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BRIEF RESEARCH REPORT

Emergency Medical Services

Association of race and socioeconomic status with the rate of bystander-initiated CPR in Memphis

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Abstract

Study objective: This study evaluated the association of race and socioeconomic status with the rate of bystander cardiopulmonary resuscitation (CPR) in out-of-hospital cardiac arrest in Memphis, TN and compared it to 25 years prior.

Methods: This was a retrospective cross-sectional study of out-of-hospital cardiac arrest events in the Memphis area from 2012–2018. The primary outcome of interest was the provision of bystander CPR. Socioeconomic status was estimated using the Economic Hardship Index model. A generalized linear mixed model analysis was conducted.

Results: The overall rate of bystander CPR was 33.6%. White patients were more likely to receive bystander CPR compared to black patients (44.0% vs 29.8%, adjusted odds ratio [OR] = 1.70; 95% confidence interval [CI] = 1.40–2.05). Patients in areas of increased economic hardship were less likely to receive bystander CPR (OR = 0.713, 95% CI = 0.569–0.894). Overall bystander CPR rate increased by 18.7% over the past 25 years.

Conclusion: Despite significant increases in bystander CPR compared to 25 years ago, black individuals are still less likely to receive bystander CPR than white individuals in Memphis. Both race and socioeconomic status were independent predictors of the rate of bystander CPR. By using neighborhood demographics and the Economic Hardship Index, communities with low overall bystander CPR rates, such as Memphis, can focus limited resources on areas of greatest need and potential effectiveness.

1 | INTRODUCTION

1.1 | Background

Out-of-hospital cardiac arrest is a major public health concern that affects over 350,000 patients per year in the United States and is associated with significant mortality.[1] Survival after cardiac arrest has been increasing with advances in both out-of-hospital and hospital care but is still < 11% on average and much lower in some patient populations and geographic regions.[2] A significant part of regional variation in survival after cardiac arrest can be explained by variation in the rate of bystander-initiated cardiopulmonary resuscitation (CPR).[1] Previous studies have found an association between race and rates of bystander CPR in the community.[3,4] Similarly, multiple studies have also shown an independent effect of neighborhood socioeconomic level on the provision of bystander CPR.[5-7]

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1.2 | Importance

Despite the number of studies showing the effects of race and socioeconomic status on the rates of bystander CPR, we are unaware of studies that have compared current rates of bystander CPR with available historical figures in the same geographic region to evaluate changes over time. The association between race and bystander CPR has been measured previously in Memphis, TN, an area of black majority population with most living in lower than average socioeconomic conditions.[4,8]

1.3 | Goals of this investigation

We evaluated the association of race and other socioeconomic factors with the provision of bystander-initiated CPR during out-of-hospital cardiac arrest in Memphis, TN to determine if rates of bystander CPR have changed over time when compared to previously reported figures in the same geographic region 25 years prior.

2 | METHODS

2.1 | Study design

This study is a retrospective cross-sectional study of out-of-hospital cardiac arrest events in Memphis, TN. Cases of out-of-hospital cardiac arrest were identified in the Memphis Fire Department emergency medical services (EMS) catchment area by retrospective review of available incident records. Memphis Fire Department EMS is the sole provider of advanced life support services in the Memphis area and uses the ImageTrend Elite system (ImageTrend, Inc., Lakeville, MN), a commercial web-based incident database, for storage of patient records. Records are prospectively collected by responding EMS providers and submitted electronically to the online database. The study was approved by the University of Tennessee Health Science Center Institutional Review Board and waiver of informed consent was granted due to the retrospective collection and de-identified analysis of the collected data.

2.2 | Selection of participants

Records of cardiac arrest were queried from the database using the "Type of CPR Provided" variable with the presence of "Compressions" used as the initial inclusion criteria. Excluded were patients under the age of 18, those with suspected traumatic or non-cardiac etiology of cardiac arrest, and those in whom no resuscitative efforts were initiated by bystanders or EMS because they were judged to be dead at the scene. Cases that occurred in the presence of a healthcare provider or in a healthcare facility were also excluded. We included all cases between January 1, 2012 and December 31, 2018.

The Bottom Line

Community factors may influence out-of-hospital cardiac arrest survival. In this analysis of 2792 out-of-hospital cardiac arrests in Memphis, Tennessee, black patients and those from low socioeconomic status were less likely to receive bystander CPR.

2.3 | Outcomes

The primary outcome of interest was the provision of bystander CPR. Patient characteristics including age, sex, race, location of cardiac arrest, who witnessed the arrest, and who initiated CPR were collected from the incident report.

To link neighborhood-level characteristics to each incident, arrest location zip code tabulation areas were used to obtain values for socioeconomic factors of interest from the 2013–2017 American Community Survey prepared by the U.S. Census Bureau.[8] Neighborhood socioeconomic status was determined using the Economic Hardship Index, a model that combines 6 equally weighted factors associated with socioeconomic hardship to provide a single composite value that can be used to compare geographical areas. The 6 factors that make up this composite value include unemployment (percentage of the population who are unemployed), dependency (percentage of the population under the age of 18 and over the age of 64), education (percentage of persons over the age of 25 who have less than a high school education), income (income per capita), crowded housing (percentage of occupied housing with > 1 person per room), and poverty (percentage of families below the poverty line).[9] Economic Hardship Index values were adjusted to a 100-point scale with the degree of economic hardship increasing as the value increases.

2.4 | Data analysis

We used a generalized linear mixed model to evaluate the associations between arrest characteristics and the provision of bystander CPR. Non-significant variables were removed by step-wise elimination until only significant factors remained in the final model. Fixed effects included in the final model were race of the patient, age of the patient, EMS time to arrival at patient, witness status of arrest, and socioeconomic status based on Economic Hardship Index. The zip code tabulation areas of the arrest location was added as a random effect to evaluate for possible geographic clustering within the study population. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated for the fixed effects. A *P*-value of 0.05 was used as the cutoff for statistical significance. All statistical analyses were performed using SPSS (IBM SPSS Statistics for Windows, Version 24.0. IBM Corp., Armonk, NY).

TABLE 1 Baseline patient characteristics and location demographics by provision of bystander-initiated CPR

Characteristics	Overall(n = 2792)	Bystander CPR(n = 938)	No bystander CPR(n = 1854)
Age, years, mean (SD)	60.69 (16.70)	59.67 (16.80)	61.20 (16.64)
Sex, no. (%)			
Male	1605 (57.5)	539 (33.6)	1066 (66.4)
Female	1187 (42.5)	399 (33.6)	788 (66.4)
Race, no. (%)			
Black	2047 (73.3)	610 (29.8)	1437 (70.2)
White	745 (26.7)	328 (44.0)	417 (56.0)
Bystander-initiated AED, no. (%)	25 (0.9)	23 (92.0)	2 (8.0)
Arrest witnessed by, no. (%)			
Bystander witness	1490 (53.4)	577 (38.7)	913 (61.3)
No witness	1302 (46.6)	361 (27.7)	941 (72.3)
Initial rhythm with EMS, no. (%)			
Shockable rhythm (VF/VT)	557 (19.9)	225 (40.4)	332 (59.6)
Not shockable (aystole, PEA, other)	2235 (80.1)	713 (31.9)	1522 (68.1)
Location of arrest, no. (%)			
Public location	383 (13.7)	160 (41.8)	223 (58.2)
Private location	2409 (86.3)	778 (32.3)	1631 (67.7)
LUCAS device used, no. (%)	2075 (74.3)	708 (34.1)	1367 (65.9)
Time to arrival at patient, min, mean (SD)	10.82 (4.61)	10.53 (3.81)	10.96 (4.96)
Economic hardship index, median (IQR)	56.18 (45.58–69.96)	55.20 (39.50–65.03)	56.18 (45.58–69.96)
Economic Hardship Index, no. (%)			
High SES (Economic Hardship Index 12.66–56.18)	1502 (53.8)	555 (37.0)	947 (63.0)
Low SES (Economic Hardship Index 56.19–84.74)	1290 (46.2)	383 (29.7)	907 (70.3)

AED, automated external defibrillator; PEA, pulseless electrical activity; SES, socioeconomic status; VF/VT, ventricular fibrillation or ventricular tachycardia.

3 | RESULTS

Memphis Fire Department EMS responded to a total of 10,602 cases of cardiac arrest during the study period. A total of 2792 cases were included for final analysis after exclusion criteria. Overall, bystander CPR was performed in 938 cases (33.6%). Table 1 shows the baseline characteristics between groups according to provision of bystander CPR. Victims of out-of-hospital cardiac arrest who received bystander CPR were more likely to be younger in age, have their arrest witnessed, or be in a public place at the time of arrest. Patients who received bystander CPR were more likely to have a shockable initial rhythm or be treated with a public automated external defibrillator.

White individuals were much more likely to receive bystander CPR than black individuals in the study population overall (44.0% vs 29.8%, OR = 1.70, 95% CI = 1.40–2.05). The mean age of white patients was 60.41 years (SD = 18.18) compared to 60.79 years (SD = 16.13) for black patients. Both groups had similar incidence of bystander-witnessed cardiac arrest (52.1% for whites vs 53.8% for blacks) and the presence of a shockable initial rhythm (21.5% for whites vs 19.4% for blacks). White patients were more likely to be male (63.9% vs 55.2%) and have an arrest in a public place (17.7% vs 12.3%). Average EMS arrival times were similar between groups (10.72 minutes with SD 4.82 for white patients vs 10.85 minutes with SD 4.54 for black patients).

Individuals from lower socioeconomic areas (higher Economic Hardship Index) were less likely to receive bystander CPR when compared to those individuals in higher socioeconomic areas. When Economic Hardship Index values were divided into 2 groups by median Economic Hardship Index, the difference in bystander CPR rates between the higher socioeconomic status (Economic Hardship Index = 12.66–56.18) and the lower socioeconomic status (Economic Hardship Index = 56.19–84.74) was significant (OR = 1.40, 95% CI = 1.12–1.76). Median Economic Hardship Index values were different across racial groups as white patients (45.58, interquartile range [IQR] = 25.94–63.82) were more likely to have cardiac arrests in areas of lower Economic Hardship Index compared to black patients (56.23, IQR = 54.67–69.96).

Table 2 shows ORs with 95% CIs for factors associated with bystander CPR. At the individual level, the patient's age, race, witnessed status, initial rhythm, and time to EMS arrival were associated with an increased rate of bystander CPR. On the neighborhood level, the likelihood of bystander CPR decreased with increased Economic Hardship Index. Both race and socioeconomic status were independent predictors of bystander CPR without significant interaction between race and socioeconomic status.

TABLE 2 Model of factors associated with the provision of bystander CPR

Factor	OR (95% CI)
Individual level factors	
White race	1.70 (1.40–2.05)
Witnessed arrest	1.64 (1.39–1.94)
Shockable rhythm	1.27 (1.04–1.55)
Age	0.993 (0.989–0.998)
Time to patient	0.976 (0.958–0.995)
Neighborhood level factors	
Low socioeconomic status	0.713 (0.569–0.894)

CI, confidence interval; OR, odds ratio.

4 | LIMITATIONS

The main limitation of this study is the inability to compare to the previously published report. The previous dataset was unavailable for analysis, so there are potential unrecognized differences in the data over time that cannot be evaluated using summary comparison only. This study has several other limitations as well. First, similar to previous studies on race and bystander CPR, we had a substantial number of cases (499) that were missing demographic information and therefore excluded from analysis. Second, patients with a documented race that was not black or white were excluded from analysis due to the small number of cases (25). The race of the patient was assigned by the reporting EMS provider and there is potential bias that cannot be evaluated based on retrospective review of the records. Third, the Memphis Fire Department EMS database does not include hospital-level information so no conclusions about survival were made. Fourth, due to low numbers of cardiac arrests in some census tracts, postal codes were used instead of census tracts for determining neighborhood groupings. Although potentially underrecognizing neighborhood level effects, postal codes provide a convenient way to communicate areas of need with local government and community members when developing outreach plans. Finally, there was a lack of abstractor blinding to the results of interest when retrospectively collecting data. Routine data meetings were held between members of the study team to review collection and maintain data integrity.

5 | DISCUSSION

Bystander-initiated CPR rates in Memphis, TN have shown strong improvement over the past 25 years. Despite an 18.7% increase, from 14.9% to 33.6%, the overall bystander CPR rate continues to be below the national average of 39.2%.[2] When comparing available historical values from Brookoff et al[4] with current rates of bystander CPR, white patients showed an increase in bystander CPR rate of 22.6% compared to an increase of 20.0% in black patients. White individuals showed larger gains in bystander CPR rates when the cardiac arrest occurred in a private place (+30.4% vs +22.4%) or was unwitnessed (+22.1% vs +17.6%).[4] Black patients showed stronger increases in bystander CPR rates when the arrest was witnessed (+23.8% vs +22.7%) or occurred in a public place (+18.5% vs +9.1%).[4] Even with generalized gains in bystander CPR rates, the disparity between racial groups has not improved.

Memphis is an area of black majority population with below national average socioeconomic status based on median household income ($38,230 vs $57,652).[8] It has been shown previously in this population that race had a significant effect on whether a victim of out-of-hospital cardiac arrest received bystander CPR.[4] Studies of the Cardiac Arrest Registry to Enhance Survival have also shown differences in bystander CPR rates based on racial composition and an overrepresentation of black individuals in areas of low survival of out-of-hospital cardiac arrest.[3,6] Although both subgroups saw increases in rates of bystander CPR over time in our study, black patients are still much less likely to receive bystander CPR than white individuals.

Independent of racial differences, neighborhood socioeconomic status also appears to have an association with the provision of bystander CPR in cases of out-of-hospital cardiac arrest. Most studies of neighborhood effects on bystander CPR have used median household income as a proxy for socioeconomic status.[5-7] By using the Economic Hardship Index, the status of a neighborhood can be estimated based on a combination of factors instead of using a single data point. Patients in areas of the lowest socioeconomic status were much less likely to receive bystander CPR when compared to the highest status areas. Economic and social effects were not previously studied in our population, so conclusions about the effect of socioeconomic status on changes in bystander CPR rates over time cannot be made based on this single study. Further investigation is needed to determine if socioeconomic trends in a community have an effect on the bystander CPR rate over time.

Initiatives to improve bystander CPR rates in Memphis over the past 25 years have mostly been targeted at the general population. At the city level, dispatcher-assisted CPR is in widespread use today. To be effective, a caller must be able to describe the situation to the dispatcher on the line so that cardiac arrest can be recognized and appropriate instructions given. Those individuals who are less educated, have a language barrier or physical disability, or at extremes of age may be less likely to recognize and describe the situation to the dispatcher on an emergency call.[10] At the state level, CPR training became a Tennessee state requirement for graduation from high school in 2012. Areas with lower rates of high school education completion or increased elderly population may have fewer individuals who have been trained in CPR. Individuals may feel unable to perform CPR appropriately at a dispatcher's direction if they have never been trained in the first place. As part of a national campaign, the American Heart Association recommendation of compression-only CPR in 2008 may have played a part as it removed mouth-to-mouth as a barrier to performing CPR.[10] These initiatives are likely part of the reason that the overall bystander CPR rate has increased in Memphis.

Due to lack of neighborhood specificity, these general techniques have failed to close the gap between racial groups in the provision of bystander-initiated CPR. There have been no large-scale local training programs targeting areas of high necessity. A neighborhood-focused training approach could be effective at improving bystander CPR rates if targeted to communities based on racial and socioeconomic demographics. By determining a neighborhood's Economic Hardship Index and racial composition, cities and organizations can distribute training resources to areas of the highest need and greatest potential effect.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

JMJ and JEH conceived the study, collected data, and were responsible for statistical analysis. JRW supervised study design. JMJ and MFB drafted the manuscript. All authors contributed substantially to revision of the manuscript. JMJ takes responsibility for the paper as a whole.

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