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ORIGINAL RESEARCH

Evidence-Based Emergency Medicine

Socioeconomic status is associated with process times in the emergency department for patients with chest pain

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Abstract

Objective: Emergency department length of stay (EDLOS) is linked to crowding and patient outcomes whereas worse prognosis in low socioeconomic status remains poorly understood. We studied whether income was associated with ED process times among patients with chest pain.

Methods: This was a registry-based cohort study on 124,980 patients arriving at 14 Swedish EDs between 2015 and 2019 with chest pain as their chief complaint. Individual-level sociodemographic and clinical data were linked from multiple national registries. The associations between disposable income quintiles, whether the time to physician assessment exceeded triage priority recommendations as well as EDLOS were evaluated using crude and multivariable regression models adjusted for age, gender, sociodemographic variables, and ED-management circumstances.

Results: Patients with the lowest income were more likely to be assessed by physician later than triage recommendations (crude odds ratio [OR] 1.25 (95% confidence interval [CI] 1.20–1.29) and have an EDLOS exceeding 6 h (crude OR 1.22 (95% CI 1.17–1.27). Among patients subsequently diagnosed with major adverse cardiac events, patients with the lowest income were more likely to be assessed by a physician later than triage recommendations, crude OR 1.19 (95% CI 1.02–1.40). In the fully adjusted model, the average EDLOS was 13 min (5.6%) longer among patients in the lowest income quintile, 4:11 [h:min], (95% CI 4:08–4:13), compared to patients in the highest income quintile, 3:58 (95% CI 3:56–4:00).

Conclusions: Among ED chest pain patients, low income was associated with longer time to physician than recommended by triage and longer EDLOS. Longer process times may have a negative impact due to crowding in the ED and delay diagnosis and timely treatment of the individual patient.

KEYWORDS
acute coronary syndrome, emergency department, length of stay, socioeconomic status, time to physician assessment

The Bottom Line

This study investigated whether low socioeconomic status was associated with longer process times in the emergency department among patients with chest pain. Patients with the lowest income were 25% more likely to be seen by a physician later than the time recommended by triage and 22% more likely to have a length of stay over 6 hours compared to those with the highest income.

1 | INTRODUCTION

1.1 | Background

Chest pain is one of the most common chief complaints at the emergency department (ED).[1–2] Underlying medical urgencies include acute coronary syndrome (ACS), aortic dissection, and pulmonary embolism—conditions that require timeliness in diagnosis and treatment in the ED.[3–4] ED crowding is a globally growing phenomenon with clear negative consequences for both patients and health care workers.[5–7] ED crowding is associated with longer ED length of stay (EDLOS) regardless of the chief complaint as well as with inpatient mortality.[1,8] A longer EDLOS may result in delay of diagnosis and, consequently, of treatment and admission to in-hospital care.

Low socioeconomic status (SES) has consistently been associated with unfavorable health in general.[9–10] In people with lower SES, conventional risk factors for cardiovascular disease (CVD), such as smoking, diabetes mellitus, hyperlipidemia, and hypertension, are more common.[10–14] Low SES is also associated with incident cardiovascular events,[9,11,15] pulmonary embolism,[16] and higher mortality after percutaneous coronary intervention[12] as well as aortic dissection.[17] Low SES is also linked to patient delay in seeking care until more severe symptoms of CVD occur.[18]

1.2 | Importance

Because longer ED waiting times are linked to worse outcomes it is important to study whether ED process times are associated with individual-level SES in unselected chest pain patients in a tax-financed health care system.

1.3 | Objective

The primary objective of this study was therefore to investigate whether SES (by the proxy disposable income) is associated with time to physician assessment and EDLOS in ED patients with chest pain as their chief complaint.

2 | METHODS

2.1 | Study design and setting

This was a retrospective cohort study in a tax-financed health care system based on the national quality register of EDs in Sweden, SVenska AkutvårdsRegistret (SVAR).[19] SVAR contains data from 14 EDs across 4 Swedish counties, including both larger regional hospitals and smaller county hospitals. Data from the electronic health care records of the participating hospitals are continuously exported to SVAR. We linked SVAR-data to Swedish national registers managed by the Swedish National Board of Health and Welfare and Statistics Sweden that are further described in the Supplemental Methods. The study was approved by the Regional Ethics Review Board in Stockholm, Sweden (dnr 2018/1373-31/1) and comply with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.[20]

2.2 | Selection of participants

Patients above 30 years of age with chest pain as their chief complaint who visited any of the 14 EDs in SVAR between January 1, 2015, and December 31, 2019, were included. If an individual visited an ED more than once during the study period, only the first visit was included. Chest pain patients below 30 years of age were not included because serious underlying causes to chest pain are very uncommon in this group.

2.3 | Exposure

Data on individual-level disposable income, educational level, and marital status were collected from Statistics Sweden. Disposable income per consumption unit was used as the primary measure of socioeconomic status and was obtained from the year preceding the ED visit. It was defined as the sum of income sources minus negative income factors for all household members divided by the number of household members weighted by consumption weight.[21–22] The resulting individual income was finally divided into quintiles that were stratified by sex, calendar year, and 4 age groups (30–49, 50–64, 65–79, and 80+ years) to account for differences in income by sex and age. Quintile 1 had the lowest annual income and quintile 5 had the highest annual income.

2.4 | Sociodemographic variables

The educational categories were provided by Statistic Sweden and narrowed down to 3 categories to be comparable to most other countries: compulsory (<10 years), upper secondary (10–12 years), and postsecondary (>12 years) education. Marital status was categorized as married (including registered partner) or not married. Country of origin was divided into Sweden, Nordic countries, Europe, Asia, Africa, and America. Years from immigration to Sweden was divided into

0–2 years, 2–5 years, 5–10 years, 10–20 years, 20–30 years, 30+ years, and native.

2.5 | Outcomes

The outcomes studied were whether the time to physician assessment exceeded triage recommendation and EDLOS. The time to physician assessment was defined as time of arrival to time when the first physician signed up for the patient expressed in minutes. A time to physician assessment that was 0 min or less was excluded (n = 2543 or 2.0%) due to likely erroneous values. The first outcome was defined as a time to physician assessment exceeding triage recommendation, according to the rapid emergency triage and treatment system (RETTS-A),[23–24] for orange >20 min; for yellow >120 min; and for green >240 min. Blue triage (no time defined) was not included. Patients triaged to red (immediately) were not included in this analysis because the time stamps were likely of insufficient quality to assess such short time periods (within 0 min) and often recorded after leaving the ED. EDLOS, was defined as the time from arrival to the time of departure rounded to the nearest whole minute. All patients with an EDLOS that was 0 min or less were excluded (n = 484 or 0.4%) as well as those with an EDLOS more than 48 h (n = 24 or 0.02%) due to likely erroneous values.[19] Patients were categorized into having either a long EDLOS (≥6 h) or a normal EDLOS (<6 h).

2.6 | Covariates and descriptive data

Several variables describing relevant information on the ED visit were collected from SVAR. Arrival mode was divided into 3 categories: emergency medical service, walk-in, and other. Departure was divided into 3 groups: admitted, walk-out to home, or other. Admitted was defined as being admitted to another unit in the same hospital. The category other included referrals to other form of care, to other hospitals, or patient deaths. Time of arrival was divided into 3 categories: 08:00–15:59 (day shift), 16:00–23:59 (evening shift), and 00:00–07:59 (night shift). The 14 hospitals in the study were divided into regional or county hospitals based on their resources and catchment areas as reflected by their ID status in SVAR.

Data on comorbidities, cardiovascular risk factors, and major adverse cardiac events were collected from national registers managed by the Swedish National Board of Health and Welfare as described in Supplementary methods. The data underlying this article cannot be shared publicly due to the privacy of individuals that participated in the study. The data will be shared on reasonable request to the corresponding author.

2.7 | Data analysis

Patient visit characteristics are presented by disposable income quintile in frequency (percent) for categorical variables and as mean (SD) or median (interquartile range) for continuous variables. Logistic regression was used to study the associations between the income quintiles and the 2 binary outcomes: time to physician assessment exceeding triage recommendation (yes/no) and EDLOS exceeding 6 h (yes/no). The associations between the stratified income quintiles and the outcomes were studied using 1 univariable and 2 multivariable regression models. A directed acyclic graph was used in building the multivariable models for estimates of bias-minimized total and direct effects, respectively, between exposure and the outcomes (Figure S8). The first multivariable regression model included age, sex, educational level, marital status, country of origin, and years from immigration. Age and sex were included as covariates because the stratification of exposure by 4 age-groups and sex was assumed to not fully account for possible confounding effects by age and sex on the association between income-quintile and the outcomes. The second was further adjusted for arrival mode, triage, time of visit, arrival weekday, and cardiovascular risk factors. This group of mediators is referred to as ED-management circumstances. The outcome variables EDLOS and time to physician assessment were also studied as continuous variables with the same univariable and multivariable regression models as described They were found to be log-normally distributed and therefore logarithmic transformation was applied. Two-sided P values from a 1-sample t test for linear regression are reported for each regression coefficient, where the null hypothesis is that the coefficient is equal to zero. The obtained regression coefficients and their 95% confidence intervals (CIs) were reported in forest plots. The following formula was used to get an estimate of the predicted value on the original time scale: [LOS/time to physician assessment] = exp(-cons)–exp(-cons+[q]) for quintile q. Subgroup analyses were performed in the patients experiencing a major adverse cardiac event and in ED visits to regional versus county hospitals separately. Analyses were conducted using STATA version 16.1 (StataCorp, College Station, Texas, USA).

3 | RESULTS

3.1 | Patient characteristics

During the study period, a total of 2,408,256 ED visits by 1,126,318 individual patients were registered in SVAR. Out of that population there were 220,530 visits by 164,353 unique individuals with chest pain as their chief complaint. A total of 19,374 individuals were excluded due to missing information regarding mediators and confounders. Missing data are further described in Table S1. A total of 2397 individuals were excluded because their LOS was either >48 h, or ≤0 h, and 17,597 individuals were excluded because their age was <30 years. Further exclusion rendered a final study population of 124,980 unique visits and individuals, as shown in Figure 1. The characteristics of excluded and included patients are compared in Table S7.

Study population characteristics by income quintiles are presented in Table 1. High level of education and being married was more common in the higher income groups whereas arriving by emergency

TABLE 1 Characteristics of emergency department-patients with chest pain by income quintiles.

	Quintile 1 N = 25,011	Quintile2 N = 24,995	Quintile3 N = 24,999	Quintile4 N = 24,994	Quintile5 N = 24,981
Disposable income (kSEK)*	125 (93–143)	180 (164–201)	240 (211–268)	309 (271–347)	454 (383–569)
Sex					
Female	12,431 (49.7%)	12,426 (49.7%)	12,424 (49.7%)	12,425 (49.7%)	12,417 (49.7%)
Age group					
30–49	7289 (29.1%)	7285 (29.1%)	7285 (29.1%)	7285 (29.1%)	7280 (29.1%)
50–64	7,78 (29.5%)	7374 (29.5%)	7375 (29.5%)	7374 (29.5%)	7370 (29.5%)
65–79	7147 (28.6%)	7144 (28.6%)	7146 (28.6%)	7144 (28.6%)	7143 (28.6%)
80+	3197 (12.8%)	3192 (12.8%)	3193 (12.8%)	3191 (12.8%)	3188 (12.8%)
Education‡					
<10 years	9698 (38.8%)	7926 (31.7%)	5895 (23.6%)	4278 (17.1%)	2610 (10.4%)
10–12 years	9999 (40.0%)	11,534 (46.1%)	12,031 (48.1%)	11,097 (44.4%)	8747 (35.0%)
>12 years	5314 (21.2%)	5535 (22.1%)	7073 (28.3%)	9619 (38.5%)	13,624 (54.5%)
Marital status					
Married	8716 (34.8%)	9901 (39.6%)	13,029 (52.1%)	15,065 (60.3%)	16,583 (66.4%)
Country of origin					
Sweden	12,273 (49.1%)	15,885 (63.6%)	18,294 (73.2%)	19,885 (79.6%)	21,191 (84.8%)
Nordic countries	1222 (4.9%)	985 (3.9%)	940 (3.8%)	862 (3.4%)	717 (2.9%)
European Union	3205 (12.8%)	2699 (10.8%)	2392 (9.6%)	1890 (7.6%)	1415 (5.7%)
Africa	1195 (4.8%)	953 (3.8%)	494 (2.0%)	331 (1.3%)	177 (0.7%)
Asia	6498 (26.0%)	3887 (15.6%)	2412 (9.6%)	1635 (6.5%)	1162 (4.7%)
America	618 (2.5%)	586 (2.3%)	467 (1.9%)	391 (1.6%)	319 (1.3%)
Years from immigration					
0–2 years	825 (3.3%)	237 (0.9%)	109 (0.4%)	68 (0.3%)	88 (0.4%)
2–5 years	1535 (6.1%)	615 (2.5%)	338 (1.4%)	223 (0.9%)	186 (0.7%)
5–10 years	1933 (7.7%)	1239 (5.0%)	766 (3.1%)	612 (2.4%)	490 (2.0%)
10–20 years	2819 (11.3%)	2051 (8.2%)	1496 (6.0%)	1080 (4.3%)	973 (3.9%)
20–30 years	2974 (11.9%)	2354 (9.4%)	1797 (7.2%)	1450 (5.8%)	1105 (4.4%)
30+ years	3387 (13.5%)	3136 (12.5%)	2782 (11.1%)	2434 (9.7%)	2185 (8.7%)
Arrival mode					
Emergency medical service	9257 (37.0%)	8617 (34.5%)	7542 (30.2%)	6742 (27.0%)	5867 (23.5%)
Walk-in	15,754 (63.0%)	16,378 (65.5%)	17,457 (69.8%)	18,252 (73.0%)	19,114 (76.5%)
Triage priority §					
Blue	88 (0.4%)	86 (0.3%)	77 (0.3%)	78 (0.3%)	75 (0.3%)
Green	9660 (38.6%)	9516 (38.1%)	9908 (39.6%)	10,109 (40.4%)	10,007 (40.1%)
Yellow	8649 (34.6%)	9121 (36.5%)	9091 (36.4%)	9211 (36.9%)	10,070 (40.3%)
Orange	5823 (23.3%)	5545 (22.2%)	5240 (21.0%)	4985 (19.9%)	4297 (17.2%)
Red	791 (3.2%)	727 (2.9%)	683 (2.7%)	611 (2.4%)	532 (2.1%)
Time of visit					
08:00–15:59	11,939 (47.7%)	12,676 (50.7%)	13,267 (53.1%)	13,256 (53.0%)	13,332 (53.4%)
16:00–23:59	8882 (35.5%)	8288 (33.2%)	7838 (31.4%)	7880 (31.5%)	8059 (32.3%)
00:00–07:59	4190 (16.8%)	4031 (16.1%)	3894 (15.6%)	3858 (15.4%)	3590 (14.4%)
Arrival day					
Weekend	5986 (23.9%)	5756 (23.0%)	5547 (22.2%)	5545 (22.2%)	5623 (22.5%)
Weekday	19,025 (76.1%)	19,239 (77.0%)	19,452 (77.8%)	19,449 (77.8%)	19,358 (77.5%)

(Continues)

TABLE 1 (Continued)

	Quintile 1 N = 25,011	Quintile2 N = 24,995	Quintile3 N = 24,999	Quintile4 N = 24,994	Quintile5 N = 24,981
Type of hospital					
County	13,314 (53.2%)	13,783 (55.1%)	13,983 (55.9%)	14,105 (56.4%)	14,195 (56.8%)
Region	11,697 (46.8%)	11,212 (44.9%)	11,016 (44.1%)	10,889 (43.6%)	10,786 (43.2%)
Departure					
Admitted	8458 (33.8%)	8159 (32.6%)	7899 (31.6%)	7747 (31.0%)	7575 (30.3%)
Home	16,210 (64.8%)	16,538 (66.2%)	16,839 (67.4%)	17,010 (68.1%)	17,189 (68.8%)
Other	342 (1.4%)	298 (1.2%)	261 (1.0%)	237 (0.9%)	217 (0.9%)
Cardiovascular risk factors					
Previous CVD	,834 (23.3%)	5543 (22.2%)	4984 (19.9%)	4532 (18.1%)	3938 (15.8%)
Diabetes 1	695 (2.8%)	555 (2.2%)	435 (1.7%)	389 (1.6%)	268 (1.1%)
Diabetes 2	3380 (13.5%)	2812 (11.3%)	2230 (8.9%)	1781 (7.1%)	1327 (5.3%)
Hypertension	10,045 (40.2%)	9863 (39.5%)	9568 (38.3%)	9248 (37.0%)	8756 (35.1%)
Hyperlipidemia	2694 (10.8%)	2618 (10.5%)	2433 (9.7%)	2256 (9.0%)	2013 (8.1%)
Obesity	1409 (5.6%)	1340 (5.4%)	1025 (4.1%)	840 (3.4%)	595 (2.4%)
Vital parameters					
Systolic BP (mmHg)†	145 (25)	146 (25)	147 (24)	148 (24)	147(23)
Diastolic BP (mmHg)†	84 (14)	84 (14)	85 (14)	85 (14)	84 (14)
Respiratory rate (bpm)†	18 (4)	18 (4)	17 (3)	17 (3)	17 (3)
Heart rate (bpm)†	81 (18)	80 (18)	80 (18)	79 (18)	78 (18)
Temperature (C)†	36.8(0.7)	36.8 (0.6)	36.8 (0.6)	36.8 (0.6)	36.8 (0.6)
Saturation (%)*	98 (96–99)	98 (96–99)	98 (96–99)	98 (96–99)	98 (96–99)
Departure					
Admitted	8458 (33.8%)	8159 (32.6%)	7899 (31.6%)	7747 (31.0%)	7575 (30.3%)
Home	16,210 (64.8%)	16,538 (66.2%)	16,839 (67.4%)	17,010 (68.1%)	17,189 (68.8%)
Other	342 (1.4%)	298 (1.2%)	261 (1.0%)	237 (0.9%)	217 (0.9%)
ED time variables					
EDLOS > 6 h	6880 (27.5%)	6423 (25.7%)	6267 (25.1%)	6010 (24.0%)	5935 (23.8%)
Time to physician longer than triage recommendation	9925 (39.7%)	9482 (37.9%)	9108 (36.4%)	8964 (35.9%)	8750 (35.0%)

Note: Data are presented as median (interquartile range)* or mean (SD)† for continuous measures, and *n* (%) for categorical measures. Income quintiles were stratified by gender and age-groups. ‡Educational categories refer to compulsory (<10 years), upper secondary (10–12 years), and postsecondary (>12 years) education. §Triage priority level based on the urgency of medical treatment according to the rapid emergency triage and treatment system (RETTS-A)[23–24]: Red (need to see a physician immediately), orange (within 20 min), yellow (within 120 min), green (within 240 min), and blue (no time defined).

Abbreviations: BP, blood pressure; CVD, cardiovascular disease; ED, emergency department; EDLOS, emergency department length of stay; kSEK, thousand Swedish kronor.

medical service and higher triage priority was more common in the lowest income quintile. The cardiovascular risk factors were in general more frequent among people with lower income. Previous CVD was highly overrepresented in lower income groups, as was diabetes, hypertension, and obesity.

3.2 | Time to physician assessment

The number of patients with a longer time to physician assessment than recommended by triage was 9925 (39.7%) in the lowest income quintile compared to 8750 (35.0%) in the highest income quintile. The odds of having a longer time to physician assessment than recommended by triage was higher in the group with lowest income compared to highest income (Table 2), both in univariate analysis odds ratio (OR) 1.25 (95% CI 1.20–1.29) and when fully adjusted for confounders, OR 1.10 (95% CI 1.05–1.15). Overall time to physician assessment by income quintile is presented in Table 3. The predicted time to physician assessment was 4 min (5.3%) longer in the lowest versus the highest income quintile when adjusting for ED management circumstances.

TABLE 2 Odds of longer time to physician assessment than recommended by triage and length of stay >6 h for patients with chest pain by income quintile presented as odds ratio (95% confidence interval).

Longer time to physician assessment than recommended by triage			
Household disposable income	Crude (OR)	Adjusted for age, gender, and sociodemographic variables (OR)	Adjusted for age, gender, sociodemographic variables, and ED-management circumstances (OR)
Quintile 1	1.25 (1.20–1.29)	1.15 (1.10–1.19)	1.10 (1.05–1.15)
Quintile 2	1.15 (1.11–1.19)	1.09 (1.05–1.13)	1.05 (1.00–1.09)
Quintile 3	1.07 (1.04–1.12)	1.04 (1.00–1.08)	1.03 (0.99–1.08)
Quintile 4	1.04 (1.01–1.08)	1.03 (0.99–1.07)	1.02 (0.98–1.06)
Quintile 5	1	1	1
Length of stay ≥6 h			
	(OR)	(OR)	(OR)
Quintile 1	1.22 (1.17–1.27)	1.20 (1.15–1.26)	1.19 (1.14–1.25)
Quintile 2	1.11 (1.07–1.16)	1.09 (1.05–1.14)	1.10 (1.05–1.15)
Quintile 3	1.07 (1.03–1.19)	1.06 (1.02–1.11)	1.08 (1.03–1.12)
Quintile 4	1.02 (0.98–1.06)	1.01 (0.97–1.06)	1.02 (0.98–1.06)
Quintile 5	1	1	1

Abbreviations: CI, confidence interval; ED, emergency department; OR, odds ratio.

TABLE 3 Time to physician assessment and length of stay for patients with chest pain in the emergency department according to income presented as predicted time in hours (95% confidence interval) crude and adjusted for confounders.

Time to physician assessment			
Household disposable income	Crude (h:min)	Adjusted for age, gender, and sociodemographic variables (h:min)	Adjusted for age, gender, sociodemographic variables, and ED-management circumstances (h:min)
Quintile 1	1:05 (1:04–1:06)	1:05 (1:04–1:05)	1:12 (1:11–1:13)
Quintile 2	1:03 (1:02–1:04)	1:04 (1:02–1:04)	1:10 (1:10–1:11)
Quintile 3	1:04 (1:02–1:04)	1:05 (1:04–1:05)	1:10 (1:10–1:11)
Quintile 4	1:04 (1:02–1:04)	1:05 (1:04–1:06)	1:09 (1:08–1:10)
Quintile 5	1:05 (1:04–1:05)	1:06 (1:05–1:07)	1:08 (1:07–1:09)
Length of stay			
Quintile 1	4:07 (4:05–4:09)	4:07 (4:05–4:09)	4:11 (4:08–4:13)
Quintile 2	4:01 (3:59–4:03)	4:01 (3:59–4:02)	4:04 (4:02–4:07)
Quintile 3	3:58 (3:58–4:01)	3:59 (3:58–4:01)	4:03 (4:01–4:05)
Quintile 4	3:55 (3:54–3:58)	3:56 (3:55–3:58)	3:59 (3:58–4:02)
Quintile 5	3:54 (3:53–3:57)	3:55 (3:54–3:58)	3:58 (3:56–4:00)

Abbreviation: ED, emergency department.

3.2.1 | ED length of stay

The number of patients with an EDLOS >6 h was 9925 (39.7%) in the lowest income quintile compared to 8750 (35.0%) in the highest income quintile. The odds for having a EDLOS >6 h was higher in the group with lowest income compared to highest income (Table 2), both in univariate analysis OR 1.22 (95% CI 1.17–1.27) and when fully adjusted for confounders OR 1.19 (95% CI1.14–1.25). In the crude analysis, predicted EDLOS was 13 min longer in the lowest income quintile compared to the highest income quintile and the differences in predicted EDLOS remained similar after adjusting for confounders (Table 3). Similarly, in both univariable and multivariable regression analyses, a lower annual income was associated with a longer EDLOS with a gradual increase over the quintiles as illustrated in Figure 2. The median time to physician assessment and EDLOS by income quintile are presented in Table S2. Results were similar in analyses restricted to regional and county hospital, respectively (Table S3–S4).

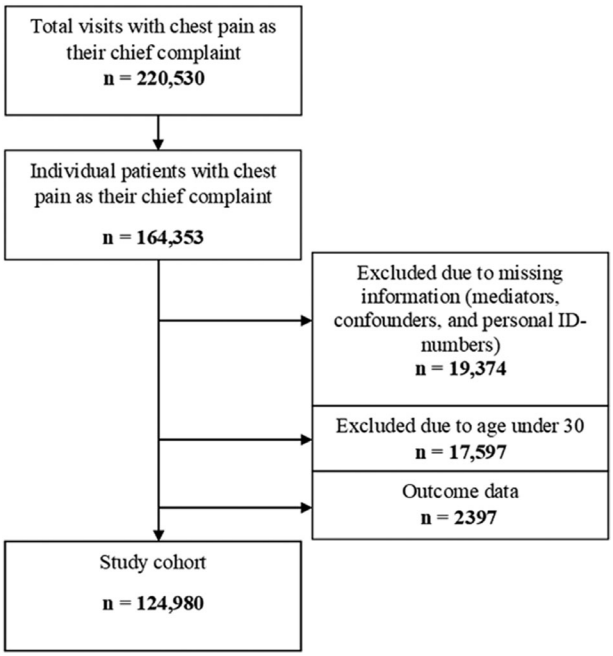

FIGURE 1 Selection of participants.

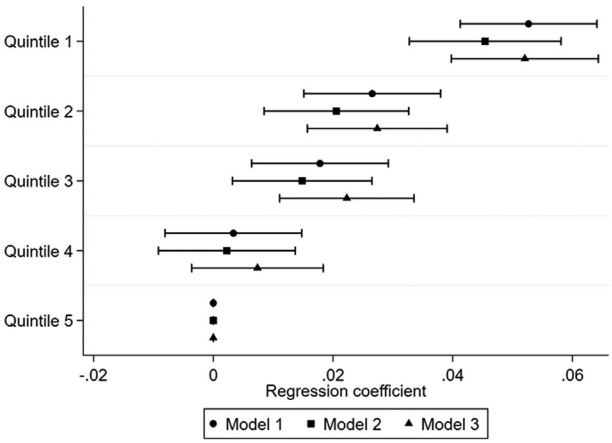

FIGURE 2 Length of stay in all patients with chest pain by income quintile presented in coefficient log-hour with 95% CI. Quintile 5 with highest income is the reference group. Model 1 is crude. Model 2 is adjusted for age, gender, and sociodemographic variables. Model 3 is adjusted for age, gender, sociodemographic variables, and ED-management circumstances. Abbreviations: CI, confidence interval; ED, emergency department.

3.3 | Patients with major adverse cardiac events

Within the subgroup ultimately diagnosed with major adverse cardiac events (MACE), the time to physician assessment was approximately 30 min shorter and EDLOS was approximately 1 h shorter than for all patients (Table S2). The odds for having a longer time to physician than recommended by triage among patients with MACE is presented in Table S5 and was higher in the group with lowest income compared to highest income in the univariate analysis OR 1.19 (95% CI 1.02–1.40). However, no differences between income groups were observed when adjustments were made for age, gender, sociodemographic variables, and ED-management circumstances. The predicted time to physician assessment and EDLOS was also similar across income groups when adjusted for confounders (Table S6).

4 | LIMITATIONS

Strengths of this study include the large cohort and reliable individual-level data from a variety of EDs obtained through SVAR and national registries. The wealth of data allowed for control of plausible confounding factors including priority as a proxy for acuity and language barriers although the risk of residual confounding is inherent with the observational design. Although we did adjust for different types of ED (smaller rural hospitals and larger regional university hospitals) that generally have different volumes of patients, we could not adjust the analysis for variation in ED census and crowding due to lack of such data.

There may be differences in how the data are collected, measured, and uploaded in the electronic health care records at different hospitals and EDs. Disposable income and secondarily educational level were used to define SES. However, other unmeasured indicators of SES may have better captured SES in our study setting. The study design did not allow for inclusion of patients without a Swedish personal identification number, such as undocumented immigrants and temporary visitors to Sweden. The management and disposition of chest pain patients may differ between countries and such differences may influence the generalizability of the findings.

5 | DISCUSSION

In this large cohort study on consecutive chest pain patients attended at a representative sample of Swedish EDs, low-income groups were more likely to have longer time to physician than recommended by triage as well as a EDLOS over 6 h. The association was independent of age, sex, sociodemographic variables, ED management circumstances, and cardiovascular risk factors. This finding is novel and may add to the understanding of ED crowding and the generally worse outcomes in low SES groups. The clinical significance of observing longer time to physician than recommended by triage also for patients later diagnosed with MACE is unclear but may indicate that SES should be considered early by ED-staff, at or after triage, in chest pain patients.

Our main findings were that low SES was associated both with a longer time to physician than recommended by triage and a longer EDLOS. Many previous studies have indicated that ED crowding, and long EDLOS are associated with increased mortality and morbidity.[1,5,6,8,14] In several studies, SES has also been associated with higher morbidity and mortality in general and specifically in ACS, which is a major underlying cause of ED chest pain.[10,12,25] Although the small observed differences in time to physician assessment and EDLOS between income groups may not affect hard outcomes in the individual patient, they represent an inequity on a group level that remained

significant after adjusting for a vast number of possible confounders. Our finding that patients with MACE had a longer time to physician than recommended by triage but did not have significant differences in total EDLOS by income group is important because it strongly suggests that the measures after the physician assessment help in achieving equal care. However, as the clinical significance of our findings remain unclear, further study is warranted.

In particular, the finding that low income was associated with a longer wait for the physician assessment than recommended by the initial triage, also in the crude analysis of patients subsequently diagnosed with MACE, suggest that SES is a factor that contributes to inequality in timely care in the ED. A recent study also found inequality in access to timely care in British EDs,[26] but our finding based on individual-level SES-data is novel and may add to the understanding of social inequities in the initial chain of acute care. Future studies are needed to clarify the reasons for these differences.

In the group arriving with emergency medical service, there was a higher proportion of people with low income. Arriving with emergency medical service can be used as an indicator of an on average sicker patient or of a reduced capability of independently seeking care.[19] It is possible that these results indicate that people with lower SES seek care when their symptoms become more severe.[18] In coherence with our results that low SES was associated with arrival by emergency medical service, a German study has previously shown that there is a greater share of deployment of emergency medical service in socially disadvantaged areas measured by unemployment rates.[27] The observed differences in triage level, with the higher prioritized triage levels being more common in low income, may also indicate that people with low income are sicker when they seek care.[18] These are factors that all decrease the time to physician assessment and may explain why longer time to physician among low (vs high) SES was observed in the fully adjusted model only.

In agreement with previous reports, traditional risk factors such as diabetes, hypertension, hyperlipidemia, obesity, and previous CVD were all more common in low-income groups in this study.[10–13] However, this alone does not explain a higher incidence and recurrence of acute myocardial infarction (AMI) and CVD in lower SES groups.[9,15,28–29] Previous studies have shown that recurrent CVD after AMI may be predicted by disposable income, education level, and marital status even when adjusting for cardiovascular risk factors.[30] An unmarried status has previously been associated with higher risk of AMI.[31] We found that being married was more common in groups with high income and unmarried was more common in low income groups when adjusted for age. Marital status could possibly be associated with morbidity because marriage can be seen as a support system in taking prescribed medication along with healthy lifestyle and reduced stress.[32–33]

In conclusion, among unselected ED chest pain patients in a tax-financed health care system, low income was associated with longer time to physician than recommended by triage and longer EDLOS. Longer process times may have a negative impact due to crowding in the ED and the longer time to physician than recommended by triage observed in patients with MACE may delay diagnosis and timely treatment for the individual patient. Our findings suggest that ED staff should be aware of socioeconomic disparities and that SES should be considered in chest pain patients. Further study is needed to elucidate why ED waiting times are longer in low SES including components other than time to physician assessment.

AUTHOR CONTRIBUTIONS

Study concept and design (Sebastian Herlitz, Joel Ohm, Henrike Häbel, and Per Svensson), acquisition of the data (Per Svensson), analysis and interpretation of the data (Sebastian Herlitz, Joel Ohm, Henrike Häbel, Ulf Ekelund, Robin Hofmann, and Per Svensson), drafting of the manuscript (Sebastian Herlitz Joel Ohm, and Per Svensson), critical revision of the manuscript for important intellectual content (Sebastian Herlitz, Joel Ohm, Henrike Häbel, Ulf Ekelund, Robin Hofmann, and Per Svensson), statistical expertise (Henrike Häbel), and acquisition of funding (Per Svensson)

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CONFLICT OF INTEREST STATEMENT

The authors report no conflict of interest.

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REFERENCES

1. Wickman L, Svensson P, Djärv T. Effect of crowding on length of stay for common chief complaints in the emergency department: a STROBE cohort study. *Medicine*. 2017;96:e8457. doi:10.1097/MD.0000000000008457
2. Dawson LP, Smith K, Cullen L, et al. Care models for acute chest pain that improve outcomes and efficiency: JACC state-of-the-art review. *J Am Coll Cardiol*. 2022;79:2333-2348. doi:10.1016/j.jacc.2022.03.380
3. Cannon CP, Gibson CM, Lambrew CT, et al. Relationship of symptom-onset-to-balloon time and door-to-balloon time with mortality in patients undergoing angioplasty for acute myocardial infarction. *JAMA*. 2000;283:2941-2947. doi:10.1001/jama.283.22.2941
4. Foo CY, Bonsu KO, Nallamothu BK, et al. Coronary intervention door-to-balloon time and outcomes in ST-elevation myocardial infarction: a meta-analysis. *Heart*. 2018;104:1362-1369. doi:10.1136/heartjnl-2017-312517
5. Morley C, Unwin M, Peterson GM, Stankovich J, Kinsman L. Emergency department crowding: a systematic review of causes, consequences and solutions. *PLoS One*. 2018;13:e0203316. doi:10.1371/journal.pone.0203316
6. Hoot NR, Aronsky D. Systematic review of emergency department crowding: causes, effects, and solutions. *Ann Emerg Med*. 2008;52:126-136. doi:10.1016/j.annemergmed.2008.03.014 e121
7. Paling S, Lambert J, Clouting J, González-Esquerré J, Auterson T. Waiting times in emergency departments: exploring the factors associated with longer patient waits for emergency care in England using routinely collected daily data. *Emerg Med J*. 2020. doi:10.1136/emermed-2019-208849. emermed-2019-208849.
8. Perdahl T, Axelsson S, Svensson P, Djärv T. Patient and organizational characteristics predict a long length of stay in the emergency department - a Swedish cohort study. *Eur J Emerg Med*. 2017;24:284-289. doi:10.1097/MEJ.0000000000000352

9. Kivimäki M, Batty GD, Pentti J, et al. Association between socioeconomic status and the development of mental and physical health conditions in adulthood: a multi-cohort study. *Lancet Public Health*. 2020;5:e140-e149. doi:10.1016/s2468-2667(19)30248-8
10. Reijneveld SA. Neighbourhood socioeconomic context and self reported health and smoking: a secondary analysis of data on seven cities. *J Epidemiol Community Health*. 2002;56:935-942. doi:10.1136/jech.56.12.935
11. Roth C, Berger R, Kuhn M. The role of the socio-economic environment on medical outcomes after ST-segment elevation myocardial infarction. *BMC Public Health*. 2019;19:630. doi:10.1186/s12889-019-6966-z
12. Jones DA, Howard JP, Rathod KS, et al. The impact of socio-economic status on all-cause mortality after percutaneous coronary intervention: an observational cohort study of 13,770 patients. *EuroIntervention*. 2015;10:e1-8. doi:10.4244/EIJV10I10A196
13. Lynch JW, Kaplan GA, Cohen RD, Tuomilehto J, Salonen JT. Do cardiovascular risk factors explain the relation between socioeconomic status, risk of all-cause mortality, cardiovascular mortality, and acute myocardial infarction? *Am J Epidemiol*. 1996;144:934-942. doi:10.1093/oxfordjournals.aje.a008863
14. Dawson LP, Andrew E, Nehme Z, et al. Association of socioeconomic status with outcomes and care quality in patients presenting with undifferentiated chest pain in the setting of universal health care coverage. *J Am Heart Assoc*. 2022;11. doi:10.1161/jaha.121.024923
15. Manrique-Garcia E, Sidorchuk A, Hallqvist J, Moradi T. Socioeconomic position and incidence of acute myocardial infarction: a meta-analysis. *J Epidemiol Community Health*. 2011;65:301-309. doi:10.1136/jech.2009.104075
16. Kort D, Van Rein N, Van Der Meer FJM, et al. Relationship between neighborhood socioeconomic status and venous thromboembolism: results from a population-based study. *J Thromb Haemost*. 2017;15:2352-2360. doi:10.1111/jth.13868
17. Kabbani LS, Wasilenko S, Nypaver TJ, et al. Socioeconomic disparities affect survival after aortic dissection. *J Vasc Surg*. 2016;64:1239-1245. doi:10.1016/j.jvs.2016.03.469
18. Schröder SL, Fink A, Hoffmann L, et al. Socioeconomic differences in the pathways to diagnosis of coronary heart disease: a qualitative study. *Eur J Public Health*. 2017;27:1055-1060. doi:10.1093/eurpub/ckx147
19. Af Ugglas B, Lindmarker P, Ekelund U, Djärv T, Holzmann MJ. Emergency department crowding and mortality in 14 Swedish emergency departments, a cohort study leveraging the Swedish Emergency Registry (SVAR). *PLoS One*. 2021;16:e0247881. doi:10.1371/journal.pone.0247881
20. Elm EV, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. Strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. *BMJ*. 2007;335:806-808. doi:10.1136/bmj.39335.541782.ad
21. Ludvigsson JF, Svedberg P, Olén O, Bruze G, Neovius M. The longitudinal integrated database for health insurance and labour market studies (LISA) and its use in medical research. *Eur J Epidemiol*. 2019;34:423-437. doi:10.1007/s10654-019-00511-8
22. Statistics Sweden. *Longitudinal integration database for health insurance and labour market studies (LISA)*. Statistics Sweden; 2022. Accessed December 13. http://www.scb.se/lisa-en
23. Widgren BR, Jourak M. Medical Emergency Triage and Treatment System (METTS): a new protocol in primary triage and secondary priority decision in emergency medicine. *J Emerg Med*. 2011;40:623-628. doi:10.1016/j.jemermed.2008.04.003
24. Rosenqvist M, Bengtsson-Toni M, Tham J, Lanbeck P, Melander O, Akesson P. Improved outcomes after regional implementation of sepsis alert: a novel triage model. *Crit Care Med*. 2020;48:484-490. doi:10.1097/CCM.0000000000004179
25. Suadicani P, Hein HO, Gyntelberg F. Socioeconomic status and ischaemic heart disease mortality in middle-aged men: importance of the duration of follow-up. The Copenhagen Male Study. *Int J Epidemiol*. 2001;30:248-255. doi:10.1093/ije/30.2.248
26. Turner AJ, Francetic I, Watkinson R, Gillibrand S, Sutton M. Socioeconomic inequality in access to timely and appropriate care in emergency departments. *J Health Econ*. 2022;85:102668. doi:10.1016/j.jhealeco.2022.102668
27. Hanefeld C, Haschemi A, Lampert T, et al. Social gradients in myocardial infarction and stroke diagnoses in emergency medicine. *Dtsch Arztebl Int*. 2018;115:41-48. doi:10.3238/arztebl.2018.0041
28. Kucharska-Newton AM, Harald K, Rosamond WD, Rose KM, Rea TD, Salomaa V. Socioeconomic indicators and the risk of acute coronary heart disease events: comparison of population-based data from the United States and Finland. *Ann Epidemiol*. 2011;21:572-579. doi:10.1016/j.annepidem.2011.04.006
29. Clark AM, Desmeules M, Luo W, Duncan AS, Wielgosz A. Socioeconomic status and cardiovascular disease: risks and implications for care. *Nat Rev Cardiol*. 2009;6:712-722. doi:10.1038/nrcardio.2009.163
30. Ohm J, Skoglund PH, Discacciati A, et al. Socioeconomic status predicts second cardiovascular event in 29,226 survivors of a first myocardial infarction. *Eur J Prev Cardiol*. 2018;25:985-993. doi:10.1177/2047487318766646
31. Lammintausta A, Airaksinen JK, Immonen-Räihä P, et al. Prognosis of acute coronary events is worse in patients living alone: the FINAMI myocardial infarction register. *Eur J Prev Cardiol*. 2014;21:989-996. doi:10.1177/2047487313475893
32. Hu B, Li W, Wang X, et al. Marital status, education, and risk of acute myocardial infarction in mainland China: the INTER-HEART study. *J Epidemiol*. 2012;22:123-129. doi:10.2188/jea.je20100175
33. Chen R, Zhan Y, Pedersen N, et al. Marital status, telomere length and cardiovascular disease risk in a Swedish prospective cohort. *Heart*. 2020;106:267-272. doi:10.1136/heartjnl-2019-315629

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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