During the Novel Coronavirus Disease 2019 Pandemic in New York City. JAMA Cardiol 2020;5(10):1154. https://doi.org/10.1001/jamacardio.2020.2488.
27. Chan PS, Girotra S, Tang Y, Al-Araji R, Nallamothu BK, McNally B. Outcomes for Out-of-Hospital Cardiac Arrest in the United States During the Coronavirus Disease 2019 Pandemic. *JAMA Cardiol*. Published online November 14, 2020. doi:10.1001/jamacardio.2020.6210.
28. Chavez S, Huebinger R, Chan HK, et al. The impact of COVID-19 on incidence and outcomes from out-of-hospital cardiac arrest (OHCA) in Texas. *The American Journal of Emergency Medicine*. Published online April 13, 2022. doi:10.1016/j.ajem.2022.04.006.
29. Monlezun DJ, Samura AT, Patel RS, Thannoun TE, Balan P. Racial and Socioeconomic Disparities in Out-Of-Hospital Cardiac Arrest Outcomes: Artificial Intelligence-Augmented Propensity Score and Geospatial Cohort Analysis of 3,952 Patients. Cardiol Res Pract 2021;2021:3180987. https://doi.org/10.1155/2021/3180987.
30. Ndugga N, Artiga S. Disparities in Health and Health Care: 5 Key Questions and Answers. KFF. Published May 11, 2021. Accessed March 28, 2022. https://www.kff.org/racial-equity-and-health-policy/issue-brief/disparities-in-health-and-health-care-5-key-question-and-answers/.
31. Andraska EA, Alabi O, Dorsey C, et al. Health care disparities during the COVID-19 pandemic. Semin Vasc Surg 2021;34(3):82–8. https://doi.org/10.1053/j.semvascsurg.2021.08.002.
32. Lei H, Hu J, Liu L, Xu D. Sex differences in survival after out-of-hospital cardiac arrest: a meta-analysis. Crit Care 2020;24(1):613. https://doi.org/10.1186/s13054-020-03331-5.
33. Blewer AL, McGovern SK, Schmicker RH, et al. Gender Disparities Among Adult Recipients of Bystander Cardiopulmonary Resuscitation in the Public. *Circulation: Cardiovascular Quality and Outcomes*. 2018;11(8):e004710. doi:10.1161/CIRCOUTCOMES.118.004710.
34. Jin JM, Bai P, He W, et al. Gender Differences in Patients With COVID-19: Focus on Severity and Mortality. *Frontiers in Public Health*. 2020;8. Accessed February 7, 2022. https://www.frontiersin.org/article/10.3389/fpubh.2020.00152.
35. Marik PE, DePerrior SE, Ahmad Q, Dodani S. Gender-based disparities in COVID-19 patient outcomes. J Invest Med 2021;69(4):814–8. https://doi.org/10.1136/jim-2020-001641.