

Race/Ethnicity and Neighborhood Characteristics Are Associated With Bystander Cardiopulmonary Resuscitation in Pediatric Out-of-Hospital Cardiac Arrest in the United States: A Study From CARES

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Background—Whether racial and neighborhood characteristics are associated with bystander cardiopulmonary resuscitation (BCPR) in pediatric out-of-hospital cardiac arrest (OHCA) is unknown.

Methods and Results—An analysis was conducted of CARES (Cardiac Arrest Registry to Enhance Survival) for pediatric nontraumatic OHCA from 2013 to 2017. An index (range, 0–4) was created for each arrest based on neighborhood characteristics associated with low BCPR (>80% black; >10% unemployment; <80% high school; median income, <\$50 000). The primary outcome was BCPR. BCPR occurred in 3399 of 7086 OHCA (48%). Compared with white children, BCPR was less likely in other races/ethnicities (black: adjusted odds ratio [aOR], 0.59; 95% CI, 0.52–0.68; Hispanic: aOR, 0.78; 95% CI, 0.66–0.94; and other: aOR, 0.54; 95% CI, 0.40–0.72). Compared with arrests in neighborhoods with an index score of 0, BCPR occurred less commonly for arrests with an index score of 1 (aOR, 0.80; 95% CI, 0.70–0.91), 2 (aOR, 0.75; 95% CI, 0.65–0.86), 3 (aOR, 0.52; 95% CI, 0.45–0.61), and 4 (aOR, 0.46; 95% CI, 0.36–0.59). Black children had an incrementally lower likelihood of BCPR with increasing index score while white children had an overall similar likelihood at most scores. Black children with an index of 4 were approximately half as likely to receive BCPR compared with white children with a score of 0.

Conclusions—Racial and neighborhood characteristics are associated with BCPR in pediatric OHCA. Targeted CPR training for nonwhite, low-education, and low-income neighborhoods may increase BCPR and improve pediatric OHCA outcomes. (*J Am Heart Assoc.* 2019;8:e012637. DOI: 10.1161/JAHA.119.012637.)

Key Words: bystander cardiopulmonary resuscitation • children • out-of-hospital cardiac arrest • pediatric • race/ethnicity • socioeconomic status

Pediatric out-of-hospital cardiac arrest (OHCA) outcomes remain poor, with only 1 in 10 children surviving to hospital discharge.^{1,2} Bystander cardiopulmonary resuscitation (BCPR) is an effective intervention to improve outcome after OHCA, and communities that have increased their rates of BCPR have improved survival after OHCA.^{3,4}

A recent study from the CARES (Cardiac Arrest Registry to Enhance Survival) in the United States demonstrated that BCPR is associated with better outcomes after pediatric OHCA.² That study also revealed a racial and ethnic disparity in the provision of BCPR and outcome. White children were much more likely to receive BCPR compared with black and

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Accompanying Tables S1 through S9 are available at <https://www.ahajournals.org/doi/suppl/10.1161/JAHA.119.012637>

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Received March 12, 2019; accepted May 2, 2019.

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Clinical Perspective

What Is New?

- In this analysis of data from CARES (Cardiac Arrest Registry to Enhance Survival) of 7086 out-of-hospital cardiac arrests in children aged <18 years in the United States, individual race/ethnicity, neighborhood race/ethnicity, employment, education, and income were significantly associated with provision of bystander cardiopulmonary resuscitation.

What Are the Clinical Implications?

- Racial/ethnic and socioeconomic disparities exist in the provision of bystander cardiopulmonary resuscitation in pediatric out-of-hospital cardiac arrest.
- Targeted cardiopulmonary resuscitation training for non-white, low-education, and low-income neighborhoods may increase bystander cardiopulmonary resuscitation provision and improve out-of-hospital cardiac arrest outcomes in children.

Hispanic children, and black children were less likely to have neurologically favorable survival compared with white children. A similar racial and ethnic disparity in BCPR and outcome in OHCA has been observed in adult studies.^{5–7} However, there is ongoing controversy whether this disparity exists at all,^{8–10} is on the basis of race alone, or associated with socioeconomic^{11–14} and/or neighborhood characteristics.^{15–19}

Using the CARES national database, the goal of this investigation was to further elucidate the relationship of the race/ethnicity of cardiac arrest victims and neighborhood characteristics with BCPR provision for children with OHCA. We hypothesized that race/ethnicity of the cardiac arrest victim and neighborhood racial and socioeconomic characteristics are associated with the provision of BCPR.

Methods

Because of the sensitive nature of the data collected for this study, requests to access the data set from qualified researchers trained in human subject confidentiality protocols may be sent to CARES at cares@emory.edu. CARES includes an overall catchment area of >115 million people in 41 states across the United States. CARES is an emergency medical services–based registry for OHCA, composed of a limited standard set of data elements from 3 sources: 911 call centers, emergency medical services providers, and receiving hospitals.²⁰ Detailed information on the design and development of this registry as well as the data elements included in the registry is published elsewhere.²¹

CARES captures all 911-activated nontraumatic cardiac arrest events, defined as apnea and unresponsiveness, in which resuscitation with either CPR or defibrillation is attempted. Children with obvious signs of death (eg, rigor mortis or dependent lividity) or for whom a “do not resuscitate” order was respected are not included. Standardized international Utstein definitions for clinical variables and outcomes are used to ensure uniformity in reporting.²² CARES analysts confirm the capture of all cardiac arrests by each community’s 911 call center during the data review process. CARES establishes a point of contact at each participating hospital and trains the contact on CARES hospital element definitions and the data entry process. The local hospital contact abstract information from the patient’s medical record and enter data.

All data were entered using a web-based platform, and an Excel file (Microsoft Corporation, Redmond, WA) was generated with all cardiac arrest events for the specified date range.

This study was approved by the institutional review board at Emory University (Atlanta, GA). Given the use of deidentified data, the study was determined to be exempt for institutional review board review by the Children’s Hospital of Philadelphia (Philadelphia, PA) and the Children’s Hospital of Los Angeles (Los Angeles, CA).

Study Sample

The CARES database for OHCA, from January 1, 2013, through December 31, 2017, was analyzed; and all pediatric cases aged ≤18 years with nontraumatic OHCA submitted to the registry during the study period were eligible for inclusion. As the cause of cardiac arrest in children is difficult to determine, especially in cases that result in death, all nontraumatic cases were included regardless of presumed cause, including respiratory tract, cardiac, drowning, electrocution, or other. Arrests that occurred in medical facilities or nursing homes, traumatic arrests, and emergency responder witnessed arrests were excluded.

Variables of Interest and Study Outcome

Patient characteristics obtained from the database included age, sex, race/ethnicity, bystander witness status, arrest location, initial rhythm, and automated external defibrillator use. Race/ethnicity was assigned as considered by the child, family, or 911 responder. The race/ethnicity category included white, black/African American, Hispanic/Latino, and other (American Indian/Alaskan, Asian, and Native Hawaiian/Pacific). Geocoding was performed using the Centrus Desktop Geocoder, version 6.0 (Pitney Bowes). Census tract was used as a proxy for neighborhood. Neighborhood-

level variables were linked to each geocoded OHCA event address using the 2010 US Census Summary Files and the 2016 American Community Survey 5-year estimates. Neighborhoods with a census tract race of >80% were classified as predominantly of that race. Those without a predominant racial composition were classified as integrated. Neighborhoods were also classified as white (>80% white) and nonwhite (>80% black, >80% Hispanic, or integrated).¹⁵ An index was created for each arrest on the basis of neighborhood characteristics historically associated with lower BCPR

provision from bivariable analysis (>80% black; >10% unemployment; <80% high school; median household income, <\$50 000). For median household income, \$50 000 was used as it was the median household income in the United States across the years of the study. A score of 0 or 1 was assigned to each of the 4 characteristics for a total index score that ranged from 0 to 4. The primary outcome of interest was BCPR provision. BCPR was defined as CPR administered by a layperson, defined as lay family member, unrelated layperson, or person with medical training (ie, physician, nurse, or

Table 1. BCPR Characteristics

Characteristics	All (N=7086)	BCPR (N=3399)	No BCPR (N=3687)	P Value
Year of arrest				
2013	951 (13.42)	496 (13.45)	455 (13.39)	0.680
2014	1102 (15.55)	563 (15.27)	539 (15.86)	
2015	1444 (20.38)	751 (20.37)	693 (20.39)	
2016	1654 (23.34)	845 (22.92)	809 (23.80)	
2017	1935 (27.31)	1032 (27.99)	903 (26.57)	
Age, y				
≤1	4349 (61.37)	2350 (63.74)	1999 (58.81)	<0.001
2–11	1421 (20.05)	697 (18.90)	724 (21.30)	
12–18	1316 (18.57)	640 (17.36)	676 (19.89)	
Sex				
Female	2869 (40.49)	1533 (41.58)	1336 (39.31)	0.052
Male	4217 (59.51)	2154 (58.42)	2063 (60.69)	
Race/ethnicity				
White	2215 (31.26)	954 (25.87)	1261 (37.10)	<0.001
Black	2213 (31.23)	1343 (36.43)	870 (25.60)	
Hispanic	746 (10.53)	398 (10.79)	348 (10.24)	
Other	215 (3.03)	127 (3.44)	88 (2.59)	
Unknown	1697 (23.95)	865 (23.46)	832 (24.48)	
Bystander witnessed arrest				
Bystander witnessed	1722 (24.30)	734 (19.91)	988 (29.07)	<0.001
Unwitnessed	5364 (75.70)	2953 (80.09)	2411 (70.93)	
Arrest location				
Nonhome/public	973 (13.73)	468 (12.69)	505 (14.86)	0.008
Home/residence	6113 (86.27)	3219 (87.31)	2894 (85.14)	
Shockable rhythm				
Nonshockable	6577 (92.82)	3475 (94.25)	3102 (91.26)	<0.001
Shockable	509 (7.18)	212 (5.75)	297 (8.74)	
AED used before EMS				
No	5741 (81.02)	2981 (80.85)	2760 (81.20)	0.708
Yes	1345 (18.98)	706 (19.15)	639 (18.80)	

Data are given as number (percentage). AED indicates automated external defibrillation; BCPR, bystander cardiopulmonary resuscitation; EMS, emergency medical services.

Table 2. Logistic Regression Characteristics and BCPR Provision

Characteristics	Adjusted % BCPR*	95% CI		Adjusted OR	95% CI		P Value
Individual race/ethnicity							
White	54.42	52.24	56.60	Reference			
Black	41.71	39.52	43.89	0.591	0.517	0.676	<0.001
Hispanic	48.49	44.82	52.17	0.783	0.656	0.935	0.007
Other	39.63	33.10	46.15	0.541	0.403	0.726	<0.001
Unknown	48.45	46.12	50.79	0.782	0.686	0.891	<0.001
Neighborhood predominant race							
<80% White	47.59	46.14	49.03				
>80% White	48.76	46.55	50.98	1.050	0.935	1.180	0.408
Age, y							
≤1	47.39	45.89	48.89				
2–11	49.86	47.31	52.41	1.109	0.979	1.257	0.105
12–18	47.81	45.12	50.50	1.018	0.892	1.162	0.793
Sex							
Female	46.97	45.19	48.75				
Male	48.65	47.16	50.13	1.073	0.973	1.182	0.158
Bystander witnessed arrest							
No	45.30	43.98	46.62				
Yes	56.27	53.85	58.68	1.577	1.403	1.774	<0.001
Arrest location							
Nonhome/public	47.34	44.16	50.51				
Home/residence	48.07	46.83	49.30	1.031	0.892	1.191	0.677
AED used before EMS							
No	48.72	47.45	49.99				
Yes	44.76	42.12	47.41	0.847	0.747	0.959	0.009
Median household income, \$/y							
<50 000	46.54	44.77	48.31				
>50 000	49.51	47.64	51.38	1.132	1.006	1.272	0.039
Unemployment, %							
<10	49.93	48.38	51.48				
>10	44.54	42.40	46.67	0.799	0.710	0.899	<0.001
High school education, %							
<80	43.24	40.77	45.70				
>80	49.79	48.37	51.21	1.314	1.158	1.491	<0.001

AED indicates automated external defibrillation; BCPR, bystander cardiopulmonary resuscitation; EMS, emergency medical services; OR, odds ratio.

*Predicted probability of outcome, adjusting for covariates.

paramedic) who was not part of the organized emergency medical response. Secondary outcomes included survival to hospital admission, survival to hospital discharge, and neurologically favorable survival, defined as a cerebral performance category of 1 (no neurologic disability) or 2 (moderate disability) at the time of discharge.²

Statistical Analysis

Descriptive analyses report overall child and arrest characteristics and characteristics for arrests with BCPR or no BCPR. Logistic regression was used to investigate the association of BCPR with race/ethnicity, neighborhood characteristics

(median income, unemployment percentage, percentage high school education, and predominant race), an interaction term of neighborhood index score, and individual race/ethnicity. The analysis was adjusted for potential confounders, including age, sex, arrest witness status, location of the arrest, rhythm, and automated external defibrillator use. Logistic regression was used to investigate the association of survival to hospital discharge and neurologically favorable survival with the neighborhood index score and was adjusted for the potential confounders listed above. Given the small cell sizes for survival to hospital discharge and neurologically favorable survival in neighborhoods with index scores of 3 and 4, these neighborhoods were combined for analysis. Sensitivity analyses were conducted for the neighborhood index score using a 50% black, \$40 000, as used in a previous CARES article,¹⁵ \$52 000, and \$54 000 median income cutoff without a significant change in results. Additional sensitivity analyses were conducted for the association of neighborhood index and survival to hospital discharge and neurologically favorable survival, excluding infants without a significant change in results. Results are expressed as adjusted odds ratios (aORs) and predicted probabilities with 95% CIs. Tests of interactions were assessed via the Wald χ^2 test. To correct for multiple comparisons, we used the Bonferroni correction at a total α of 0.05; therefore, for our main analyses of the relationship between neighborhood index and BCPR, the *P* value for the comparison was set at <0.01 (0.05/5). Analyses were performed using SAS 9.3 (SAS Institute, Cary, NC) and STATA 10.3 (StataCorp, College Station, TX).

Results

Arrest and Bystander CPR Characteristics

A total of 7086 cardiac arrests were evaluated (Table 1). Most cardiac arrests occurred in infants (61.4%), and more frequently in male (59.5%) than in female individuals. Children who were white (31.3%) and black (31.2%) composed the largest racial groups, followed by Hispanic (10.5%) and other (3.0%). Race was unknown (missing) for 23.9% of arrests. Most arrests occurred at home/residence (86.3%), were unwitnessed (75.7%), and presented with a nonshockable rhythm (asystole or pulseless electrical activity) (92.8%). Most arrests did not receive automated external defibrillator application by a bystander or first responder before emergency medical services arrival (81.0%). Most arrests occurred in low-income (<\$50 000/year: 52.4%), low-unemployment (<10% unemployment: 63.1%), and more educated (>80% high school education: 71.8%) neighborhoods (Table 2). Survival to hospital admission occurred in 24.9% (1764 of 7086), survival to hospital discharge in 10.0% (710 of 7086), and 8.3% (587 of 7086) had neurologically favorable survival. Therefore, 82.7% (587 of 710) of survivors had a favorable neurological outcome.

Individual Characteristics and Bystander CPR Provision

BCPR was provided in 48.0% of arrests (Table 1). BCPR was more common for whites (56.9%) compared with blacks

Table 3. Provision of BCPR by American Community Survey Variables, Including Income, Unemployment, Race, and Education

Neighborhood Characteristic	All	No BCPR	BCPR	<i>P</i> Value
Median household income, \$/y				
<50 000	3714 (52.41)	2137 (57.96)	1577 (46.40)	<0.001
>50 000	3372 (47.59)	1550 (42.04)	1822 (53.60)	
Unemployment, %				
<10	4474 (63.14)	2113 (57.31)	2361 (69.46)	<0.001
>10	2612 (36.86)	1574 (42.69)	1038 (30.54)	
High school education, %				
<80	1996 (28.17)	1219 (33.06)	777 (22.86)	<0.001
>80	5090 (71.83)	2468 (66.94)	2622 (77.14)	
White, %				
<80	4818 (67.99)	2669 (72.39)	2149 (63.22)	<0.001
>80	2268 (32.01)	1018 (27.61)	1250 (36.78)	
Black, %				
<80	6306 (88.99)	3165 (85.84)	3141 (92.41)	<0.001
>80	780 (11.01)	522 (14.16)	258 (7.59)	

Data are given as number (percentage). BCPR indicates bystander cardiopulmonary resuscitation.

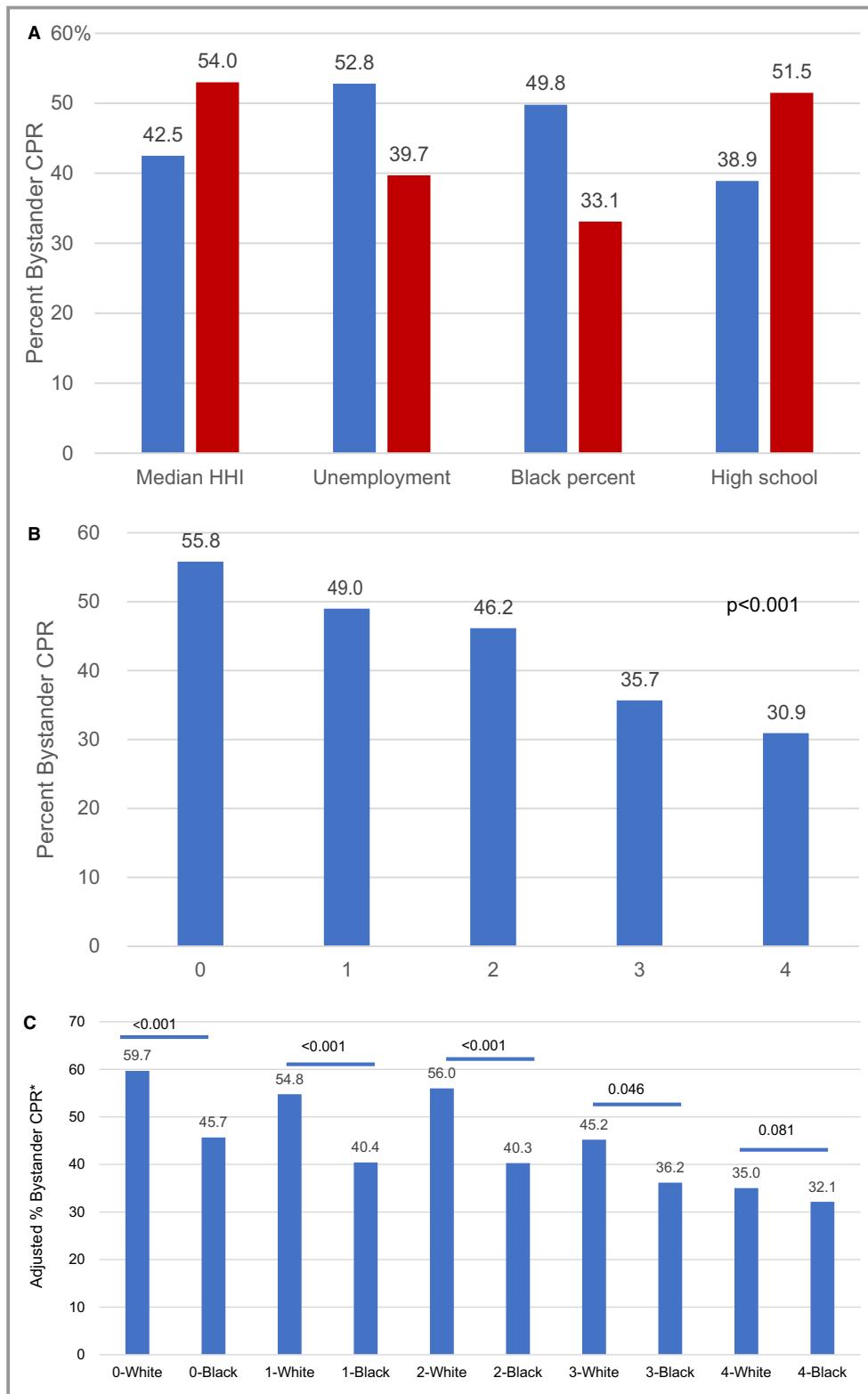


Figure 1. A, Bystander cardiopulmonary resuscitation (CPR) provision in income, unemployment, race, and education categories. Red values (beneficial): >\$50 000 median household income (HHI), >10% unemployment, >80% black, >80% high school education. Blue values (less beneficial): <\$50 000 median HHI, <10% unemployment, <80% black, <80% high school education. B, Bystander CPR by neighborhood index score. C, Neighborhood index score and race interaction with bystander CPR provision. *Predicted probability of outcome, adjusting for covariates.

Table 4. Neighborhood Index Score

Index	Overall	>80% Black	>10% Unemployment	<80% High School	Median Household Income <\$50 000
0	2774 (39.15)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
1	1425 (20.11)	17 (1.19)	321 (22.53)	155 (10.88)	932 (65.40)
2	1330 (18.77)	71 (5.34)	742 (55.79)	622 (46.77)	1225 (92.11)
3	1211 (17.09)	346 (28.57)	1203 (99.34)	873 (72.09)	1211 (100.00)
4	346 (4.88)	346 (100.00)	346 (100.00)	346 (100.00)	346 (100.00)
Total	7086	780 (11.01)	2612 (36.86)	1996 (28.17)	3714 (52.41)

Data are given as number (percentage). Index score: sum of 1 point for each of the 4 characteristics (>80% black, >10% unemployment, <80% high school, and median household income <\$50 000).

(39.3%), Hispanics (46.6%), children of other race/ethnicities (40.9%), and children with unknown race/ethnicity (49.0%) ($P<0.001$). BCPR was also more common in older children (aged 2–18 years), witnessed arrests, nonhome/public arrests, and arrests with a shockable rhythm. In multivariable logistic regression compared with white children, children with other races/ethnicities were less likely to receive BCPR (white: predicted probability of BCPR, 54.4%; black: 41.7% aOR, 0.59; 95% CI, 0.52–0.68; Hispanic: 41.7% aOR, 0.78; 95% CI, 0.66–0.94; other races/ethnicities: 39.6% aOR, 0.54; 95% CI, 0.40–0.72; and unknown races/ethnicities: 48.5% aOR, 0.78; 95% CI, 0.69–0.89), independent of neighborhood predominant race (Table 2).

Neighborhood Characteristics and Bystander CPR Provision

BCPR was more common in high-income neighborhoods compared with low-income neighborhoods (median household income >\$50 000: 54.0%, versus median household income <\$50 000: 42.5%; $P<0.001$), low-unemployment neighborhoods compared with high-unemployment neighborhoods (unemployment <10%: 52.8%, versus unemployment >10%: 39.7%; $P<0.001$), and high-education compared with low-education neighborhoods (high school education >80%: 51.5%, versus high school education <80%: 38.9%; $P<0.001$). There was more BCPR provision in predominantly white neighborhoods compared with predominantly nonwhite neighborhoods (white, 55.1%; nonwhite, 44.6%; $P<0.001$). In predominantly black neighborhoods, there was less BCPR provision compared with predominantly nonblack neighborhoods (black versus nonblack, 33.1% versus 49.8%; $P<0.001$) (Table 3, Figure 1A).

Index Score and Analysis

More (39.2%, 2774 of 7086) cardiac arrests occurred in neighborhoods with an index score of 0 compared with 20.1% of arrests with a neighborhood index score of 1,

18.8% with an index score of 2, 17.1% with an index score of 3, and 4.9% with an index score of 4 (Table 4). In unadjusted analysis, BCPR was significantly more likely for arrests that occurred in neighborhoods with an index score of 0 compared with all other groups (Figure 1A and 1B). On multivariable analysis, compared with arrests in a neighborhood with an index score of 0 (predicted probability of BCPR, 55.9%), BCPR occurred less commonly for arrests in a neighborhood with an index score of 1 (48.4%, aOR, 0.80; 95% CI, 0.70–0.91), an index score of 2 (46.9%, aOR, 0.75; 95% CI, 0.65–0.86), an index score of 3 (38.3%, aOR, 0.52; 95% CI, 0.45–0.61), and an index score of 4 (35.4%, aOR, 0.46; 95% CI, 0.35–0.59) (Table 5).

To assess the interaction of neighborhood index score with individual race/ethnicity, an additional multivariable logistic regression was performed (Table 6). Black children had an incrementally lower likelihood of BCPR provision with increasing index score, compared with white children in neighborhoods with an index score of 0, whereas white children had an overall similar likelihood of BCPR provision at most index scores. Compared with white children in a neighborhood with a score of 0 who had an predicted probability of BCPR of 59.7%, black children in a neighborhood with an index score of 4 were almost half as likely to receive BCPR, with a predicted probability of BCPR of 32.1% (aOR, 0.32; 95% CI, 0.24–0.42). For most neighborhood index scores, white children had higher rates of BCPR provision compared with black children (Figure 1C). For example, a black child experiencing an OHCA in a neighborhood with an index of 0 (predicted probability of BCPR, 45.7%, aOR, 0.56; 95% CI, 0.45–0.70) was as likely to receive BCPR as a white child in a neighborhood with an index of 3 (predicted probability of BCPR, 45.2%, aOR, 0.55; 95% CI, 0.39–0.79).

Unadjusted survival to hospital admission was more likely for arrests that occurred in neighborhoods with an index score of 0 compared with those with an index score of 4 (29.6% versus 14.5%; $P<0.001$) (Figure 2). Unadjusted

Table 5. Logistic Regression of BCPR as Outcome and Neighborhood Index Score as Main Predictor

Characteristic	Adjusted % BCPR*	95% CI		Adjusted OR	95% CI		P Value
Index score							
0	53.93	52.01	55.85				
1	48.44	45.88	51.00	0.799	0.701	0.910	0.001
2	46.91	44.23	49.58	0.750	0.654	0.860	<0.001
3	38.31	35.48	41.14	0.523	0.451	0.607	<0.001
4	35.38	30.10	40.66	0.460	0.358	0.592	<0.001
Age, y							
≤1	47.43	45.93	48.93				
2–11	49.78	47.23	52.33	1.103	0.974	1.250	0.123
12–18	47.78	45.10	50.46	1.015	0.889	1.158	0.828
Sex							
Female	46.97	45.19	48.75				
Male	48.64	47.16	50.13	1.073	0.973	1.182	0.158
Race/ethnicity							
White	54.29	52.16	56.41				
Black	42.32	40.18	44.47	0.610	0.536	0.694	<0.001
Hispanic	47.42	43.82	51.02	0.754	0.634	0.896	0.001
Other	39.24	32.76	45.72	0.535	0.399	0.716	<0.001
Unknown	48.28	45.95	50.61	0.781	0.686	0.888	<0.001
Bystander witnessed arrest							
No	45.29	43.97	46.61				
Yes	56.28	53.87	58.69	1.579	1.405	1.776	<0.001
Arrest location							
Nonhome/public	47.26	44.10	50.42				
Home/residence	48.08	46.85	49.32	1.035	0.896	1.196	0.640
AED used before EMS							
No	48.69	47.42	49.96				
Yes	44.90	42.25	47.54	0.852	0.752	0.966	0.012

AED indicates automated external defibrillation; BCPR, bystander cardiopulmonary resuscitation; EMS, emergency medical services.
 *Predicted probability of outcome, adjusting for covariates.

survival to hospital discharge was more likely for arrests that occurred in neighborhoods with an index score of 0 compared with those with an index score of 4 (13.1% versus 4.9%; $P<0.001$) (Figure 3). Similarly, neurologically favorable survival was more likely for arrests in neighborhoods with an index score of 0 compared with those with an index score of 4 (11.4% versus 3.5%; $P<0.001$) (Figure 4). In multivariate analysis, there was a significant difference in survival to hospital admission of children from neighborhoods with an index score of 2 and 4 compared with neighborhoods with an index score of 0 (neighborhood index score 2: aOR, 0.75; 95% CI, 0.63–0.90; neighborhood score 4: aOR, 0.70; 95% CI, 0.50–0.98) (Table S1). There was also

a decreased odds in survival to hospital discharge of children from neighborhoods with an index score of 2 compared with neighborhoods with an index score of 0 (aOR, 0.68; 95% CI, 0.52–0.89) (Table S2). The odds of neurologically favorable survival were lower for children who had arrests in neighborhoods with an index score of 2 compared with a neighborhood index of 0 (aOR, 0.63; 95% CI, 0.47–0.84) (Table S3). This remained significant for all 3 survival outcomes in a sensitivity analysis excluding infants for neighborhoods with an index score of 2 (Tables S4 through S6). Black and Hispanic children who had a cardiac arrest in neighborhoods with an index score 2 had a significantly lower odds of survival to hospital admission, survival to

Table 6. Logistic Regression of BCPR as Outcome and the Interaction of Neighborhood Index and Individual Race as Main Predictor

Characteristics	Bivariate % BCPR	P Value	Adjusted % BCPR*	95% CI		Adjusted OR	95% CI		P Value
Index score/individual race									
0-White	60.00	<0.001	59.7	56.9	62.5				
0-Black	46.30		45.7	41.2	50.2	0.563	0.453	0.701	<0.001
1-White	54.60		54.8	50.4	59.1	0.816	0.659	1.010	0.061
1-Black	40.70		40.4	35.6	45.2	0.453	0.358	0.573	<0.001
2-White	55.80		56.0	50.7	61.3	0.858	0.670	1.099	0.226
2-Black	40.00		40.3	36.0	44.6	0.451	0.363	0.560	<0.001
3-White	44.80		45.2	37.0	53.4	0.553	0.388	0.788	0.001
3-Black	35.80		36.2	32.4	40.0	0.378	0.307	0.464	<0.001
4-White	33.30		35.0	11.4	58.6	0.359	0.125	1.035	0.058
4-Black	31.70		32.1	26.5	37.8	0.315	0.236	0.420	<0.001
Age, y									
≤1	45.7	0.002	47.6	45.7	49.4				
2–11	50.6		50.8	47.6	54.0	1.146	0.977	1.345	0.094
12–18	50.8		47.2	43.8	50.6	0.984	0.832	1.165	0.855
Sex									
Female	46.4	0.144	47.3	45.1	49.5				
Male	48.5		48.7	46.8	50.6	1.060	0.937	1.200	0.356
Bystander witnessed arrest									
No	44.5	<0.001	45.2	43.5	46.9				
Yes	57.2		57.3	54.2	60.3	1.659	1.429	1.927	<0.001
Arrest location									
Nonhome/public	52.0	0.013	49.5	45.3	53.7				
Home/residence	47.0		47.9	46.4	49.5	0.937	0.774	1.134	0.504
AED used									
No	47.6	0.953	48.9	47.3	50.5				
Yes	47.7		44.7	41.3	48.1	0.836	0.712	0.981	0.028

AED indicates automated external defibrillation; BCPR, bystander cardiopulmonary resuscitation; OR, odds ratio.
 *Predicted probability of outcome, adjusting for covariates.

hospital discharge, and neurologically favorable survival compared with white children who had arrests in a neighborhood with an index of 0 (Tables S7 through S9).

Discussion

This study describes the association of the cardiac arrest victim’s race/ethnicity and neighborhood racial and socioeconomic factors for pediatric OHCA in the United States. These data demonstrate racial disparity in the provision of BCPR for children. In addition, neighborhood racial and socioeconomic factors are strongly associated with BCPR provision. The most disadvantaged neighborhoods have the lowest rates of BCPR.

The overall rate of BCPR was 48.0%, with an overall survival rate of 10.0% and a neurologically favorable survival rate of 8.3%, similar to prior reports.^{2,23} Children were less likely to receive BCPR in low-income compared with high-income (42.8% versus 52.2%), low-education compared with high-education (40.2% versus 50.7%), and high-unemployment compared with low-unemployment (40.3% versus 52.1%) neighborhoods. There was more BCPR provision in predominantly white neighborhoods (54.9%). In predominantly black neighborhoods, there was a low rate of BCPR provision (33.8%). These results are similar to those reported in adult OHCA. Sasson et al studied neighborhoods characteristics in 14 225 adult cardiac arrests from CARES and found that adults who had an OHCA in low-income black, low-income white, and high-income black

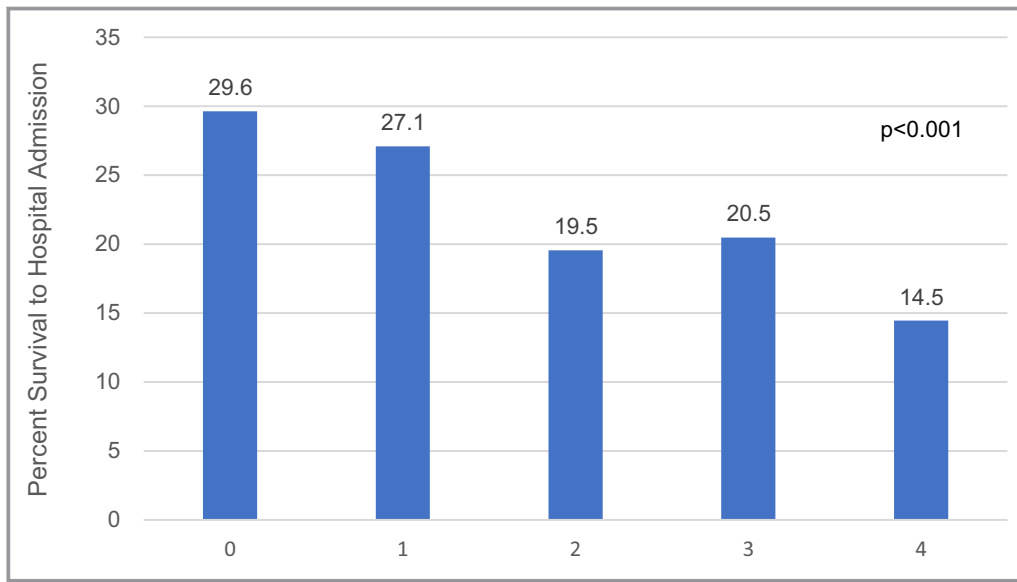


Figure 2. Survival to hospital admission by neighborhood index score.

neighborhoods were less likely to receive BCPR compared with adults in high-income white neighborhoods.¹⁵

The current study found a racial disparity in BCPR provision, where nonwhite children were less likely to receive BCPR compared to white children. Black children had an incrementally lower likelihood of BCPR provision with increasing index score, whereas white children had an overall similar likelihood of BCPR provision at most index scores. Moreover, black children with all 4 neighborhood characteristics were almost half as likely to receive BCPR compared with white children, with an index score of 0 (59.7% versus 32.1%, aOR, 0.32; 95% CI, 0.24–0.42). A black child experiencing an OHCA in a neighborhood with an index of 0 was as likely to receive

BCPR as a white child in a neighborhood with an index of 3. A similar disparity has been observed in adult studies. Becker et al studied 6451 adult nontraumatic OHCA in the Chicago, IL, area between 1987 and 1988 and found that black adults were less likely to receive BCPR, have a witnessed cardiac arrest, have a shockable rhythm, or be admitted to a hospital.⁷ Similarly, in Seattle, WA, Cowie et al studied 1332 adult OHCA and showed much less BCPR in black compared with white victims of OHCA (18.1 versus 31.7; $P=0.003$).⁵

We constructed an index that increased with each additional neighborhood characteristic associated with lower BCPR provision. On multivariable analysis, arrests that occurred in neighborhoods with none of these characteristics had higher

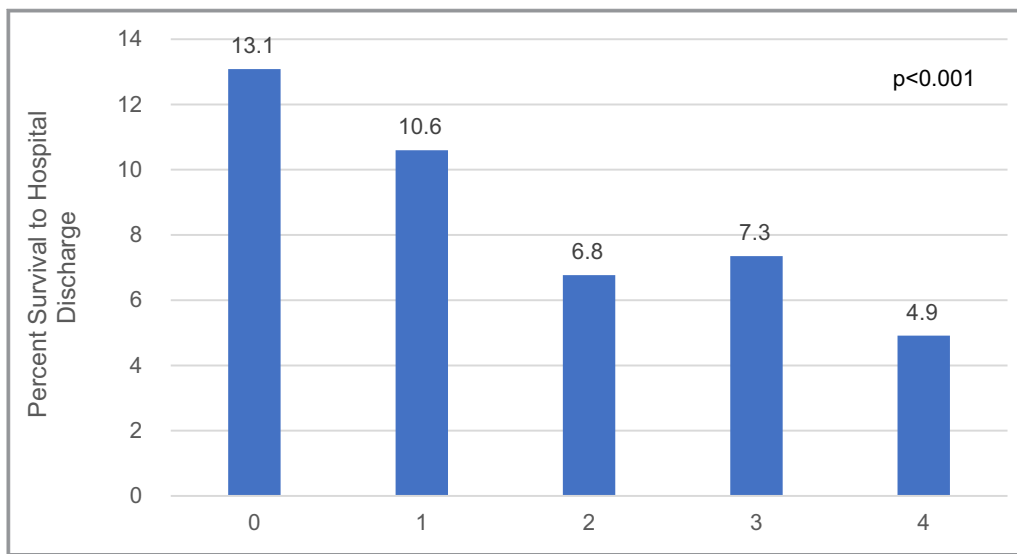


Figure 3. Survival to hospital discharge by neighborhood index score.

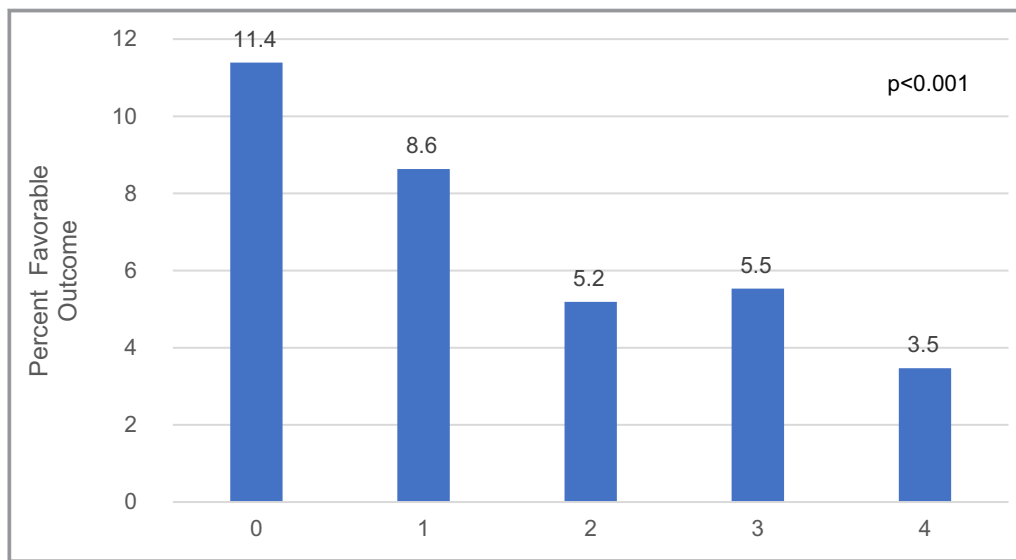


Figure 4. Neurologically favorable survival by neighborhood index score.

BCPR rates compared with those with all 4 characteristics (predicted probability of BCPR, 52.3% vs 37.3%, aOR, 0.53; 95% CI, 0.40–0.71). Similarly, the unadjusted rates of survival to hospital admission, survival to hospital discharge, and neurologically favorable survival decreased when comparing neighborhoods with no risk factors in neighborhoods with all 4. Given that survival was a rare event, we believe that the study was likely underpowered to assess for survival differences with the index score on multivariable analysis. These data are similar to adult OHCA studies from Canada¹¹ and Seattle, WA,¹³ where people in lower socioeconomic strata were less likely to receive BCPR¹¹ and survive an episode of OHCA.^{11,13} Although the index used in the current study included neighborhood characteristics associated with lower BCPR provision, including median income, education, unemployment, and predominant race, the adult studies used residential property values as a proxy for socioeconomic status, which can vary significantly within communities; and true status can vary, depending on whether a property is inherited, rented, or mortgaged. A recent nationwide pediatric OHCA study from Denmark used individual parental socioeconomic status and found that high parental education was associated with a 3 times greater odds of survival compared with lower parental education, and although there were differences in unadjusted survival in arrests between high and low household income, adjusted rates were not significant.²⁴

These data suggest a need for focused intervention in low-income, nonwhite, low-education neighborhoods where a public health strategy, such as targeted CPR training, can be undertaken to enhance BCPR provision and improve outcome in pediatric OHCA. Parents are the most common providers of BCPR in children² and are in general highly interested in improving the health of their children. Consequently, parents

and caregivers in communities with a higher index score are attractive potential targets of public health interventions, including CPR training to improve BCPR provision, such as BCPR training at the time of hospital discharge with a newborn or in a pediatrician's office. Using data from these neighborhoods, based on their race/ethnicity characteristics, may facilitate improved design and implementation of CPR programs. A study exploring identification of barriers and facilitators to learning and performing CPR in low-income, high-risk, and predominantly black neighborhoods in Columbus, OH, found that the financial cost of CPR training, lack of information, and the fear of risking one's own life must be addressed when designing a community-based CPR educational program.²⁵ A similar study exploring barriers in low-income Hispanic communities in Denver, CO, showed that distrust of law enforcement, language concerns, lack of recognition of cardiac arrest, and financial issues need to be addressed when trying to implement community-based programs in Hispanic communities.²⁶ Therefore, engaging such communities with the help of community leaders, development of free BCPR education programs, and programs in Spanish will likely improve BCPR rates.

The current study has several limitations related to the nature of observational data collection that include unmeasured confounding, reporting bias, selection bias, and recall bias. These results establish association, but not necessarily causality. We were not able to use individual-level socioeconomic data but used proxy data based on neighborhood characteristics that may have led to misclassification of socioeconomic status. Many of the cardiac arrests had unknown race (23.9%), where patient-level race was missing from the database; however, these arrests were able to be geocoded and were included as they had an index score

based on neighborhood characteristics. Determining the cause of a cardiac arrest in the field is problematic, so all nontraumatic causes were considered regardless of the presumed initial field cause that was chosen. This study did not include quality CPR data. There were no data on the duration of CPR or time to initiation of CPR. In addition, there is no long-term follow-up of survivors.

In conclusion, race/ethnicity and neighborhood characteristics are associated with the provision of BCPR in pediatric OHCA. Targeted CPR training for low-income, nonwhite majority, low-education neighborhoods may increase BCPR provision and improve OHCA outcomes in children.

Sources of Funding

CARES (Cardiac Arrest Registry to Enhance Survival) was funded by the US Centers for Disease Control and Prevention from 2004 to 2012. The program is now supported through private funding from the American Red Cross, the American Heart Association, Stryker Corporation, and in-kind support from Emory University. At present, the Centers for Disease Control and Prevention provides technical support and expertise for the program. This work was also supported by the Cardiac Center Clinical Research Core at Children's Hospital of Philadelphia.

Disclosures

None.

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