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Clinical paper

Impact of neighbourhood socio-economic status on bystander cardiopulmonary resuscitation in Paris[☆]

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ABSTRACT

Background: No European data currently describe the relation between neighbourhood socio-economic status (SES) and rates of out-of-hospital cardiac arrest (OHCA) bystander cardiopulmonary resuscitation (CPR). This study aims to analyse this effect with a robust deprivation index.

Methods: Data about all OHCA in Paris were collected prospectively between 2000 and 2010. A geographical neighbourhood unit was assigned to each case. Median household income, and rates of blue-collar workers, unemployment, and adults without high school diplomas were selected as SES characteristics and used to classify neighbourhoods as low SES or higher SES. We analysed the relationship between neighbourhood SES characteristics and the probability of receiving bystander CPR.

Results: Of the 4009 OHCA with mappable addresses recorded, 777 (19.4%) received bystander CPR. Compared to OHCA who did not receive bystander CPR, those receiving CPR were significantly more likely to have occurred in public locations, have had a witness to their OHCA, and not to have collapsed in a low SES neighbourhood, or in a neighbourhood with a median household income in the lowest quartile and with rates of no high school diplomas and blue-collar workers in the highest quartile. In the multilevel analyses, bystander CPR provision was significantly less frequent in low than in higher SES neighbourhoods (OR 0.85; 95% confidence interval [CI] 0.72–0.99).

Q4 **Conclusion:** In the city of Paris, OHCA victims were less likely to receive bystander CPR in low SES neighbourhoods. These first European data are consistent with observations in North America and Asia.

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Introduction

Out-of-hospital cardiac arrest (OHCA), with a global survival rate around 7%, is a major public health concern.¹ Early bystander cardiopulmonary resuscitation (CPR) is associated with higher survival rates for OHCA victims.^{2,3} Despite major efforts over the past decade in research, public information campaigns, financial invest-

ment, and new regulations to encourage bystander CPR initiation and early defibrillation, bystander CPR rates remain low in many communities.^{2,4–6}

Socio-economic status (SES) is a well-known determinant of health outcomes, coronary disease incidence, and mortality.^{7–9} Recent studies in North America and Asia report lower bystander CPR rates in deprived areas. These studies defined deprivation by various criteria, including household income, racial and ethnic composition, and real estate prices.^{10–14} Nonetheless, a robust deprivation index that reflects various dimensions of SES (occupation, income, and education level) is required to confirm that people with OHCA in deprived areas are less likely to receive bystander

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CPR.^{9,15} Moreover, no European data describe the effect of neighbourhood SES on this type of bystander CPR.

The city of Paris provides an excellent setting for testing this hypothesis because of its wide socio-economic disparities.¹⁶ This study was therefore conducted in Paris and sought to determine the relation between low SES neighbourhood and bystander CPR initiation rates.

Methods

Study setting

We analysed data from a prospective registry of all OHCA attended by emergency medical services (EMS) personnel in Paris, France between January 2000 and July 2010. Detailed information about this registry has been previously reported.¹⁷ The city of Paris is densely populated with 2,275,000 inhabitants, and the EMS is a two-tiered response system: a basic life support tier provided by firefighters of the Brigade de Sapeurs Pompiers de Paris, who can apply automated external defibrillation (AED), and an advanced cardiac life support tier served by ambulance teams comprising an emergency physician, a nurse, and an ambulance driver (Service d'Aide Médicale Urgente, SAMU).¹⁸

Population study

OHCA was defined as a sudden death with a resuscitation attempted by EMS in the absence of an obvious extracardiac cause (such as a drug overdose, suicide, trauma, hypoxia, or stroke).¹⁹ OHCA data were prospectively recorded according to the Ustein style with the exact address and the category of location where the event occurred.²⁰

This study included OHCA occurring in streets, public areas, private facilities, and private dwellings. The analysis excluded cases with incomplete addresses that could not be geocoded and without information about bystander CPR.

Study design

Patients' characteristics, including age, sex, known cardiovascular risk factors, whether the collapse was witnessed, time from EMS call to AED application by EMS team, category of location (private or public settings), time of OHCA, and survival rate to hospital admission were obtained from our database. We used neighbourhood SES characteristics as surrogate for bystander SES since the registry did not collect bystanders' individual SES.

The availability of OHCA addresses enabled a census tract to be assigned to each participant (geocoding). We used Batch Geocoder[®] to convert OHCA addresses into mappable coordinates, which were then plotted into a geographic information system (GIS) software program, Arcgis (ESRI, Redlands, California). In France, the smallest available census tracts defined by the French National Institute for Statistics and Economic Studies (INSEE) are housing blocks regrouped for statistical information, or *Ilots Regroupés pour l'Information Statistique* (IRIS). TIRIS, which are formed by a group of IRIS (usually 3) were used as census tracts in this study. Thus, 81 TIRIS were identified in Paris.

SES is a composite of different dimensions including occupation, income, and education, reflecting individual or family economic and social position in relation to others. There is no consensus about the variables most relevant to SES, and studies examining associations between SES and health outcomes use a variety of different indicators.^{10,12,21–23} INSEE provides a large number of socio-economic indicators. These indicators are calculated using data collected from 8% of households each year during five years.

We used data from 2009 which reflect in fact the five years period before. In this study, we selected the following relevant indicators of different ecological dimensions of SES for each TIRIS: median household income, the percentage of blue-collar workers in the working population, the unemployment rate, and the percentage of adults without high school diplomas.^{9,24} The median household income is a positive indicator of SES, and the last three variables are negative indicators. Since a single indicator could not accurately reflect the SES, we used these four components to classify neighbourhood SES into two categories: low and higher SES. For the median household income, the lowest quartile, i.e., with an upper limit of 31,000 euros (€)/year, was considered a component of low SES. For the rates of blue-collar workers, unemployment, and adults without high school diplomas, the highest quartiles, with lower limits respectively of 9%, 9% and 12% were further components of low SES. Thus, for each TIRIS, a low SES neighbourhood was defined by the association of all these criteria: a median household income \leq €31,000/year, a blue-collar worker rate $>$ 9%, an unemployment rate $>$ 9%, and a rate of adults without high school diplomas $>$ 12%. Other TIRIS, which did not meet all these criteria, were considered higher SES neighbourhoods.

Statistical analyses

The primary outcome was the performance of CPR by bystanders.

We reported continuous variables as means (\pm SD) and categorical variables as numbers (proportions). We used Student's t-test for continuous variables and the Chi-square test or Fisher's exact test for categorical variables as appropriate. Odds ratios (ORs) and their 95% confidence intervals (CI) were calculated. All tests were two-tailed, and P values of less than 0.05 were considered to indicate statistical significance.

We used a two-level hierarchical logistic regression model that took individual-level and neighbourhood-level variables into account to determine the association of neighbourhood SES with the performance of bystander CPR. Individual-level characteristics were added to the model as fixed effects and the TIRIS were added as random effects to examine their independent contributions. Interaction terms between variables were assessed. Then, a two-level hierarchical logistic regression model was used to determine the association of neighbourhood SES with survival.

All data were analysed at INSERM, Unit 970, Cardiovascular Epidemiology and Sudden Death Expertise Centre, Paris, with SAS version 9.4 (SAS Institute Inc., Cary, NC, USA).

Results

OHCA characteristics according to bystander CPR status

During the study period, 8234 OHCA occurred in Paris; 5296 were considered for resuscitation, and 4176 OHCA were presumed to have a cardiac cause. The global incidence of cardiac arrest was 36 cases per 100,000 population per year. Complete addresses and bystander CPR status were available for 4009 OHCA that were finally geocoded and included in this analysis (Fig. 1): 777 (19.4%) received bystander CPR in the field.

Table 1 reports OHCA characteristics according to bystander CPR. Bivariate analysis showed important differences between OHCA victims who did and did not receive bystander CPR. Compared to individuals with OHCA who did not receive bystander CPR, those who did were more likely to be male (74% vs 68%, $p < 0.002$), younger (mean age 64 vs 68, $p < 0.0001$), in a public place (56% vs 29%, $p < 0.0001$) from 0600 to 2400 (86% vs 82%, $p < 0.001$), and to have a shockable rhythm (60% vs 38%, $p < 0.0001$). History of car-

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