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CLINICAL RESEARCH
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Discriminatory cardiac arrest care? Patients with low socioeconomic status receive delayed cardiopulmonary resuscitation and are less likely to survive an in-hospital cardiac arrest

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Aims

Individuals with low socioeconomic status (SES) face widespread prejudice in society. Whether SES disparities exist in treatment and survival following in-hospital cardiac arrest (IHCA) is unclear. The aim of the current retrospective registry study was to examine SES disparities in IHCA treatment and survival, assessing SES at the patient level, and adjusting for major demographic, clinical, and contextual factors.

Methods and results

In total, 24 217 IHCAs from the Swedish Register of Cardiopulmonary Resuscitation were analysed. Education and income constituted SES proxies. Controlling for age, gender, ethnicity, comorbidity, heart rhythm, aetiology, hospital, and year, primary analyses showed that high (vs. low) SES patients were significantly less likely to receive delayed cardiopulmonary resuscitation (CPR) (highly educated: OR = 0.89, and high income: OR = 0.98). Furthermore, patients with high SES were significantly more likely to survive CPR (high income: OR = 1.02), to survive to hospital discharge with good neurological outcome (highly educated: OR = 1.27; high income: OR = 1.06), and to survive to 30 days (highly educated: OR = 1.21; and high income: OR = 1.05). Secondary analyses showed that patients with high SES were also significantly more likely to receive prophylactic heart rhythm monitoring (highly educated: OR = 1.16; high income: OR = 1.02), and this seems to partially explain the observed SES differences in CPR delay.

Conclusion

There are clear SES differences in IHCA treatment and survival, even when controlling for major sociodemographic, clinical, and contextual factors. This suggests that patients with low SES could be subject to discrimination when suffering IHCA.

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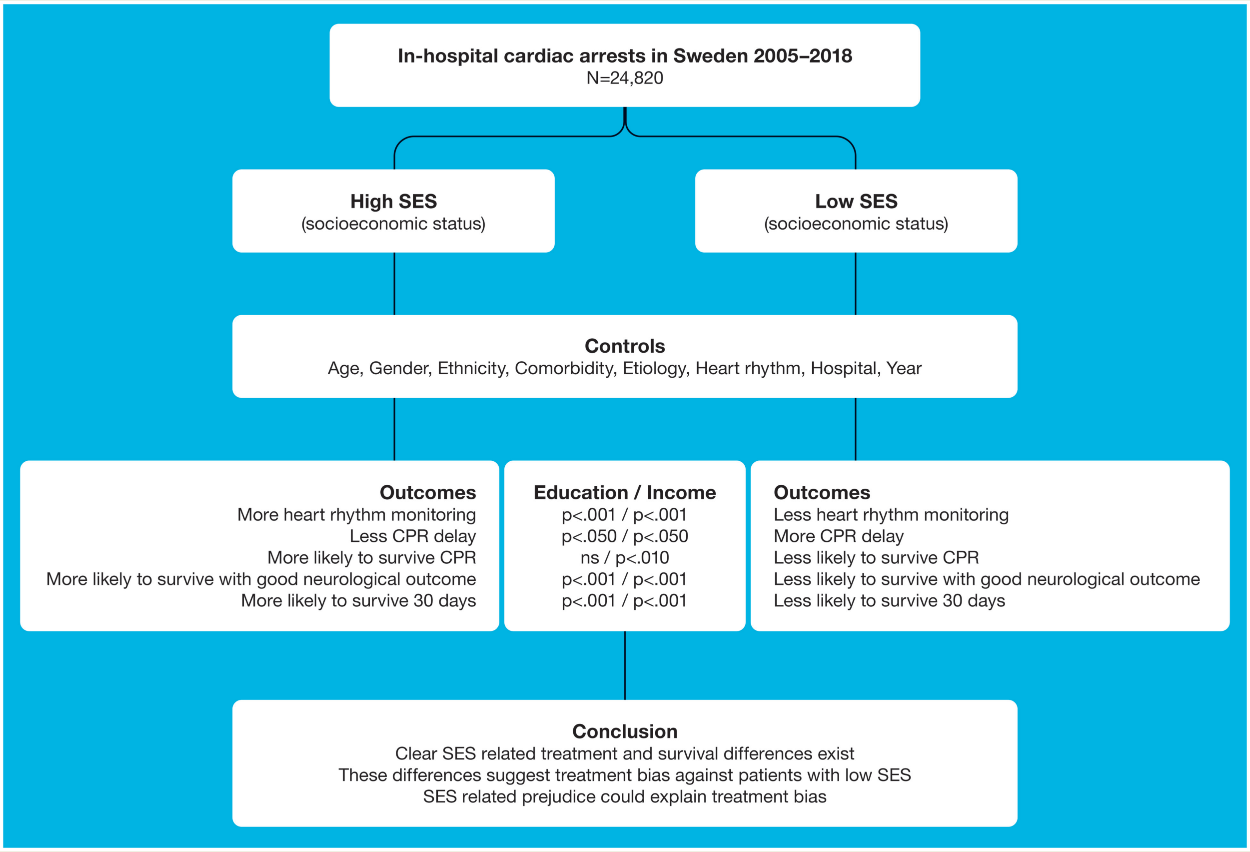
Graphical Abstract



Keywords Socioeconomic status • In-hospital cardiac arrest • Cardiopulmonary resuscitation • Survival • Discrimination

Introduction

Sudden cardiac arrest (CA) is one of the leading causes of death in the Western world, and around 1 million people are estimated to suffer from CA annually in North America and Europe together.[1] Given its high prevalence, detecting, explaining, and combating group inequalities in CA treatment and survival seems particularly important. Numerous studies have examined the association between socioeconomic status (SES) and survival after out-of-hospital cardiac arrests (OHCA). This research has generally found that patients with higher SES are more likely to survive OHCA,[2–8] although some studies do not report a relationship.[9,10] Patients with higher SES appear to be more likely to receive bystander cardiopulmonary resuscitation (CPR), which might partly explain the positive overall relationship between SES and survival after OHCA.[6,11]

Whether there are SES disparities in relation to in-hospital cardiac arrest (IHCA), however, is unclear. A recent review of the small number of studies ($N = 6$) on the association between SES and IHCA outcomes reveals inconclusive results.[12] The included studies have primarily investigated outcomes like survival and neurological status at hospital discharge, leaving potential treatment differences largely unexplored. Moreover, most studies have not adjusted for important medical confounders (e.g. comorbidity), which is problematic considering that lower SES is associated with poorer health.[13] As with most OHCA research, another limitation concerns the lack of adjustment for the patient's racial/ethnic background, which is problematic considering the robust association between SES and race/ethnicity.[9,10] Because race/ethnicity has been found to predict survival after both IHCA and OHCA,[14–16] it could potentially confound any uncovered SES difference in treatment and survival. Additionally, existing IHCA studies have primarily originated from the USA. To our knowledge, no European study on SES and IHCA has been reported. The lack of knowledge about the role of patient SES in the context of IHCA is noteworthy considering that IHCA is common, with an estimated incidence between 1 and 5 cases per 1000 hospital admissions.[17]

Compared with OHCA, IHCA should put researchers in a better position to study the sources of SES differences in survival. Because the afflicted patients are already in the hospital, an association between CA treatment and survival should less likely be due to structural SES differences in access to care (e.g. proximity of emergency medical services).[14] Furthermore, there should be more extensive, reliable, information about the patient and the IHCA event, giving researchers more control over potential SES confounding factors. Clarifying the sources of SES disparities is important for the development of successful interventions aimed at combating group inequalities. Socioeconomic status disparities in CA survival produced by differences in access to cardiopulmonary resuscitation (CPR) trained bystanders, underlying ethnicity, or pre-existing comorbidities, require different types of interventions than do survival differences caused by medical staff providing differential treatment solely based on patient SES (discrimination).

The aim of the current retrospective registry study was to examine SES disparities in IHCA treatment and survival, assessing SES at the individual (patient) level and adjusting for major demographic, clinical, and contextual factors.

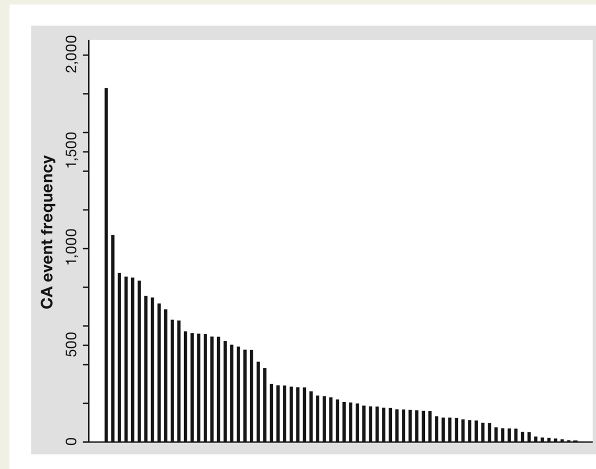


Figure 1 Number of cardiac arrest events per hospital.

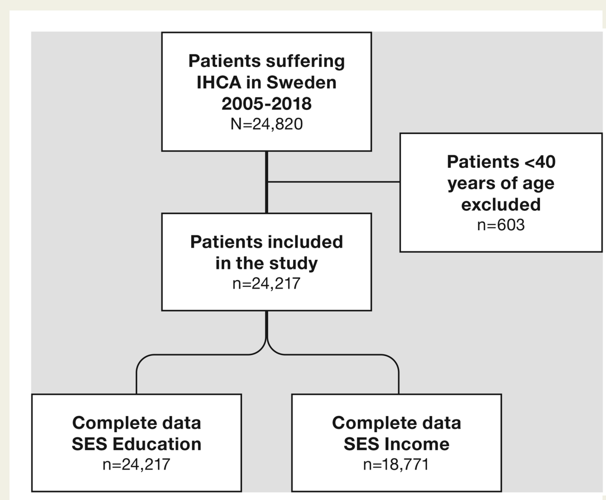


Figure 2 Flowchart displaying selection of patients.

Methods

The Swedish Register of Cardiopulmonary Resuscitation

This study used data from the Swedish Register of Cardiopulmonary Resuscitation (SRCR), a national quality registry whose aim is to facilitate prospective quality control of resuscitation practices in Sweden. The registry employs a predefined, Utstein-style reporting framework. The National Registry Committee continuously performs random inspections of the data to validate the registry.

The SRCR consists of two parts: IHCA and OHCA. The current study uses the IHCA registry, which contains individual-level data on patients who underwent CPR. As of 2018, 73 out of 74 Swedish emergency hospitals report IHCA data (*Figure 1*).

The IHCA registry contains data on prophylactic treatment (e.g. heart rhythm monitoring), treatment during the CA (e.g. CPR delay, CPR duration), immediate survival, survival to discharge from hospital, 30-day survival, neurological function (cerebral performance category score; CPC) among survivors, and post-arrest treatment. Additionally, it contains basic sociodemographic variables (gender and age), comorbidity, initial heart rhythm, likely aetiology of the CA, and contextual factors (e.g. year and hospital). Finally, the registry includes the hospital staff's own assessment of the quality of the treatment they provided during the CA (treatment satisfaction).

Statistics Sweden

Patient-level SES data were obtained from Statistics Sweden's LISA database. Two fundamental SES proxies were used: highest level of completed education and annual income.[18] From LISA, we also obtained patient-level data on origin of birth (proxy for ethnicity).

Selection of patients

The current study included all patients, 40 years or older, registered in the IHCA registry between 2005 (start year) and 20 August 2018 (extraction date) (*Figure 2*). The rationale for the age criteria was that (i) SES proxies are not accurate for younger patients since many of them have not reached their highest income or level of completed education and (ii) these patients could be a selective group with different unobserved initial health due to the low CA prevalence for this age group.

Variables

Outcome variables: *CPR delay* indicates the delay from discovery of the patient to the start of CPR (0 = <1 min, 1 = 1 min or longer); *CPR duration* (minutes); *Survival after CPR* (0 = dead, 1 = alive); *Treatment satisfaction* reported by the medical staff (0 = unsatisfactory, 1 = satisfactory); *Survival* *to hospital discharge with good neurological outcome* (1 = CPC ≤ 2, indicating no, mild, or moderate neurological deficits, 0 = CPC 3–5, indicating severe neurological deficit, coma, or death); *30-day survival* (0 = dead, 1 = alive).

Predictor variables (SES): *Education* (0 = high school or below, 1 = college/university education). *Income* is a percentile score which reflects the patient's relative standing in the income distribution. Since many of the patients in the sample are retired, the income variable was based on two types of income: annual earned income and retirement pension. The percentile score was based on either of the two types of income, depending on whether the patient was working or retired.

Control variables: *Age*; *Gender*; *Ethnicity* (Nordic, Western Europe, Southern Europe, Eastern Europe, Middle Eastern, African, Asian, South American, 'Other'); *Hospital*; *Year*; *Comorbidity* (previous history of heart failure, myocardial infarction, stroke, respiratory insufficiency, diabetes, cancer, and metastatic cancer); initial *Heart rhythm* (ventricular fibrillation, ventricular tachycardia, pulseless electrical activity, or asystole); *Aetiology* of the CA (e.g. myocardial infarction/ischaemia, arrhythmia, heart failure, respiratory insufficiency, intoxication).

Statistical analysis

Fixed-effects regression models were estimated to account for the fact that the data are grouped on hospital and year and that unobserved hospital characteristics and time trends may affect outcomes and simultaneously be correlated with SES, potentially leading to omitted variable bias. The regressions included fixed effects for hospital (73 dummies as explanatory variables, i.e. one dummy for each hospital) and the year of the CA event (one dummy for each year), in addition to the other control variables listed above. Logistic fixed-effects regression analysis was conducted to test for SES differences in relation to the dichotomous outcome variables (CPR delay, Survival after CPR, Treatment satisfaction, Survival to discharge with good neurological outcome, and 30-day survival) and fixed-effects ordinary least squares regressions were estimated to analyse the continuous outcome variable (CPR duration). Separate analyses were performed with SES income and SES education ($r = 0.309$), respectively, as predictor variables. The level of statistical significance was set at $P < 0.05$. The statistical analysis was performed in Stata 16.[19]

Results

Baseline characteristics

A majority of the patients had no CPR delay (59.1%). Cardiopulmonary resuscitation duration was on average 16.2 min (SD = 14.8). Half of the patients (51.6%) survived CPR. The medical staff reported being satisfied with the treatment provided in 71.8% of the cases. One-fourth (23.1%) survived to discharge with good neurological outcome, and one-third (29.4%) survived to 30 days (see *Table 1* for additional descriptive statistics).

Primary analyses: socioeconomic status, in-hospital cardiac arrest treatment, and survival

The results of the regression analyses, controlling for age, gender, and ethnicity, comorbidity, heart rhythm, and aetiology, and including fixed effects for hospital and year, are reported in *Table 2*.

Cardiopulmonary resuscitation delay

Patients with higher SES were less likely to receive delayed CPR. For highly educated patients, the likelihood of a delay was significantly lower than for patients with low education (OR = 0.89, $P = 0.012$). For income, being one decile (10 percentage points) higher up in the income distribution was significantly associated with a lower likelihood of a delay (OR = 0.98, $P = 0.038$).

Cardiopulmonary resuscitation duration

Highly educated patients received significantly shorter CPR duration ($B = -0.06$, $P = 0.039$). For income, the association was not statistically significant ($B = -0.00$, $P = 0.674$).

Survival after cardiopulmonary resuscitation

Education was not statistically significant associated with immediate survival (OR = 1.07, $P = 0.081$). However, higher income was significantly associated with a higher likelihood of immediate survival (OR = 1.02, $P = 0.004$).

Treatment satisfaction

Neither education nor income was significantly associated with treatment satisfaction (OR = 1.08, $P = 0.304$ vs. OR = 1.01, $P = 0.516$).

Survival to discharge with good neurological outcome

High education was significantly associated with a higher likelihood to be alive at discharge with good neurological outcome compared with low education (OR = 1.27, $P < 0.001$). Income was also significantly associated with survival to discharge with good neurological outcome (OR = 1.06, $P < 0.001$).

30-day survival

Highly educated patients were significantly more likely to be alive after 30 days compared with patients with low education (OR = 1.21, $P < 0.001$). Higher income was also significantly associated with greater 30-day survival (OR = 1.05, $P < 0.001$).

Secondary analyses: socioeconomic status and heart rhythm monitoring

The results revealed that highly educated patients (OR = 1.16, $P < 0.001$) and patients with higher income (OR = 1.02, $P = 0.001$) were significantly more likely to have their heart rhythm monitored *prior* to the onset of the CA, even with fixed effects for hospital and year in the regression and when controlling for demographic characteristics (age, gender, ethnicity) and comorbidity.

In addition to being associated with SES, heart rhythm monitoring was significantly associated with less CPR delay (rho = -0.213), shorter CPR duration (rho = -0.163), and increased survival immediately after CPR (rho = 0.238), survival to discharge with good neurological status (rho = 0.283), and survival to 30 days (rho = 0.285). Consequently, we examined the possibility that higher incidence of heart rhythm monitoring among patients with high SES would partly explain the SES differences in CA outcomes in *Table 2*. To this end, the fixed-effects regression analyses in *Table 2* were repeated, but now with heart rhythm monitoring as an additional control variable (*Table 3*). Socioeconomic status was no longer a significant predictor of CPR delay (Education, $P = 0.050$; Income, $P = 0.074$). The

Table 1 Descriptive statistics (unadjusted) for the full sample and different socioeconomic status groups

	All (n = 24 217)	High SES (education) (n = 3760)	Low SES (education) (n = 20 457)	SES income (4th quartile) (n = 4733)	SES income (3rd quartile) (n = 4909)	SES income (2nd quartile) (n = 4878)	SES income (1st quartile) (n = 4251)
Age, mean (SD)	73.6 (11.6)	70.9 (11.8)	74.1 (11.5)	72.7 (10.7)	74.6 (10.4)	76.0 (10.1)	77.7 (11.0)
Gender, n (%)							
Female	9287 (38.4)	1227 (32.6)	8060 (39.4)	597 (12.6)	1062 (21.6)	2434 (49.9)	3081 (72.5)
Male	14 930 (61.7)	2533 (67.4)	12 397 (60.6)	4136 (87.4)	3847 (78.4)	2444 (50.1)	1170 (27.5)
Ethnic background, n (%)							
Nordic	22 266 (91.9)	3404 (90.5)	18 862 (92.2)	4532 (95.8)	4641 (94.5)	4582 (93.3)	3764 (88.5)
Africa	110 (0.5)	19 (0.5)	91 (0.4)	13 (0.8)	9 (0.2)	7 (0.1)	25 (0.6)
Asia	146 (0.6)	42 (1.1)	104 (0.5)	17 (0.4)	10 (0.2)	17 (0.4)	40 (0.94)
Eastern Europe	393 (1.6)	92 (2.4)	301 (1.5)	60 (1.3)	85 (1.73)	69 (1.4)	81 (1.9)
Middle East	437 (1.8)	80 (2.1)	357 (1.8)	14 (0.3)	24 (0.5)	29 (0.6)	148 (3.5)
South Europe	469 (1.9)	46 (1.2)	423 (2.0)	28 (0.6)	68 (1.4)	89 (1.8)	122 (2.9)
Western Europe	338 (1.4)	69 (1.8)	269 (1.3)	64 (1.4)	67 (1.36)	71 (1.5)	56 (1.3)
Other	58 (0.2)	8 (0.2)	50 (0.2)	5 (0.1)	5 (0.1)	14 (0.29)	15 (0.4)
Comorbidity index (0–7), mean (SD)	1.38 (1.19)	1.22 (1.17)	1.41 (1.19)	1.36 (1.19)	1.49 (1.21)	1.45 (1.18)	1.37 (1.16)
Initial heart rhythm, n (%)							
Ventricular fibrillation	3938 (16.3)	700 (18.6)	3238 (15.8)	956 (20.0)	867 (17.7)	734 (15.1)	547 (12.9)
Ventricular tachycardia	1565 (6.5)	297 (7.9)	1268 (6.2)	378 (7.99)	332 (6.76)	288 (5.9)	196 (4.6)
Pulseless electrical activity	4785 (19.8)	729 (19.4)	4056 (19.8)	825 (17.4)	944 (19.2)	977 (20.0)	799 (18.8)
Asystole	7788 (32.2)	1167 (31.0)	6621 (32.4)	1407 (29.7)	1531 (31.2)	1615 (33.1)	1502 (35.3)
Missing	6141 (25.4)	867 (23.1)	5274 (25.8)	1167 (24.7)	1235 (25.2)	1264 (25.9)	1207 (29.4)
Cardiac aetiology, n (%)							
Yes	11 514 (47.6)	1775 (47.2)	9739 (47.6)	2427 (51.3)	2481 (50.5)	2400 (49.2)	1993 (46.9)
No	2281 (9.4)	359 (9.6)	1922 (9.4)	350 (7.4)	412 (8.4)	407 (8.3)	358 (8.4)
Missing	10 422 (43.0)	1626 (43.2)	8796 (43.0)	1956 (41.3)	2016 (41.1)	2071 (42.5)	1900 (44.7)
Monitored, n (%)							
Yes	12 502 (51.6)	2142 (57.0)	10 360 (50.6)	2592 (54.8)	2627 (53.5)	2411 (49.4)	2009 (47.3)
No	11 360 (46.9)	1555 (41.4)	9805 (47.9)	2068 (43.7)	2222 (45.3)	2396 (49.1)	2194 (51.6)
Missing	355 (1.5)	63 (1.7)	292 (1.43)	73 (1.5)	60 (1.22)	71 (1.5)	48 (1.13)
CPR delay, n (%)							
Yes	6118 (25.3)	842 (22.4)	5276 (25.8)	1094 (23.1)	1224 (24.9)	1295 (26.6)	1139 (26.8)
No	14 303 (59.1)	2325 (61.8)	11 978 (58.6)	2854 (60.3)	2883 (58.7)	2829 (58.0)	2506 (59.0)
Missing	3796 (15.7)	593 (15.8)	3203 (15.7)	785 (16.6)	802 (16.3)	754 (15.5)	606 (14.3)
CPR duration in minutes, mean (SD)	16.2 (14.8)	15.8 (15.1)	16.3 (14.8)	16.6 (16.0)	16.2 (14.2)	15.9 (14.3)	15.8 (14.4)
Missing, n (%)	14 561 (60.1)	2135 (56.8)	12 426 (60.7)	3169 (67.0)	3194 (65.1)	3274 (67.1)	2863 (67.4)
Survival after CPR, n (%)							
Yes	12 503 (51.6)	2128 (56.6)	10 375 (50.7)	2601 (55.0)	2524 (51.4)	2370 (48.6)	1985 (46.7)
No	11 714 (48.4)	1632 (43.4)	10 082 (49.3)	2132 (45.0)	2385 (48.6)	2508 (51.4)	2266 (53.3)
Treatment satisfaction, n (%)							
Yes	17 378 (71.8)	2699 (71.8)	14 679 (71.8)	3358 (71.0)	3541 (72.1)	3546 (72.7)	3067 (72.2)

Continued

Table 1 *Continued*

	All (*n* = 24 217)	High SES (education) (*n* = 3760)	Low SES (education) (*n* = 20 457)	SES income (4th quartile) (*n* = 4733)	SES income (3rd quartile) (*n* = 4909)	SES income (2nd quartile) (*n* = 4878)	SES income (1st quartile) (*n* = 4251)
No	6839 (28.2)	1061 (28.2)	5778 (28.2)	1375 (29.0)	1368 (27.9)	1332 (27.3)	1184 (27.9)
Survival to discharge with good neurological outcome, *n* (%)							
Yes	5597 (23.1)	1127 (30.0)	4470 (21.9)	1333 (28.2)	1150 (23.4)	991 (20.3)	745 (17.5)
No	16 839 (69.5)	2362 (62.8)	14 477 (70.8)	3147 (66.5)	3528 (71.9)	3667 (75.2)	3314 (78.0)
Missing	1781 (7.4)	271 (7.2)	1510 (7.4)	253 (5.4)	231 (4.7)	220 (4.5)	192 (4.5)
30-day survival, *n* (%)							
Yes	7130 (29.4)	1387 (36.9)	5743 (28.0)	1648 (34.8)	1450 (29.5)	1283 (26.3)	997 (23.5)
No	17 087 (70.6)	2373 (63.1)	14 714 (71.9)	3085 (65.2)	3459 (70.5)	3595 (73.7)	3254 (76.6)

A quartile split was performed for SES income for sake of simplicity, although income was used as a continuous variable in the regression analyses. Cardiopulmonary resuscitation duration was longer than 90 min in 0.9% of the cases. These cases were recoded as missing, since such high numbers are unrealistic. The reason for the high fraction of missing values for CPR duration is mainly that this variable did not exist in the register until 2013.

Table 2 **Association between socioeconomic status and outcome variables (treatment and survival)**

	CPR delay (0/1) odds ratios (SE) (1)	CPR duration (ln) B (SE) (2)	Survival after CPR (0/1) odds ratios (SE) (3)	Treatment satisfaction (0/1) odds ratios (SE) (4)	Survival to discharge with good neurological outcome (0/1) odds ratios (SE) (5)	30-day survival (0/1) odds ratios (SE) (6)
Highly educated	0.8907*	-0.0597*	1.0728	1.0816	1.2703**	1.2065**
Standard error	(0.0408)	(0.0289)	(0.0432)	(0.0826)	(0.0611)	(0.0531)
95% confidence interval	[0.8141, 0.9744]	[-0.1165, -.0030]	[0.9915, 1.1608]	[0.9313, 1.2562]	[1.1560, 1.3959]	[1.1067, 1.3152]
Pseudo R^2 (R^2 in col. 2)	0.048	0.171	0.142	0.038	0.244	0.223
C-statistic	0.648	n/a	0.740	0.646	0.819	0.805
N	20 407	9444	24 030	18 953	22 155	24 030
Income decile	0.9842*	-0.0023	1.0202**	1.0084	1.0627**	1.0468**
Standard error	(0.0076)	(0.0055)	(0.0071)	(0.0129)	(0.0093)	(0.0084)
95% confidence interval	[0.9694, 0.9991]	[-0.0130, 0.0084]	[1.0065, 1.0342]	[0.9833, 1.0340]	[1.0446, 1.0810]	[1.0306, 1.0634]
Pseudo R^2 (R^2 in col. 2)	0.054	0.172	0.149	0.045	0.260	0.237
C-statistic	0.655	n/a	0.745	0.659	0.829	0.813
N	15 813	6139	18 666	14 796	17 472	18 659

Each cell/estimate is from a separate regression. All regressions used all observations of the full study population for which the dependent variable and SES proxy is non-missing. All regressions included fixed effects for hospital and the year of the CA event and controlled for age, gender, ethnicity, comorbidity, heart rhythm, and aetiology. Standard errors in parentheses are robust. 95% confidence intervals are reported in brackets.
*Significant at the 5% level.
**Significant at the 1% level.

Table 3 Association between socioeconomic status and outcome variables (treatment and survival), adding adjustment for heart rhythm monitoring

	CPR delay (0/1) odds ratios (SE) (1)	CPR duration (ln) B (SE) (2)	Survival after CPR (0/1) odds ratios (SE) (3)	Treatment Satisfaction (0/1) odds ratios (SE) (4)	Survival to discharge with good neurological outcome (0/1) odds ratios (SE) (5)	Survival 30 days (0/1) odds ratios (SE) (6)
Highly educated	0.9122	-0.0524	1.0562	1.0649	1.2548**	1.1911**
Standard error	(0.0427)	(0.0286)	(0.0430)	(0.0815)	(0.0612)	(0.0533)
95% confidence interval	[0.8322, 0.9999]	[-0.1083, 0.0036]	[0.9752, 1.1439]	[0.9165, 1.2373]	[1.1404, 1.3808]	[1.0911, 1.3002]
Pseudo R^2 (R^2 in col. 2)	0.074	0.189	0.156	0.047	0.262	0.243
C-statistic	0.684	n/a	0.754	0.663	0.831	0.818
N	20 407	9444	24 030	18 953	22 155	24 030
Income decile	0.9861	-0.0016	1.0186**	1.0067	1.0610**	1.0448**
Standard error	(0.0077)	(0.0054)	(0.0071)	(0.0129)	(0.0094)	(0.0085)
95% confidence interval	[0.9711, 1.0014]	[-0.0122, 0.0090]	[1.0047, 1.0326]	[0.9818, 1.0322]	[1.0427, 1.0796]	[1.0283, 1.0615]
Pseudo R^2 (R^2 in col. 2)	0.078	0.187	0.163	0.055	0.276	0.256
C-statistic	0.688	n/a	0.759	0.673	0.839	0.826
N	15 813	6139	18 666	14 796	17 472	18 659

Regressions mirror those reported in *Table 2* but add adjustment for heart rhythm monitoring.
**Significant at the 1% level.

association between SES and CPR duration was also no longer significant (Education, $P = 0.067$; Income, $P = 0.769$). Finally, the association between SES and our survival outcomes (survival after CPR, to discharge with good neurological outcome, and to 30 days) remained significant. In sum, heart rhythm monitoring may partially explain the relationship between SES and CPR delay.

The role of hospital type

Because heart rhythm monitoring facilities is a clear indicator of hospital capacity, the possibility that SES differences in heart rhythm monitoring emerge in certain hospital types were examined. In the following analyses, the hospitals were now categorized into three different types based on the hospital classification system currently employed in Sweden to indicate hospital capacity (e.g. range of care and patient capacity in emergency departments). In descending order of capacity, the three hospital types were: regional, county, and district hospitals.

The previous fixed-effect regressions with heart rhythm monitoring as the dependent variable were repeated, but with the SES variable replaced by the three interaction terms between SES and hospital type. Note that the regressions still controlled for individual hospital (fixed effect; 73 dummies). *F*-tests of equal coefficients of the three interaction terms did not reject that the associations between education and heart rhythm monitoring, and income and heart rhythm monitoring, were equal across hospital types (Education, $P = 0.778$; and Income, $P = 0.584$). Thus, SES differences in heart rhythm monitoring seem to be independent of hospital type.

In addition to heart rhythm monitoring facilities, access to other resources could also vary across hospital types. Therefore, the possibility of heterogeneity in the association between SES and the other studied outcome variables across hospital types was examined. All regressions in *Table 2* were repeated, but now with the SES variable replaced by the SES by hospital type interaction terms (still controlling for individual hospital as above). For each regression, an *F*-test of equal SES coefficients across hospital types could not reject that the association between SES and the outcome are equal across hospital types. Thus, the SES differences in outcomes reported in *Table 2* appear independent of hospital type.

Discussion

This study demonstrates that higher SES is associated with a significantly lower likelihood of receiving delayed CPR when suffering IHCA, as well as a subsequent higher likelihood of being alive immediately after CPR. Furthermore, patients with high SES are more likely to survive to discharge with good neurological outcome, and to be alive 30 days after IHCA. We also find that patients with high SES are more likely to have their heart rhythm monitored prior to the IHCA, despite having better health (less comorbidity). This more frequent heart rhythm monitoring seems to partially explain the less delayed CPR for patients with high SES.

The finding that SES differences remain after controlling for major demographic, clinical, and contextual factors suggests the presence of treatment bias/discrimination. Such bias, where patients are treated differently due to their SES, may stem from prejudiced attitudes among hospital staff. If so, this would be consistent with a body of research showing that low SES groups (e.g. poor and homeless people) face some of the most severe prejudices in society.[20] They tend to be disrespected and elicit negative emotional reactions (e.g. contempt and disgust).[20] At the extreme, research on dehumanization suggests that these groups are sometimes perceived as possessing fewer human attributes compared with more respected groups in society.[21]

Reassuringly, however, most of the uncovered associations between patient SES and the studied outcomes are small, meaning that a large majority of IHCA patients with low SES is not subjected to disparate treatment. However, because human lives are at stake, an SES-related survival odds difference of ∼21% (our effect size for 30-day survival) should not be ignored. This would mean that 818 of the 14 714 IHCA deaths of the lowly educated patients reported in the SRCR (2005–18) could be attributed to education.

It should be noted that patients with high SES have shorter CPR duration. This is not surprising considering that the resuscitation attempt seems to be started earlier for these patients. Moreover, patients with high SES are more likely to be successfully resuscitated which may also explain a somewhat shorter CPR duration. However, the relationship between SES and CPR duration becomes non-significant when heart rhythm monitoring is controlled for. It is nevertheless reassuring to find that resuscitation does not appear to be terminated more rapidly among patients with low SES once CPR has been started, although there seems to be a slight delay in the decision to start resuscitation.

Treatment satisfaction was not significantly related to patient SES in any of our analyses. This is interesting given that patients with low SES are more likely to receive delayed CPR, and less likely to survive the IHCA. It is possible that the medical staff do not realize that they provide different treatment due to patient SES, and that survival rates are lower among patients with low SES. Another interpretation could be that the medical staff has a lower threshold for what constitutes satisfactory treatment when the patients have low SES. Alternatively, they may be reluctant to report less treatment satisfaction after having treated patients with low SES in order to avoid appearing prejudiced.

Clinical implications

The SES differences in treatment and survival need further attention. It seems particularly important to address why patients with low SES have their heart rhythm monitored less frequently. It is troublesome that this group of patients is prioritized less when it comes to prophylactic treatment despite having a seemingly greater need for this due to poorer initial health. The argument that they are too ill to receive such treatment appears invalid because the studied sample only contains patients who received CPR.

To combat these seemingly unjustified SES differences and to prevent future ones from occurring, hospitals may consider enrolling their CA teams in equality training programmes. The focus of such programmes could be on awareness training where teams become mindful of their own bias and learn how SES-related prejudice might translate into discriminatory treatment.

Limitations

The SRCR only contains patients on whom resuscitation was attempted. The current study likely constitutes a conservative test of discrimination because it probed for discrimination in a sample where the first decision to treat had already been made. It is possible that most discrimination occurs earlier, during the decision-making process itself. Once the medical staff have decided to start CPR, they may be determined to continue.

It is also possible that the observed SES disparities are underestimated due to the statistical adjustment for heart rhythm and aetiology. Although hearth rhythm and aetiology mostly should reflect health status that is fixed at the time of the CA, these variables are not strictly predetermined. Because heart rhythm is assessed after the CA alarm, and aetiology is determined post-CA, they could partly be influenced by events happening after the onset of the CA. For example, the greater CPR delay observed for patients with low SES could result in a less benign (non-shockable) heart rhythm. Controlling for heart rhythm may therefore remove some of the variance attributed to SES.[22]

We did not specifically adjust for the care unit in which the CA occurred. However, information about whether the patient's heart rhythm was monitored at the time of the CA could be seen as a 'proxy' for care unit, since most patients in the intensive care unit are heart rhythm monitored, whereas the opposite holds true for general wards.

The current research was conducted in Sweden. The results may not generalize to other countries. However, since Sweden is regarded to be at the forefront of equality,[23] the observed group differences may be larger in other countries.

Compared with previous research, the current study controlled for a large number of potential confounders. Nevertheless, our findings are correlational, not causal. It is possible that some unobserved factor (e.g. smoking habits or some other lifestyle factor) explains the observed SES differences. Relatedly, although we were able to adjust for major clinical factors, the existence of more extensive comorbidity data would have allowed for even more rigorous control over potential medical confounders.

The SES income proxy had missing values in 22% of the cases (zero-reported income from work and zero retirement benefits in Statistics Sweden's registers). We cannot rule out that these patients are a selective group and that the results would be affected if we had data for these patients.

Conclusion

There are clear SES differences in IHCA treatment and survival, even when controlling for major sociodemographic, clinical, and contextual factors. This suggests that patients with low SES could be subject to discrimination when suffering IHCA.

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Study approval

This research has been conducted according to the principles of Helsinki and was approved by the Regional Ethical Review Board in Linköping, Sweden (No. 2017/293-31).

Data availability

Data cannot be shared for ethical/privacy reasons.

Conflict of interest: none declared.

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Corrigendum

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In the originally published version of this manuscript, there was an error in the title. The title referred to "Treatment of heart failure with reduced ejection fraction the dawn of the era of sodium–glucose co-transporter-2 inhibitors". This has now been corrected online to "Treatment of heart failure: the dawn of the era of sodium–glucose co-transporter-2 inhibitors".