Published in final edited form as:
Prehosp Emerg Care. 2009 ; 13(4): 478–486. doi:10.1080/10903120903144833.

SOCIOECONOMIC STATUS IS ASSOCIATED WITH PROVISION OF BYSTANDER CARDIOPULMONARY RESUSCITATION

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Abstract

Objective—Although socioeconomic status (SES) has been linked to multiple health outcomes, there have been few studies of the effect of SES on the provision of bystander cardiopulmonary resuscitation (CPR) during cardiac arrest events and no studies that we know of on the effect of SES on the provision of dispatcher-assisted bystander CPR. This study sought to define the relationship between SES and the provision of bystander CPR in an emergency medical system that includes dispatcher-provided CPR instructions.

Methods—This study was a retrospective, cohort analysis of cardiac arrests due to cardiac causes occurring in private residences in King County, Washington, from January 1, 1999, to December 31, 2005. We used the tax-assessed value of the location of the cardiac arrest as an estimate of the SES of potential bystanders as well as multiple measures from 2000 Census data (education, employment, median household income, and race/ethnicity). We also examined the effect of patient and system characteristics that may affect the provision of bystander CPR. Logistic regression models were used to analyze the association of these factors with two outcomes: the provision of bystander CPR with and without dispatcher assistance.

Results—Forty-four percent (1,151/2,618) of cardiac arrest victims received bystander CPR. Four hundred fifty-seven people (17.5% of the entire study population, 39.7% of those who received any bystander CPR) received CPR without telephone instructions. A total of 694 people received dispatcher-assisted bystander CPR (25.6% of the entire population, 60.4% of those receiving any bystander CPR). After adjusting for demographic and care factors, we found a strong association between the tax-assessed value of the cardiac arrest location and increased odds of the provision of bystander CPR without dispatcher instructions and bystander CPR with dispatcher assistance compared with no bystander CPR.

Conclusions—This study suggests that higher bystander SES is associated with increased rates of bystander CPR with and without dispatcher instructions. CPR training programs that target lower-SES communities and assessment of these training methods may be warranted.

Keywords

cardiopulmonary resuscitation (CPR); cardiac arrest; bystander CPR; out-of-hospital CPR; socioeconomic status

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The authors alone are responsible for the content and writing of the paper. The authors report no conflicts of interest. This study received no financial or material support from an outside agency or company.

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INTRODUCTION

Out-of-hospital sudden cardiac arrest is a leading cause of mortality in the United States and accounts for more than 50% of cardiovascular-related deaths.[1–3] Bystander cardiopulmonary resuscitation (CPR) can significantly improve outcomes from out-of-hospital cardiac arrest (OHCA).[4,5] Previous studies have shown an association between socioeconomic status (SES) and cardiac arrest outcomes. For example, lower community-based SES has been associated with higher incidence of sudden cardiac arrest,[6] and higher SES has been associated with improved survival from OHCA.[7] However, there are few studies on the effect of SES on the provision of bystander CPR.[8,9] If SES is related to bystander CPR, it could help target community training efforts.

Community-level measurements are often employed to investigate relationships between SES and public health outcomes. Additionally, community-level measurements have also been used as surrogates for individual-level characteristics.[10–13] We extend this idea to research the relationship between SES and the provision of bystander CPR. In addition to using neighborhood socioeconomic indicators, we also include the tax-assessed valuation of the location where the cardiac arrest occurred. This variable is used as a more precise surrogate of SES to compare with neighborhood SES.

This study sought to define the relationship between SES and the provision of bystander CPR in an emergency medical system that includes dispatcher-provided CPR instructions.

METHODS

Study Setting and EMS System

King County (excluding Seattle) has an area of approximately 2,000 square miles including urban, suburban, and rural areas. The population of King County, according to the 2000 Census, is approximately 1,200,000.[14] King County is served by a two-tiered emergency medical services (EMS) system. First-tier service is provided by firefighter–emergency medical technicians equipped with automated external defibrillators and second-tier service is provided by paramedics trained in advanced life support (ALS). First-tier providers arrive on scene an average of 5minutes after dispatch and paramedics arrive on scene approximately 5 minutes later.

The EMS system is activated by calling 9-1-1. Emergency medical dispatchers follow a specific protocol to identify cardiac arrest cases. In identified cases, both service tiers are dispatched simultaneously and the emergency dispatcher asks whether anyone on the scene knows how to perform CPR. If no one knows how to perform CPR, the dispatcher provides detailed instructions, which have been described previously.[15–17]

The telephone CPR program in the study area began in 1983. From 1983 to June 2004, dispatcher instructions included chest compressions and ventilation. Starting in June 2004, a large randomized control trial (RCT) began in the study area in which patients who were given dispatcher-assisted CPR could receive chest-compression-only or chest-compression-plus-ventilation CPR.

Study Population and Data Collection

We performed a retrospective, cohort study of OHCA due to cardiac causes among persons greater than 18 years of age in King County, Washington (excluding Seattle), from January 1, 1999, to December 31, 2005. We excluded arrests occurring after the arrival of EMS personnel because these patients would not have been eligible to receive bystander CPR. We also excluded arrests that occurred in medical offices or nursing homes (because workers at these facilities are presumably trained in CPR and would not need dispatcher assistance) and arrests that occurred in a public location.

Data on each cardiac event were collected from the King County EMS cardiac arrest surveillance system. Data in this registry are collected from a combination of forms filled out by EMS personnel at the scene of a response to a 9-1-1 call, dispatch recordings, hospital and/or death certificate records, and defibrillator downloads, as described previously.[18,19]

Exposure Measures

We studied how the SES of a bystander affects the provision of bystander CPR. Socioeconomic status is seen as a composite picture of a person's affluence by measuring educational attainment, mean income, occupation, and wealth.[13,20,21] Accurately measuring a bystander's SES necessarily requires interviewing bystanders at the incident scene, but this information is not collected as part of the cardiac arrest registry. Instead, we employed two surrogate measures for bystander SES: 1) SES based on the tax-assessed value of the location in which the arrest took place and 2) SES of the neighborhood in which the arrest occurred. For the purposes of this study, we assumed that the community-level census data linked to each incident location, as well as the property value of the incident location, accurately describe the SES of cardiac arrest patients, bystanders, and witnesses.

We used the tax-assessed property value for the year 2000 for each home or private residence in which a cardiac arrest occurred as a surrogate for the SES of bystanders who may have been present at the time of the arrest.[7] Tax-assessed valuation was obtained through the King County Assessor's Office by matching the reported incident address to addresses contained in the assessor's records. The value of any residence constructed after the year 2000 was adjusted for inflation to the valuation in year 2000 dollars. For arrests that occurred in residences with multiple dwellings, such as condominiums or apartment buildings, we calculated the value per unit by dividing the total assessed value of the building by the reported number of units. We divided the home-value and value-per-unit data into quartiles with the following ranges: first quartile ($2,200–$106,000), second quartile ($106,000–$149,000), third quartile ($150,000–$203,999), and fourth quartile ($204,000–$3,696,000).

Additionally, neighborhood-level characteristics were used to estimate the SES of bystanders. Neighborhood boundaries were defined by census tract borders. We determined the latitude and longitude of the reported incident address using ArcGIS software (ESRI, Redlands, CA), a method that has been shown to be comparable to the use of a commercial firm for mapping the event location.[22] We used this information to assign a census tract to each cardiac arrest location. All addresses that did not show a 100% match of address, street name, street direction, city, and zip code were manually entered into the U.S. Census American FactFinder23 to verify the correct census tract. Cases for which we could not confirm an address were excluded.

Community-level socioeconomic characteristics were assigned to each census tract using 2000 Census data. For each demographic variable, each census tract was assigned to a quartile based on the fraction of the population in that tract with the characteristic. The SES variables examined were percentage of the population in the census tract with one year or more of college education; percentage of the population aged 16 years or older who were employed; median household income; percentage of the population who were African American; percentage of the population who were Asian; and percentage of the population who were Hispanic or Latino.

We also controlled for patient and response characteristics that have been shown to affect the provision of bystander CPR.[24–27] These included patient age and gender; witnessed arrest (yes/no); first monitored cardiac rhythm; and EMS response time (time interval from 9-1-1 call receipt to first EMS arrival, either basic life support [BLS] or ALS). For those events missing data on EMS response time (n= 225), we imputed the median time from 9-1-1 call to first EMS arrival from all other cardiac arrests. Additionally, we controlled for the date of cardiac arrest (prior to the start of the RCT in June 2004 or during the RCT).

In addition to indicators of SES, we selected characteristics of the community that are measured by the Census that could affect the provision of bystander CPR. These factors were also assigned to quartile groups. Variables potentially affecting the provision of bystander CPR were population density (defined as the number of people per square mile in the census tract); percentage of the population in the census tract employed as health care practitioners; percentage of households in the tract that were linguistically isolated (defined as a household in which all members aged 14 years and over spoke a language other than English and no member spoke English "very well"); and average household size (defined as the number of people living in the house). We included a variable for the number of per-capita cardiac arrests as an additional control for any neighborhood sensitization effect related to the number of cardiac arrests in the area, which may influence awareness and thus incidence of bystander CPR.[8] This variable was calculated to the log 2. Therefore, an odds ratio (OR) calculated using this variable should be interpreted as the relative odds of receiving bystander CPR if the number of per-capita cardiac arrests is doubled.

Outcome Measures

We defined two outcomes of interest: the provision of bystander CPR without dispatcher assistance and dispatcher-assisted bystander CPR. In both cases, bystander CPR was defined as any attempt, regardless of duration, to provide chest compressions only or chest compressions plus ventilations by laypersons and other medical professionals not part of the EMS response to each incident. Other medical professionals may include physicians, registered nurses, and off-duty first responders.

We determined that CPR was attempted by review of dispatch tapes. When we heard clear evidence of CPR being performed (e.g., audible chest compressions or ventilations, the counting of chest compressions, or the caller's clearly stating that CPR was being done before EMS arrival), we coded that case as receiving bystander CPR. Dispatcher-assisted CPR occurred when the bystander performing CPR was clearly following the dispatcher's instructions, even if the bystander said he or she already knew CPR. Unassisted CPR occurred when we could hear evidence of CPR being performed before the dispatcher provided instructions or when it was clear that the bystander did not need instruction. If no evidence of CPR was heard, the case was coded as not receiving bystander CPR, even if dispatcher instructions were given. Written ALS and BLS incident reports were used to determine bystander CPR status in cases where dispatch tapes were unavailable. First responders are trained to report whether bystander CPR was given and whether dispatchers provided assistance based on what they observe at the scene and what they learn from interviewing bystanders.

Data Analysis

We performed descriptive and logistic regression analyses to describe the effect of SES and other factors on the provision of bystander CPR, as defined by the two outcomes described above. Descriptive statistics were used to describe each outcome based on patient and arrest characteristics. Logistic regression analysis explored the effect of each exposure variable on the odds of receiving bystander CPR with and without dispatcher assistance, compared with no bystander CPR. All exposure variables were included in the adjusted analysis. Odds ratios greater than 1 represent increased odds of receiving bystander CPR compared with no bystander CPR. Analyses were performed using SPSS 14.0 (SPSS, Inc., Chicago, IL). This study was approved by the University of Washington Human Subjects Committee.

RESULTS

There were 4,482 cardiac arrests from January 1, 1999, to December 31, 2005, that met our inclusion criteria. We were not able to confirm an incident address for 282 of these cases. We excluded 739 incidents that occurred in a clinic or nursing home and 647 arrests at a public location. Data on witnessed status, initial cardiac rhythm, or tax-assessed property value of the incident location were missing for 196 cases, leaving 2,618 cases in our study group (Fig. 1). Dispatch tapes were reviewed for 1,860 (71%) of these cases.

Cardiac arrests occurred in 248 of the 249 census tracts located in King County. In 2000, the population of census tracts in King County ranged from 1,244 to 8,751 with a mean of 4,714 (standard deviation [SD] ±1,409). Population density (population per square mile) of census tracts ranged from 4.9 to 9,793.3 with a mean of 3,266.0 (SD ± 2,166.5).

The demographic and arrest characteristics of the study population are shown in Table 1. Forty-four percent (1,151/2,618) of cardiac arrest victims received bystander CPR. Four hundred fifty-seven people (17.5% of the entire study population, 39.7% of those who received any bystander CPR) received CPR without telephone instructions. A total of 694 people received dispatcher-assisted bystander CPR (25.6% of the entire population, 60.4% of those receiving any bystander CPR). The percentage of cardiac arrest patients receiving dispatcher-assisted bystander CPR increased after initiation of the RCT (31.9% compared with 24.8% before—data not shown). The rate of unassisted bystander CPR also increased, but to a lesser extent (19.3% after initiation of the RCT compared with 16.9% before). The mean age of the study population was 65.4 years (SD ±16.3), and 44.4% of cases in the study population had a witnessed arrest.

Table 2 shows the unadjusted effect of each included characteristic on the two bystander CPR categories. In each case, the OR represents the odds of receiving that type of bystander CPR compared with no bystander CPR.

In unadjusted analysis, increased tax-assessed value of the cardiac arrest location, an initial cardiac rhythm of ventricular fibrillation (VF), having a cardiac arrest during the RCT, and an increased percentage of the census tract employed as health care workers (up to 4.8% compared with less than 2.6%) were associated with increased odds of receipt of bystander CPR without telephone instructions, to a level of $p < 0.05$. Age, the percentage of households linguistically isolated, and an increase in the percentage of the population who were Asian were associated with a decreased odds of the provision of bystander CPR without dispatcher assistance.

In addition to the positively associated variables mentioned above, a witnessed arrest, an increased average household size, a higher employment rate, and a higher median household income were associated with an increased odds of receiving dispatcher-assisted bystander CPR. The fraction of the population employed in health care was not associated with this outcome. The same factors associated with a decrease in the odds of bystander CPR without telephone instructions were also associated with a decrease in the odds of the provision of dispatcher-assisted bystander CPR, with the addition of increases in cardiac arrests per capita, population density, and the percentage of the population who were African American.

Table 3 shows ORs for each outcome compared with the provision of no bystander CPR, adjusted for all other variables in the model. For both outcomes, each quartile of tax-assessed property value was strongly associated with an increase in the odds of the provision of bystander CPR compared with the lowest quartile of assessed value. Census tracts in the second and third quartiles of the percentage of residents employed in health care showed increased odds of the provision of CPR without telephone instructions (but not dispatcher-assisted bystander CPR) compared with census tracts in the first quartile. Having a cardiac arrest during the RCT was positively associated with increased odds of both types of bystander CPR. None of the additional variables included in the model showed a significant association with either outcome in adjusted analysis (these variables not shown in Table 3).

DISCUSSION

Although SES has been linked to multiple health outcomes, there have been few studies of the effect of SES on the provision of bystander CPR during cardiac arrest events and no studies that we know of on the effect of SES on the provision of dispatcher-assisted bystander CPR. This study demonstrated that, in arrests that occur at a private residence, higher SES, as measured by the tax-assessed value of the property at which a cardiac arrest occurs, is associated with increased odds of the provision of bystander CPR both with and without dispatcher assistance. This association was present in each quartile of tax-assessed home value compared with the first quartile and remained after adjustment for patient and community factors that may affect each outcome. This strong and persistent association suggests that improved CPR training efforts aimed at low SES communities and telephone CPR programs that more effectively convince callers in low-income populations to perform CPR may be warranted.

Several studies have attempted to measure the effects of SES on the provision of bystander CPR in EMS systems that do not include telephone CPR instructions. A study by Iwashyna et al. conducted in Chicago concluded that receipt of CPR is less a function of SES and more a function of the racial integration of a neighborhood.[8] An "integrated" neighborhood was defined as "[a neighborhood] where more than 10% of the inhabitants were not of the majority race of that neighborhood." Very few census tracts in our study area met this definition, so we did not include this variable in our final model. However, the Iwashyna study did not include tax-assessed home valuation in its model of SES. The inclusion of that variable in this study may explain our finding of an association between SES and the provision of bystander CPR where no similar association was found by Iwashyna et al. The Chicago study also reported an association between the number of cardiac arrests per capita and the provision of bystander CPR. We did not find a similar association in our adjusted model.

A study by Vaillancourt et al.[9] found that, in cardiac arrests at a private residence, SES as measured by property value was a predictor of increased odds of bystander CPR provision. While our study confirmed this result, the EMS system serving our study area provided dispatcher-administered telephone CPR instructions, which was not the case in the Vaillancourt study. Thus, this study may be more applicable to the many communities that provide dispatcher-assisted CPR.

Several patient characteristics were also associated with the two outcomes in adjusted analysis. For bystander CPR without dispatcher assistance, there was approximately a 2% decrease in the odds of bystander CPR with every one-year increase in the patient's age and a 95% increase for an initial cardiac rhythm of VF. Similar associations were seen for dispatcher-assisted CPR, with the addition of a 30% decrease in the odds of CPR for male patients compared with female patients, and a 29% increase in the odds of CPR if it was a witnessed arrest. These results agree with the findings of several previous studies.[28,29] The Hauff et al. study found that one of the major factors hindering dispatchers from successfully providing telephone instructions was the inability of the bystander to move the patient to an appropriate CPR position, either by rolling or relocating the patient to the floor.[29] This may explain the finding that male patients were less likely to receive dispatcher-assisted CPR in our study population. Even though we did not have information on the weight of patients or their body position at the time of arrest, it is possible that the male patients in our population were heavier than the female patients or experienced cardiac arrest in locations such as chairs or beds that made it difficult to successfully provide dispatcher-assisted CPR.

A 2006 prospective study conducted in Michigan collected detailed information on bystanders, showing that educational attainment is correlated with increased provision of CPR in OHCA.[24] While our study suggested that educational attainment alone did not prove to be a reliable predictor of bystander CPR when used as a surrogate for SES, the Michigan study does support our conclusion that area-based measures are too imprecise to accurately reflect the SES of bystanders and victims. Moreover, our study does provide sufficient evidence to conclude that bystanders may be more willing to intervene in locations with higher SES based on the tax-assessed value per unit of the residence.

Interestingly, we found that the proportion of the population in a given census tract who are employed as health care workers was positively associated with the provision of bystander CPR without telephone instructions, but not the provision of dispatcher-assisted bystander CPR. This may indicate that, in areas with a higher percentage of health care workers, dispatchers are unable to begin giving telephone instructions because a bystander trained in CPR has already started performing CPR.

While many studies choose to employ a single measure of SES such as median household income or tax-assessed property value, we chose to include multiple measures of SES to more accurately capture the many facets of SES. Socioeconomic status as a predictor of health outcomes is often conceptualized as a composite of education, employment, income, and wealth.[20,21] Other studies have shown that the race of the victim influences the receipt of bystander CPR.[30–32] While the exact causal pathway has not been determined, it has been shown that the combined effects of these factors often influence individual health outcomes.[21] Therefore, in addition to our primary measure of wealth (tax-assessed property value), we also included census variables to capture the other aspects of SES and race that are believed to influence health.

Because demographic information about bystanders is not collected as part of King County's cardiac arrest surveillance system, our purpose in measuring community SES is to treat it as a surrogate for the SES of bystanders capable of assisting in a cardiac arrest emergency. We believe this purpose is most accurately accomplished by restricting our analysis to cardiac arrests that occurred in private residences. There are two reasons for this assumption.

First, applying the tax-assessed value of public locations that may be valued in the millions of dollars (such as malls, golf courses, and restaurants) would not accurately approximate the SES of the people populating those locations at the time of the cardiac arrest. On the other hand, tax-assessed value of a private residence may more accurately reflect the wealth and income of the owner of that property, as well as any friends or family that may happen to be at that location at the time of the cardiac arrest.

Second, arrests that occur in commercial areas may involve bystanders who live outside the census tract for that location. Similarly, census information does not account for commuter traffic such as those coming to an area for employment or recreation. Therefore, we believe that the use of census variables when applied to arrests occurring at a private location may more accurately approximate the SES of potential bystanders than would be the case if arrests at public locations were included.

Limitations and Future Research

Bystander CPR status was determined by listening to dispatch tapes. Because EMS providers cannot be present at the scene as a cardiac arrest is occurring, we considered the review of the dispatch tape the “gold standard” for determining bystander CPR status. The dispatch tape is a record of the incident as it occurred and, in most cases, clear evidence of the CPR being performed was heard on the tape. Dispatch tapes were not available for 29% of the cases described in this study, however. In these cases, written incident reports filled out by first responders at the scene of the arrest were used, possibly leading to misclassification. We do not believe that bystander CPR status would be classified differently based on SES and, thus, do not expect this to have been a source of bias in the associations we report.

Using tax-assessed values may not have led to a consistent estimation of the SES of bystanders across the entire study area. For example, the owner of a $200,000 house in a rural area may have a higher level of relative wealth compared with the owner of a house of the same value in an urban area. We were not able to control for this effect in this investigation. Future studies may be necessary to confirm that the associations we report here are due to relative differences in SES and not any differences in the provision of CPR in rural versus urban communities.

The RCT initiated in June 2004 may have had an effect on the public perception of CPR during the study period and the way in which CPR instructions were provided by dispatchers. The percentage of cardiac arrest patients receiving dispatcher-assisted bystander CPR increased from 24.8% before the initiation of the RCT to 31.9% after the trial started. This could indicate that dispatchers were more aggressive in providing CPR instructions after implementation of the RCT or that the option of chest-compression-only CPR was more agreeable to bystanders. We must await the results of the RCT to elucidate the exact reasons. We do not believe that the presence of the RCT affects the results reported here, however, since a more aggressive protocol or more agreeable CPR instructions would have been applied equally across the pool of potential bystanders. Therefore, we believe that the RCT would not have influenced bystanders based on SES and would not have biased the current analysis.

Finally, the purpose of this study was not to measure survival rates in the study population but merely to look at the provision of CPR prior to EMS arrival. As a result, we cannot conclude that the provision of bystander CPR with and without dispatcher assistance led to better patient outcomes in this population. Many studies have shown that the provision of bystander CPR is an important contributor to increased survival rates.[4,33,34] Therefore, efforts to increase rates of bystander CPR are likely justified, independent of the overall effect on survival rates.

CONCLUSIONS

We find that tax-assessed valuation is a precise predictor of bystander CPR provision and that cardiac arrest victims in higher-SES private locations are significantly more likely to receive bystander CPR both with and without dispatcher assistance than those occurring in dwellings in the lowest SES quartile. Regardless of the approach, innovative CPR training efforts aimed at low-SES communities and telephone CPR programs that more effectively convince callers in low-income populations to perform CPR may be warranted.

Acknowledgments

The authors thank David Markel and Tishawna Smith for their assistance in data collection as well as Dmitry Sharkov for his assistance in geocoding the incident locations. The authors also acknowledge Linda Becker for her assistance with the development of the cardiac arrest database and the emergency medical dispatchers, EMT firefighters, and paramedics of King County, WA, for their ongoing commitment to care and excellence in prehospital emergency care.

References

1. Rea TD, Eisenberg MS, Sinibaldi G, White RD. Incidence of EMS-treated out-of-hospital cardiac arrest in the United States. Resuscitation 2004;63:17–24. [PubMed: 15451582]
2. American Heart Association. Statistical fact sheet, 2008 update ”out of hospital cardiac arrest—statistics.”. [Accessed July 7, 2008]. Available at: http://www.americanheart.org/downloadable/heart/1200089895981FS27SDCA08.pdf
3. Myerburg, R.; Castellanos, A. Cardiac arrest and sudden cardiac death. In: Braumwald, E., editor. Heart Disease: A Textbook of Cardiovascular Medicine. Philadelphia, PA: Saunders; 1997. p. 742-749.
4. Cummins RO, Eisenberg MS, Hallstrom AP, Litwin PE. Survival of out-of-hospital cardiac arrest with early initiation of cardiopulmonary resuscitation. Am J Emerg Med 1985;3:114–119. [PubMed: 3970766]
5. Cummins RO, Eisenberg MS. Prehospital cardiopulmonary resuscitation. Is it effective? JAMA 1985;253:2408–2412. [PubMed: 3981769]
6. Reinier K, Stecker EC, Vickers C, Gunson K, Jui J, Chugh SS. Incidence of sudden cardiac arrest is higher in areas of low socioeconomic status: a prospective two year study in a large United States community. Resuscitation 2006;70:186–192. [PubMed: 16814445]
7. Clarke SO, Schellenbaum GD, Rea TD. Socioeconomic status and survival from out-of-hospital cardiac arrest. Acad Emerg Med 2005;12:941–947. [PubMed: 16204138]
8. Iwashyna TJ, Christakis NA, Becker LB. Neighborhoods matter: a population-based study of provision of cardiopulmonary resuscitation. Ann Emerg Med 1999;34(4 pt 1):459–468. [PubMed: 10499946]
9. Vaillancourt C, Lui A, De MV, Wells GA, Stiell IG. Socioeconomic status influences bystander CPR and survival rates for out-of-hospital cardiac arrest victims. Resuscitation 2008;79:417–423. [PubMed: 18951678]
10. Diez-Roux AV. Investigating neighborhood and area effects on health. Am J Public Health 2001;91:1783–1789. [PubMed: 11684601]
11. Geronimus AT, Bound J. Use of census-based aggregate variables to proxy for socioeconomic group: evidence from national samples. Am J Epidemiol 1998;148:475–486. [PubMed: 9737560]
12. Pickett KE, Pearl M. Multilevel analyses of neighbourhood socioeconomic context and health outcomes: a critical review. J Epidemiol Community Health 2001;55:111–122. [PubMed: 11154250]
13. Robert SA. Socioeconomic position and health: the independent contribution of community socioeconomic context. Annu Rev Sociol 1999;25:489–516.
14. U.S. Census Bureau. Census. 2000 [Accessed August 20, 2008]. Available at: http://www.census.gov
15. Carter WB, Eisenberg MS, Hallstrom AP, Schaeffer S. Development and implementation of emergency CPR instruction via telephone. Ann Emerg Med 1984;13(9 pt 1):695–700. [PubMed: 6465650]
16. Culley LL, Clark JJ, Eisenberg MS, Larsen MP. Dispatcher-assisted telephone CPR: common delays and time standards for delivery. Ann Emerg Med 1991;20:362–366. [PubMed: 2003662]
17. Eisenberg MS, Cummins RO, Litwin P, Hallstrom AP, Hearne T. Dispatcher cardiopulmonary resuscitation instruction via telephone. Crit Care Med 1985;13:923–924. [PubMed: 4053640]

18. Becker L, Gold LS, Eisenberg M, White L, Hearne T, Rea T. Ventricular fibrillation in King County, Washington: a 30-year perspective. Resuscitation 2008;79:22–27. [PubMed: 18687513]
19. Rea TD, Helbock M, Perry S, et al. Increasing use of cardiopulmonary resuscitation during out-of-hospital ventricular fibrillation arrest: survival implications of guideline changes. Circulation 2006;114:2760–2765. [PubMed: 17159062]
20. Daly MC, Duncan GJ, McDonough P, Williams DR. Optimal indicators of socioeconomic status for health research. Am J Public Health 2002;92:1151–1157. [PubMed: 12084700]
21. Diez-Roux AV, Kiefe CI, Jacobs DR Jr, et al. Area characteristics and individual-level socioeconomic position indicators in three population-based epidemiologic studies. Ann Epidemiol 2001;11:395–405. [PubMed: 11454499]
22. Ward MH, Nuckols JR, Giglierano J, et al. Positional accuracy of two methods of geocoding. Epidemiology 2005;16:542–547. [PubMed: 15951673]
23. U.S. Census Bureau. American FactFinder. [Accessed August 20, 2008]. Available at: http://factfinder.census.gov/servlet/AGSGeoAddressServlet?_lang=en&_programYear=50&_treeId=420
24. Swor R, Khan I, Domeier R, Honeycutt L, Chu K, Compton S. CPR training and CPR performance: do CPR-trained bystanders perform CPR? Acad Emerg Med 2006;1:596–601. [PubMed: 16614455]
25. Holmberg M, Holmberg S, Herlitz J. Factors modifying the effect of bystander cardiopulmonary resuscitation on survival in out-of-hospital cardiac arrest patients in Sweden. Eur Heart J 2001;22:511–519. [PubMed: 11320981]
26. Brookoff D, Kellermann AL, Hackman BB, Somes G, Dobyns P. Do blacks get bystander cardiopulmonary resuscitation as often as whites? Ann Emerg Med 1994;24:1147–1150. [PubMed: 7978598]
27. Cowie MR, Fahrenbruch CE, Cobb LA, Hallstrom AP. Out-of-hospital cardiac arrest: racial differences in outcome in Seattle. Am J Public Health 1993;83:955–959. [PubMed: 8328616]
28. Rea TD, Eisenberg MS, Culley LL, Becker L. Dispatcher-assisted cardiopulmonary resuscitation and survival in cardiac arrest. Circulation 2001;104:2513–2516. [PubMed: 11714643]
29. Hauff SR, Rea TD, Culley LL, Kerry F, Becker L, Eisenberg MS. Factors impeding dispatcher-assisted telephone cardiopulmonary resuscitation. Ann Emerg Med 2003;42:731–737. [PubMed: 14634595]
30. Chu K, Swor R, Jackson R, et al. Race and survival after out-of-hospital cardiac arrest in a suburban community. Ann Emerg Med 1998;31:478–482. [PubMed: 9546017]
31. Sayegh AJ, Swor R, Chu KH, et al. Does race or socioeconomic status predict adverse outcome after out of hospital cardiac arrest: a multi-center study. Resuscitation 1999;40:141–146. [PubMed: 10395396]
32. Vadeboncoeur TF, Richman PB, Darkoh M, Chikani V, Clark L, Bobrow BJ. Bystander cardiopulmonary resuscitation for out-of-hospital cardiac arrest in the Hispanic vs the non-Hispanic populations. Am J Emerg Med 2008;26:655–660. [PubMed: 18606316]
33. Holmberg M, Holmberg S, Herlitz J. Effect of bystander cardiopulmonary resuscitation in out-of-hospital cardiac arrest patients in Sweden. Resuscitation 2000;47:59–70. [PubMed: 11004382]
34. Swor RA, Jackson RE, Cynar M, et al. Bystander CPR, ventricular fibrillation, and survival in witnessed, unmonitored out-of-hospital cardiac arrest. Ann Emerg Med 1995;25:780–784. [PubMed: 7755200]

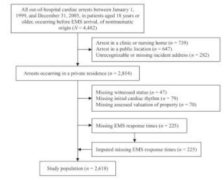

FIGURE 1.
Determination of study population. EMS = emergency medical services.

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TABLE 1

Demographic and Arrest Characteristics by Cardiopulmonary Resuscitation Group

Characteristic	No Bystander CPR (*n* = 1,467)	Bystander CPR Categories: Bystander CPR without Dispatcher Assistance (*n* = 457)	Bystander CPR Categories: Dispatcher-Assisted Bystander CPR (*n* = 694)	Any Bystander CPR Sum of the Two Bystander CPR Categories (*n* = 1,151)
Age—mean (±SD), years	67.2 (±16.3)	62.3 (±16.6)	63.7 (±15.6)	63.2 (±16.0)
Gender—male, *n* (%)	946 (64.5)	295 (64.6)	414 (59.7)	709 (61.6)
Witnessed arrest, *n* (%)	599 (40.8)	207 (45.3)	349 (50.3)	556 (48.3)
Initial cardiac rhythm VF, *n* (%)	338 (23.0)	162 (35.4)	246 (35.4)	408 (35.4)
EMS response time—mean (±SD), min*	5.9 (±2.5)	6.0 (±2.3)	6.1 (±2.3)	6.1 (±2.3)
Cardiac arrests during RCT, *n* (%)†	311 (21.2)	123 (26.9)	203 (29.3)	326 (28.3)

*Interval from receipt of 9-1-1 call to arrival of first EMS unit on the scene.

†June 1, 2004, to December 31, 2005.

CPR = cardiopulmonary resuscitation; EMS = emergency medical services; RCT = randomized controlled trial; SD = standard deviation; VF = ventricular fibrillation.

TABLE 2

Unadjusted Odds of Receiving Bystander Cardiopulmonary Resuscitation Compared with No Bystander Cardiopulmonary Resuscitation (n = 2,814)

		Bystander CPR without Dispatcher Assistance (n = 457)		Dispatcher-Assisted Bystander CPR (n = 694)	
	Characteristic	**Unadjusted OR (95% CI)**	**p-Value**	**Unadjusted OR (95% CI)**	**p-Value**
Individual OHCA variables	Age[*]	0.98 (0.98–0.99)	<0.001	0.99 (0.98–0.99)	<0.001
	Gender—male	1.00 (0.80–1.25)	0.98	0.81 (0.68–0.98)	0.03
	Witnessed arrest	1.20 (0.97–1.48)	0.09	1.47 (1.22–1.76)	<0.001
	Cardiac rhythm (VF)	1.83 (1.46–2.30)	<0.001	1.83 (1.51–2.23)	<0.001
	Time from 9-1-1 call to EMS arrival[†]	1.02 (0.98–1.06)	0.29	1.04 (1.00–1.07)	0.06
Individual measure of SES	Tax-assessed property value of arrest location				
	<$106,000	Referent	Referent	Referent	Referent
	$106,000–$149,999	1.48 (1.09–2.01)	0.01	1.67 (1.29–2.17)	<0.001
	$150,000–$203,999	1.35 (0.99–1.83)	0.06	1.49 (1.15–1.94)	0.003
	$204,000–$3,696,000	1.71 (1.27–2.31)	<0.001	1.65 (1.27–2.15)	<0.001
Factors possibly affecting bystander CPR provision	Cardiac arrests per capita (log base 2)	0.90 (0.76–1.07)	0.23	0.82 (0.71–0.95)	0.008
	Cardiac arrest during RCT[‡]	1.40 (1.08–1.74)	0.01	1.54 (1.25–1.89)	<0.001
	Population density[§]				
	1st Quartile	Referent	Referent	Referent	Referent
	2nd Quartile	0.84 (0.63–1.13)	0.12	0.73 (0.56–0.94)	0.02
	3rd Quartile	0.80 (0.59–1.07)	0.25	0.78 (0.61–1.01)	0.06
	4th Quartile	0.70 (0.52–0.94)	0.02	0.78 (0.61–1.01)	0.06
	Percent of population employed as health care practicioners[§]				
	0.0%–2.5%	Referent	Referent	Referent	Referent
	2.6%–3.5%	1.49 (1.10–2.02)	0.01	1.04 (0.80–1.34)	0.78
	3.6%–4.8%	1.43 (1.06–1.93)	0.02	1.03 (0.80–1.33)	0.81
	4.9%–13.5%	1.24 (0.91–1.68)	0.18	1.04 (0.81–1.34)	0.73
	Percent of households that are linguistically isolated[§]				
	0.0%–1.4%	Referent	Referent	Referent	Referent
	1.5%–3.6%	0.68 (0.50–0.91)	0.009	0.77 (0.60–0.99)	0.04

	Characteristic	Bystander CPR without Dispatcher Assistance (n = 457)		Dispatcher-Assisted Bystander CPR (n = 694)	
		Unadjusted OR (95% CI)	p-Value	Unadjusted OR (95% CI)	p-Value
	3.7%–6.5%	0.59 (.044–0.79)	<0.001	0.70 (0.54–0.90)	0.005
	6.5%–36.9%	0.63 (0.47–0.85)	0.002	0.61 (0.47–0.79)	<0.001
	Average household size§				
	1st Quartile	Referent	Referent	Referent	Referent
	2nd Quartile	1.13 (0.84–1.52)	0.42	1.26 (0.97–1.64)	0.09
	3rd Quartile	1.14 (0.84–1.54)	0.41	1.57 (1.21–2.03)	0.001
	4th Quartile	1.26 (0.94–1.69)	0.13	1.45 (1.12–1.88)	0.005
Community-based measures of SES	Percent of population with one year or more of college education§				
	20.6%–47.2%	Referent	Referent	Referent	Referent
	47.3%–56.9%	0.96 (0.71–1.29)	0.78	1.20 (0.93–1.55)	0.17
	57.0%–69.3%	1.00 (0.74–1.34)	1.00	1.15 (0.89–1.49)	0.28
	69.4%–92.0%	1.10 (0.82–1.48)	0.52	1.29 (1.00–1.67)	0.05
	Percent of population 16 years or older who are employed§				
	44.2%–66.6%	Referent	Referent	Referent	Referent
	66.7%–69.8%	1.05 (0.78–1.42)	0.74	1.08 (0.83–1.40)	0.58
	69.9%–73.2%	1.24 (0.92–1.66)	0.16	1.31 (1.01–1.70)	0.04
	73.3%–83.0%	1.22 (0.91–1.65)	0.19	1.36 (1.05–1.76)	0.02
	Median household income§				
	$16,185–$43,990	Referent	Referent	Referent	Referent
	$43,991–$55,900	0.82 (0.60–1.11)	0.19	1.21 (0.93–1.57)	0.15
	$55,901–$67,436	1.32 (0.99–1.76)	0.06	1.42 (1.09–1.85)	0.008
	$67,437–$133,756	1.12 (0.83–1.50)	0.46	1.45 (1.12–1.88)	0.005
	Percent of population who are African American§				
	0.0%–0.9%	Referent	Referent	Referent	Referent
	1.0%–2.8%	0.81 (0.61–1.09)	0.16	0.77 (0.60–0.99)	0.04
	2.9%–6.5%	0.70 (0.52–0.94)	0.02	0.75 (0.58–0.96)	0.02
	6.6%–32.0%	0.76 (0.56–1.02)	0.06	0.74 (0.57–0.95)	0.02
	Percent of population who are Asian§				

Characteristic	Bystander CPR without Dispatcher Assistance (n = 457)		Dispatcher-Assisted Bystander CPR (n = 694)	
	Unadjusted OR (95% CI)	p-Value	Unadjusted OR (95% CI)	p-Value
0.0%–5.0%	Referent	Referent	Referent	Referent
5.1%–9.4%	0.73 (0.54–0.97)	0.03	0.79 (0.61–1.02)	0.08
9.5%–13.0%	0.69 (0.52–0.93)	0.01	0.84 (0.65–1.08)	0.17
13.1%–38.4%	0.58 (0.43–0.77)	<0.001	0.70 (0.54–0.91)	0.007
Percent of population who are Hispanic/Latino[§]				
0.0%–2.9%	Referent	Referent	Referent	Referent
3.0%–4.4%	1.02 (0.76–1.36)	0.91	1.20 (0.93–1.54)	0.16
4.5%–7.5%	0.81 (0.60–1.09)	0.16	0.85 (0.66–1.10)	0.23
7.6%–23.2%	0.81 (0.60–1.08)	0.15	0.72 (0.55–0.93)	0.01

[*] Per one-year increase in patient age.

[†] Per 1-minute increase in EMS response time.

[‡] June 1, 2004, to December 31, 2005.

[§] Based on 2000 Census data for each census tract in which a cardiac arrest occurred. Categories represent quartile groups for each characteristic.

CI = confidence interval; CPR = cardiopulmonary resuscitation; EMS = emergency medical services; OHCA = out-of-hospital cardiac arrest; OR = odds ratio; RCT = randomized controlled trial; SES = socioeconomic status; VF = ventricular fibrillation.

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TABLE 3

Adjusted Odds of Receiving Bystander Cardiopulmonary Resuscitation Compared with No Bystander Cardiopulmonary Resuscitation (*n* = 2,814)

	Bystander CPR without Dispatcher Assistance (*n* = 457)		Dispatcher-Assisted Bystander CPR (*n* = 694)	
Characteristic	**Adjusted‡ OR (95% CI)**	**p-Value**	**Adjusted‡ OR (95% CI)**	**p-Value**
Age*	0.98 (0.97–0.99)	<0.001	0.99 (0.98–0.99)	<0.001
Gender—male	0.88 (0.70–1.12)	0.30	0.70 (0.57–0.86)	<0.001
Witnessed arrest	1.02 (0.80–1.29)	0.88	1.29 (1.05–1.58)	0.01
Cardiac rhythm (VF)	2.00 (1.55–2.59)	<0.001	1.82 (1.46–2.27)	<0.001
Time from 9-1-1 call to EMS arrival†	1.01 (0.97–1.06)	0.62	1.03 (0.99–1.07)	0.22
Tax-assessed property value of arrest location				
<$106,000	Referent	Referent	Referent	Referent
$106,000–$149,999	1.62 (1.17–2.24)	0.004	1.72 (1.31–2.27)	<0.001
$150,000–$203,999	1.48 (1.06–2.07)	0.02	1.50 (1.13–1.99)	0.006
$204,000–$3,696,000	1.96 (1.38–2.80)	<0.001	1.61 (1.18–2.21)	0.003
Date of cardiac arrest				
Before RCT	Referent	Referent	Referent	Referent
After RCT started	1.44 (1.11–1.85)	0.005	1.58 (1.27–1.96)	<0.001
Percent of population employed as health care practitioners				
0%–2.5%	Referent	Referent	Referent	Referent
2.6%–3.5%	1.68 (1.19–2.38)	0.003	1.00 (0.75–1.34)	0.98
3.6%–4.8%	1.67 (1.17–2.39)	0.005	0.95 (0.71–1.28)	0.73
4.9%–13.5%	1.35 (0.90–2.03)	0.15	0.91 (0.65–1.27)	0.58

*Per one-year increase in patient age.

†Per 1-minute increase in EMS response time.

‡Adjusted for all variables in the model, including the following (not shown): cardiac arrests per capita, population density, percentage of households linguistically isolated, household size, education, employment, median household income, percentage of population that are African American, percentage of population that are Asian, and percentage of population that are Hispanic or Latino.

CI = confidence interval; CPR = cardiopulmonary resuscitation; EMS = emergency medical services; OHCA = out-of-hospital cardiac arrest; OR = odds ratio; RCT = randomized controlled trial; SES = socioeconomic status; VF = ventricular fibrillation.