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Impact of socioeconomic status on survival following ST-elevation myocardial infarction in a universal healthcare system

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ABSTRACT

Background: Lower socioeconomic status (SES) has been associated with worse outcomes after acute myocardial infarction. Data for survival after ST-elevation myocardial infarction (STEMI) by SES in the current era of primary percutaneous coronary intervention (PCI) is more limited.
Methods: Data was collected for all patients with acute STEMI undergoing primary PCI at The South Yorkshire Cardiothoracic Centre, UK between 2009 and 2014. A Cox regression analysis was used to assess differences in survival by SES quartile (using an area-level measure).
Results: Of the 3126 STEMI patients, 2655 (84.9%) were first presentations of STEMI. Lower SES groups generally had a less favourable baseline cardiovascular risk factor profile, with higher rates of smoking ($p = 0.001$), diabetes ($p = 0.007$) and previous coronary heart disease ($p = 0.025$). With the exception of beta-blockers, the use of secondary preventative medications was similar between SES quartiles. Adjusting for age and gender, the most disadvantaged SES quartile trended to a non-significant increased mortality at 30 days (hazard ratio 1.35 (0.79–2.33)), 1 year (1.12 (0.76–1.65)), or 3 years (1.22 (0.88–1.70)) compared to the least disadvantaged SES quartile, but this was attenuated by adjusting for additional cardiovascular risk factors and medication use on discharge.
Conclusions: In this large study of unselected STEMI patients managed by primary PCI, we did not find any significant differences in survival by SES at 30 days, 1 year, or 3 years.

1. Introduction

There is a well-described association between socioeconomic status (SES) and coronary heart disease (CHD), with worse outcomes reported for lower SES groups [1–3]. This has been shown for both individual (e.g. education, income) [1–3] and area-level (e.g. post-code) measures of SES [4,5], and has been demonstrated in countries with universal healthcare systems [1].

The vast majority of studies which have investigated this association to date have grouped ST-elevation myocardial infection (STEMI) and non-ST elevation myocardial infarction (NSTEMI) together as acute myocardial infarction (MI) [1–21]. A major difference is in treatment. The paradigm of care for STEMI is urgent reperfusion therapy, whereas time to treatment in NSTEMI patients is more elective, dependent on risk stratification. It has previously been reported that lower SES groups have reduced access to elective revascularisation procedures [22], albeit with conflicting evidence [23], but have a greater use of emergency treatments [24]. In addition, many of the previous studies were conducted in the nineties or early 2000s, when the predominant reperfusion strategy for STEMI was thrombolysis [4,6,11,13–16,18,20,21]. Timely primary percutaneous coronary intervention (PCI) is now the gold-standard treatment for all STEMI patients [25], and is associated with improved outcomes relative to thrombolysis [2,26,27]. There are few studies which have assessed outcomes by SES in STEMI patients in the era of primary PCI treatment, and in many of these PCI hasn't been the predominant treatment strategy. We aimed to assess survival after an acute STEMI treated by primary PCI at 30 days, 1 year, and 3 years by SES in a contemporary population.

Abbreviations: CI, Confidence interval; CHD, Coronary heart disease; CKD, Chronic kidney disease; IMD, Index of multiple deprivation; LSOA, Lower layer super output area; MI, Myocardial infarction; NHS REC, National Health Service Research Ethics Committee; ONS, Office for National Statistics; PCI, Percutaneous coronary intervention; SES, Socioeconomic status; STEMI, ST-segment elevation myocardial infarction; TIA, Transient ischemic attack.

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2. Methods

2.1. Study population

This large, single-centred retrospective cohort study included all patients admitted with a diagnosis of acute STEMI undergoing primary PCI at The South Yorkshire Cardiothoracic Centre, Northern General Hospital, UK from 1st January 2009 to 14th January 2014. Patients were identified from the departmental coronary intervention database. The sample size was defined by the period of data collection, and commenced with the introduction of the primary PCI service in the South Yorkshire region - which has an approximate catchment population of 1.4 million [28]. Between 2012 and 2014, 99.4–99.7% of STEMI patients receiving reperfusion therapy at the South Yorkshire Cardiothoracic Centre received primary PCI, and 82.5–87.1% of patients received primary PCI within 90 min of arrival at the centre [25].

2.2. Data collection and variable definition

Case notes for all patients were reviewed to obtain more detailed information. Three of the authors (LS, AL, and JP) obtained copies of patient notes and hand-reviewed these using a standardised proforma to record the following variables: date of STEMI, age, gender, postcode of residence, drug use on discharge, hypertension, dyslipidaemia, diabetes, family history of coronary heart disease (CHD), previous CHD, chronic kidney disease (CKD) stage IV or V, previous transient ischaemic attack (TIA) or stroke, peripheral vascular disease, body mass index (BMI), and smoking status. Smoking status was categorised as current smoker, ex-smoker, and never smoker, with ex-smoker defined as one month of smoking cessation or documentation of ex-smoker in case notes. If smoking status was not documented in case notes, the primary care practitioners of the patients were contacted to obtain the smoking status where possible.

Postcode was used as a proxy for SES. Patient postcodes were queried against the Office for National Statistics' (ONS) Postcode service to Index of Multiple Deprivation (IMD) values for each patient. IMD values are the most commonly used method of measuring deprivation in England and are based on small areas called lower-layer super output areas (LSOAs). There are 32 844 LSOAs in England, each with a mean population of around 1500. IMD values are based on seven domains, weighted as income (22.5%); employment (22.5%); education, skills, and training (13.5%); health (13.5%); crime (9.3%); housing and services (9.3%); and living environment (9.3%). Each IMD value was automatically assigned a decile corresponding to national deprivation by the ONS Postcode service. Each study participant was then categorised into a SES quartile: patients up to the second decile nationally as Q1 (most disadvantaged SES), in the third to fifth deciles as Q2, in the sixth to eighth deciles as Q3, and the eighth to tenth centiles as Q4.

The only variable obtained directly from the departmental coronary intervention database was the number of diseased vessels, which was available for 2648/3126 cases (84.7%). This variable was not included in the multivariable analyses. BMI was also not included in analyses as this was inconsistently documented in clinical notes (955/3126 (30.6%)).

Survival status was collected from the ONS for all patients using the National Health Service number for each study participant.

2.3. Statistical analyses

Continuous variables with a normal distribution were presented as mean (95% confidence interval (CI)). Categorical variables were presented as number (percentage). Differences in baseline characteristics between SES groups were assessed using the Chi-squared test for categorical variables and one-way analysis of variance (ANOVA) for continuous variables.

Kaplan-Meier plots were used to assess unadjusted survival post-STEMI by SES, and differences were assessed for statistical significance using the log-rank test. Multivariable Cox regression analysis was used to adjust for age and gender. Age was categorised for the analysis due to a non-linear association with risk and age groups selected based on similar risk between five-year age bands (<45 years, 45–54 years, 55–64 years, 65–74 years, 75–84 years, ≥85 years). An additional Cox model was constructed to also adjust for additional cardiovascular risk factors (and thus included age, gender, smoking status, hypertension, dyslipidaemia, diabetes, a family history of CHD, previous CHD, CKD stage IV or V, previous TIA or stroke, peripheral vascular disease) and medication use on discharge (aspirin, P2Y12 receptor inhibitor, angiotensin-converting-enzyme inhibitor/angiotensin receptor blocker, beta-blocker, statin, and mineralocorticoid antagonist). A sub-analysis was performed including only patients who were presenting with their first STEMI. We also undertook sensitivity analyses to examine whether our findings were robust: one analysis in which SES was divided into quintiles, one with SES separated into terciles, and one with age, gender, and additional cardiovascular risk factors included in the Cox model. These modifications did not significantly change results.

SPSS version 24.0.0.0 was used for all statistical analyses.

2.4. Ethics

At the time of study initiation, National Health Service Research Ethics Committee (NHS REC) approval was not required for research involving previously collected data extracted from hospital records and rendered non-identifiable by the direct care team before being used for research purposes. Institutional permission was gained via the Sheffield Teaching Hospitals Research and Development Department to ensure the study's compliance with the Data Protection Act and to protect patient confidentiality.

3. Results

3.1. Patients

During the study period of five years, 3298 patients underwent PCI for STEMI. We excluded cases with missing data for smoking status (n = 165 (5.0%)) and SES (n = 7 (0.2%)). Of the 3126 included patients, 2655 (84.9%) were first presentations of STEMI. Complete three-year follow-up was available for 100% of patients.

The population was more deprived than the national average, with 1098 patients in Q1 (35.1%), 945 in Q2 (30.2%), 752 in Q3 (24.1%), and 331 in Q4 (10.6%). More disadvantaged SES groups generally had a less favourable baseline cardiovascular risk factor profile (Table 1). Risk factors that were significantly differently distributed among SES quartiles were smoking prevalence (p = 0.001), diabetes (p = 0.006), previous CHD (p = 0.007), and age (p = 0.001). Smoking status was the only modifiable risk factor with a clear gradient by SES. Mean age at time of STEMI increased sequentially by SES quartile: from 59.7 years (95% CI 59.0–60.5) in Q1, 62.1 years (61.3–62.0) in Q2, 63.8 years (63.0–64.7) in Q3, to 65.5 years (64.2–66.8) in Q4.

Use of secondary preventative medications was similar between SES quartiles, with the exception of beta-blockers, which were prescribed less frequently in lower SES groups (Table 1). There were no significant differences in the type of $P2Y_{12}$ receptor inhibitor used by SES. From 2012 onwards, ticagrelor was the most commonly used $P2Y_{12}$ receptor inhibitor for all SES groups (72.9–82.1%). Patients who were prescribed clopidogrel from 2012 onwards were significantly older (mean age 71.5 years (68.8–74.2)) than those prescribed ticagrelor (61.2 years (60.5–62.3)) or prasugrel (60.7 years (59.3–62.2)) (p = 0.001).

3.2. Survival following STEMI

In a univariate analysis, there were no significant differences between SES groups in survival following STEMI at 30 days (log-rank p = 0.93), 1 year (log-rank p = 0.93) and 3 years (log-rank p = 0.98; Fig. 1A).

A Cox model to address case-mix differences between SES quartiles in age and gender was constructed. Compared to the least deprived quartile, the most deprived quartile had no significantly increased mortality at 30 days (hazard ratio (HR) 1.35 (0.79–2.33)), 1 year (HR 1.12 (0.76–1.65)), or 3 years (HR 1.22 (0.88–1.70); Fig. 1B) (Table 2). Adjusting for differences in cardiovascular risk factor profile and medication use on discharge between SES quartiles did not significantly affect results, whether presented as both genders together (Table 3) or as males and females separately (Supplementary file).

In a sub-analysis of first STEMI patients only, there were no significant differences in unadjusted survival between SES groups at 30 days (log-rank p = 0.93), 1 year (log-rank p = 0.78) and 3 years (log-rank p = 0.51). In a multivariable analysis, there remained no significant differences in survival. Compared to the least deprived quartile, the most deprived quartile had no significantly increased mortality at 30 days (HR 1.63 (0.85–3.15)), 1 year (HR 1.15 (0.73–1.81)), and 3 years (HR 1.29 (0.88–1.88)) (Supplementary file).

4. Discussion

We assessed survival by SES after STEMI in patients treated by primary PCI with adjustment for age and gender in a country of universal healthcare coverage. In this contemporary population, we found no statistically significant differences in survival following STEMI at 30 days, 1 year, or 3 years between SES quartiles.

Studies which have investigated the relationship between survival after STEMI treated by PCI and SES are limited [29–33]. Three of these studies were conducted in the United States. These all reported an increased risk of in-hospital mortality in lower SES groups, with SES measured by zip code in two of the studies [30,34], and by insurance

Table 1
Differences in baseline characteristics and mortality between SES groups.

	Q1 (n = 1098; 35.1%)		Q2 (n = 945; 30.2%)		Q3 (n = 752; 24.1%)		Q4 (n = 331; 10.6%)		p
	Count	%	Count	%	Count	%	Count	%	
Baseline characteristics									
Male	768	69.9%	707	74.8%	564	75.0%	250	75.5%	*0.025*
Smoking status									*0.001*
- Current smoker	682	62.1%	420	44.4%	285	37.9%	94	28.4%	
- Ex-smoker	244	22.2%	299	31.6%	256	34.0%	109	32.9%	
- Never smoker	172	15.7%	226	23.9%	211	28.1%	128	38.7%	
Hypertension	428	39.0%	365	38.6%	302	40.2%	134	40.5%	*0.884*
Dyslipidemia	406	37.0%	342	36.2%	246	32.7%	117	35.3%	*0.285*
Diabetes	175	15.9%	141	14.9%	78	10.4%	45	13.6%	*0.006*
Previous CHD	229	20.9%	178	18.8%	109	14.5%	61	18.4%	*0.007*
Family history of CHD	455	41.4%	389	41.2%	303	40.3%	132	39.9%	*0.937*
CKD stage IV or V	15	1.4%	10	1.1%	6	0.8%	4	1.2%	*0.715*
Peripheral vascular disease	50	4.6%	27	2.9%	39	5.2%	14	4.2%	*0.092*
Previous TIA or stroke	58	5.3%	49	5.2%	36	4.8%	18	5.4%	*0.960*
BMI									*0.376*
- Underweight	2	0.6%	4	1.5%	0	0%	1	1.0%	
- Normal	101	28.6%	68	26.1%	64	26.8%	38	37.3%	
- Overweight	139	39.4%	106	40.6%	106	44.4%	39	38.2%	
- Obese	111	31.5%	83	31.8%	69	28.9%	24	23.5%	
Number of diseased vessels									*0.351*
- 0	5	0.5%	4	0.4%	1	0.1%	3	0.9%	
- 1	499	45.4%	449	47.5%	358	47.6%	142	42.9%	
- 2	139	12.7%	133	14.1%	115	15.3%	56	16.9%	
- 3	289	26.3%	216	22.9%	167	22.2%	79	23.9%	
Age groups									*0.001*
- <45 years	154	14.0%	82	8.7%	56	7.4%	15	4.5%	
- 45–55 years	280	25.5%	225	23.8%	137	18.2%	48	14.5%	
- 55–65 years	299	27.2%	263	27.8%	212	28.2%	106	32.0%	
- 65–75 years	220	20.0%	224	23.7%	212	28.2%	89	26.9%	
- 75–85 years	122	11.1%	121	12.8%	110	14.6%	56	16.9%	
- >85 years	23	2.1%	30	3.2%	25	3.3%	17	5.1%	
Mortality									
30-day mortality	62	37.1%	51	30.5%	37	22.2%	17	10.2%	*0.919*
1-year mortality	103	34.6%	89	29.9%	71	23.8%	35	11.7%	*0.926*
3-year mortality	153	35.1%	133	30.5%	102	23.4%	48	11.0%	*0.979*
Drug use on discharge									
Aspirin	1023	93.2%	882	93.3%	703	93.5%	311	94.0%	*0.965*
P2Y12 receptor inhibitor	1033	95.2%	892	95.3%	702	94.7%	311	94.8%	*0.947*
Clopidogrel	248	23.8%	191	21.3%	167	23.5%	76	24.3%	
Prasugrel	386	37.0%	350	39.0%	268	37.7%	122	39.0%	
Ticagrelor	410	39.2%	356	39.7%	275	38.7%	115	36.7%	
ACEi/ARB	927	84.4%	812	85.9%	630	83.8%	288	87.0%	*0.415*
Beta-blocker	837	76.2%	731	77.4%	594	79.0%	276	83.4%	*0.041*
Statin	996	90.7%	857	90.9%	671	89.2%	298	90.0%	*0.657*
MRA	76	6.9%	75	7.9%	78	10.4%	27	8.2%	*0.066*

ACEi = angiotensin-converting-enzyme inhibitor, ARB = angiotensin II receptor blocker, BMI = body mass index, CHD = coronary heart disease, CKD = chronic kidney disease, MRA = mineralocorticoid receptor antagonist, TIA = transient ischemic attack.

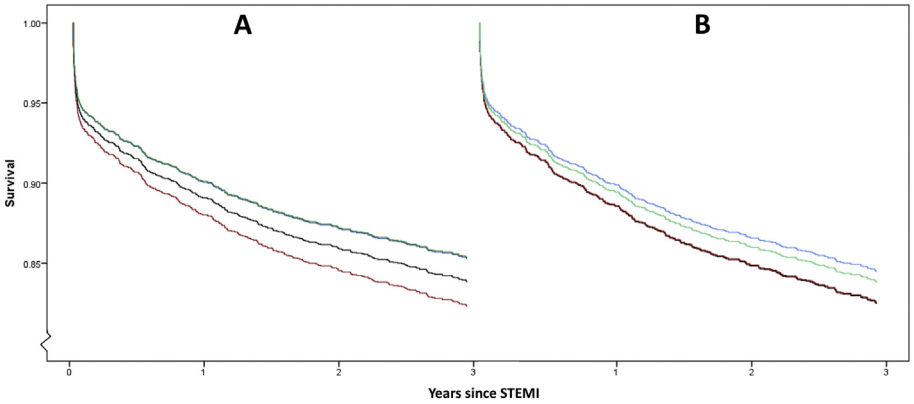

Fig. 1. (A) Kaplan-Meier plot showing unadjusted survival analysis post-STEMI by socioeconomic status quartile. (B) Cox regression analysis showing three-year survival by smoking status adjusted for age and gender. The most disadvantaged SES quartile (Q1) trended to a worse survival in an unadjusted analysis, but this was not significant. In an adjusted analysis, this difference was attenuated. Q3 and Q4 had a very similar risk.

Table 2
Hazard ratios from Cox Regression for survival post-STEMI by SES quartiles at 30 days, one year, and three years adjusted for age and gender.

	30 days			1 year			3 years		
	HR	95% CI	p	HR	95% CI	p	HR	95% CI	p
Q1 (Disadvantaged SES)	1.35	0.79–2.33	*0.273*	1.12	0.76–1.65	*0.559*	1.22	0.88–1.70	*0.230*
Q2	1.18	0.68–2.05	*0.552*	1.02	0.69–1.51	*0.918*	1.11	0.80–1.54	*0.542*
Q3	1.03	0.58–1.83	*0.915*	0.97	0.64–1.45	*0.866*	1.00	0.71–1.42	*0.980*

Reference group is Q4 (most privileged SES group).

Table 3
Hazard ratios from Cox Regression for survival post-STEMI by SES quartiles at 30 days, one year, and three years adjusted for age, gender, additional cardiovascular risk factors, and drug use on discharge.

	30 days			1 year			3 years		
	HR	95% CI	p	HR	95% CI	p	HR	95% CI	p
Q1 (Disadvantaged SES)	1.21	0.69–2.14	0.500	0.99	0.66–1.48	0.959	1.09	0.78–1.53	0.625
Q2	1.14	0.65–2.00	0.656	0.99	0.66–1.47	0.943	1.08	0.78–1.52	0.638
Q3	0.99	0.55–1.79	0.985	0.90	0.60–1.36	0.618	0.96	0.68–1.36	0.804

status in the other [33]. However, these findings may simply reflect greater inequity in access to treatments in private healthcare systems. This was suggested by the findings of decreased use of mechanical circulatory support in disadvantaged SES groups, despite their higher in-hospital mortality [30], as well as lower rates of timely PCI and drug-eluting stent use [34].

The remaining identified studies were conducted in universal healthcare systems, in Switzerland [32], Italy [29], and Denmark [31]. One of these studies reported that patients of lower SES had a higher mortality, but after adjustment for age there was no significant difference in mortality [31]. The other two studies reported no significant difference in mortality by SES [29,32]. Our study, in agreement with previous studies, reports no disparities in outcomes post-STEMI by SES in a universal healthcare system.

A difference of these studies to our study is that only approximately 40–50% of patients were reported to have received PCI or timely PCI [29,30,33,34]. In some of the studies, data collection started in 2003 or earlier [30,31,33]. Also, the US studies were reliant on coding to identify cases from samples of large, national databases [30,33,34]. In one study, only 222 patients were included [32].

In our cohort, lower SES was associated with significantly higher rates of smoking, diabetes, and previous CHD. This finding is in agreement with previous cohorts [3]. Several cohort studies have shown that differences in risk factors contribute to more than half of the higher risk of cardiovascular events in lower SES groups [35,36]. When cardiovascular risk factors were included in our multivariable model, the association between low SES and mortality was attenuated.

We also observed similar prescriptions of secondary preventative medications post-STEMI between SES groups, with the exception of beta-blockers, which were prescribed less frequently in lower SES groups. A recent systematic review also reported that beta-blockers were used less frequently in lower SES groups [37], although other UK studies have shown no differences in secondary preventative medications by SES [38,39]. We observed no significant differences in the type of $P2Y_{12}$ receptor inhibitor used by SES quartile, and from 2012 onwards, ticagrelor was the most commonly used $P2Y_{12}$ receptor inhibitor for all SES groups. This is in contrast to private healthcare systems, where clopidogrel often remains the most prescribed $P2Y_{12}$ inhibitor receptor due to its less prohibitive cost [40].

4.1. Strengths and limitations

Our study has a number of strengths and limitations. Firstly, we included all patients with acute STEMI presenting to our centre. Another strength is that we used clinical data rather than administrative data for collection of STEMI details and cardiovascular risk factors, and recorded both short- and long-term survival.

It has been suggested that poorer outcomes could still arise in lower SES groups in universal healthcare systems because of lower awareness of MI symptoms and patient delay in presentation from symptom onset [32,41]. In our study, patients with delayed presentation may have died prior to having PCI or not have had PCI - with the most common reason for no reperfusion therapy nationally being that the patient presents too late, typically >12 h after onset [25]. Surviving patients of lower SES groups presenting with STEMI may therefore represent a highly-selected and less-risky population, leading to a survivorship bias. As this study was retrospective there was also the possibility of unidentified confounders in the analyses. We also may have lacked statistical power to identify a significant difference between SES quartiles, with a trend for worse survival in lower SES groups identified in the analysis adjusted for age and gender.

A further limitation is that SES was measured by IMD, which is an area-based proxy. A weakness of area-based measures is possible misclassification of personal SES based on the SES of the surrounding neighborhood (the so-called “ecologic fallacy”), but this may be offset by the lack of an “individualistic fallacy,” whereby there is an incorrect assumption that the health of an individual subject is not affected by the neighborhood that they reside in [43].[11] SES can also change with time, which we were unable to account for - although the relative contribution of adult and early life factors to social inequalities in CHD remains uncertain [42]. Moreover, there is increased type I error rate in our study due to multiple statistical testing, and our results are from a single centre, which limits generalisability.

5. Conclusion

When adjusting for age and gender, lower SES groups trended to a worse survival, but this was attenuated by inclusion of additional cardiovascular risk factors and medication use on discharge. In this large study of unselected STEMI patients managed by primary PCI, we did not find a significant association between survival by SES at 30 days, 1 year, or 3 year.

Role of the funding source

This study received no specific funding, and was carried out as a University of Sheffield degree project.

Declaration of interests

We declare that we have no conflict of interest.

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Contributors

All authors were involved in the preparation of the manuscript, have read the manuscript, agree with the analyses of the data and the conclusions reached in the manuscript, and are accountable for all aspects of the work.

Ethical approval

At the time of study set up NHS REC approval was not required for research involving previously collected data extracted from hospital records and rendered non-identifiable by the direct care team before being used for research purposes. NHS Permission was gained for this study via the Sheffield Teaching Hospitals R&D Department to ensure the study's compliance with the data protection act and protect patient confidentiality.

Role of medical writer or editor

Not applicable.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijcard.2018.11.111.

References

[1] J.Y. Wang, et al., Low socioeconomic status increases short-term mortality of acute myocardial infarction despite universal health coverage, Int. J. Cardiol. 172 (1) (2014) 82–87.
[2] J.N. Rasmussen, et al., Mortality after acute myocardial infarction according to income and education, J. Epidemiol. Community Health 60 (4) (2006) 351–356.
[3] D.A. Alter, et al., Effects of socioeconomic status on access to invasive cardiac procedures and on mortality after acute myocardial infarction, N. Engl. J. Med. 341 (18) (1999) 1359–1367.
[4] C. Blais, D. Hamel, S. Rinfret, Impact of socioeconomic deprivation and area of residence on access to coronary revascularization and mortality after a first acute myocardial infarction in Quebec, Can. J. Cardiol. 28 (2) (2012) 169–177.
[5] T. Donyavi, et al., Socioeconomic status and mortality after acute myocardial infarction: a study from Iran, Int. J. Equity Health 10 (2011) 9.
[6] C. Tonne, et al., Long-term survival after acute myocardial infarction is lower in more deprived neighborhoods, Circulation 111 (23) (2005) 3063–3070.
[7] V. Salomaa, et al., Relation of socioeconomic position to the case fatality, prognosis and treatment of myocardial infarction events; the FINMONICA MI Register Study, J. Epidemiol. Community Health 55 (7) (2001) 475–482.
[8] G. Cafagna, C. Seghieri, Educational level and 30-day outcomes after hospitalization for acute myocardial infarction in Italy, BMC Health Serv. Res. 17 (1) (2017) 18.
[9] M. Rosvall, et al., The association between socioeconomic position, use of revascularization procedures and five-year survival after recovery from acute myocardial infarction, BMC Public Health 8 (2008) 44.
[10] I. Stirbu, et al., Income inequalities in case death of ischaemic heart disease in the Netherlands: a national record-linked study, J. Epidemiol. Community Health 66 (12) (2012) 1159–1166.
[11] I. Kirchberger, et al., Long-term survival among older patients with myocardial infarction differs by educational level: results from the MONICA/KORA myocardial infarction registry, Int. J. Equity Health 13 (2014) 19.
[12] P. Alboni, et al., In industrialized nations, a low socioeconomic status represents an independent predictor of mortality in patients with acute myocardial infarction, Ital. Heart J. 4 (8) (2003) 551–558.
[13] Y. Gerber, et al., Interaction between income and education in predicting long-term survival after acute myocardial infarction, Eur. J. Cardiovasc. Prev. Rehabil. 15 (5) (2008) 526–532.
[14] A.A. van Oeffelen, et al., The relation between socioeconomic status and short-term mortality after acute myocardial infarction persists in the elderly: results from a nationwide study, Eur. J. Epidemiol. 27 (8) (2012) 605–613.
[15] S.V. Rao, et al., Socioeconomic status and outcome following acute myocardial infarction in elderly patients, Arch. Intern. Med. 164 (10) (2004) 1128–1133.
[16] W.C. Chang, et al., Effects of socioeconomic status on mortality after acute myocardial infarction, Am. J. Med. 120 (1) (2007) 33–39.
[17] S.M. Bernheim, et al., Socioeconomic disparities in outcomes after acute myocardial infarction, Am. Heart J. 153 (2) (2007) 313–319.
[18] N. Molshatzki, et al., Role of socioeconomic status measures in long-term mortality risk prediction after myocardial infarction, Med. Care 49 (7) (2011) 673–678.
[19] N. Danchin, et al., Impact of free universal medical coverage on medical care and outcomes in low-income patients hospitalized for acute myocardial infarction: an analysis from the FrenchNational Health Insurance system, Circ. Cardiovasc. Qual. Outcomes 4 (6) (2011) 619–625.
[20] G. Bergstrom, et al., Low socioeconomic status of a patient's residential area is associated with worse prognosis after acute myocardial infarction in Sweden, Int. J. Cardiol. 182 (2015) 141–147.
[21] S.E. Ramsay, et al., Socioeconomic inequalities in coronary heart disease risk in older age: contribution of established and novel coronary risk factors, J. Thromb. Haemost. 7 (11) (2009) 1779–1786.
[22] J. Quatromoni, R. Jones, Inequalities in socio-economic status and invasive procedures for coronary heart disease: a comparison between the USA and the UK, Int. J. Clin. Pract. 62 (12) (2008) 1910–1919.
[23] A. Britton, et al., Does access to cardiac investigation and treatment contribute to social and ethnic differences in coronary heart disease? Whitehall II prospective cohort study, BMJ 329 (7461) (2004) 318.
[24] M. Asaria, T. Doran, R. Cookson, The costs of inequality: whole-population modelling study of lifetime inpatient hospital costs in the English National Health Service by level of neighbourhood deprivation, J. Epidemiol. Community Health 70 (10) (2016) 990–996.
[25] Myocardial Ischaemia National Audit Project, Annual Public Report April 2013–March 2014, [Accessed 1 Oct 2018]; Available from: http://www.ucl.ac.uk/nicor/audits/minap/documents/annual_reports/minap-2015-16-annualreport.
[26] E.C. Keeley, J.A. Boura, C.L. Grines, Primary angioplasty versus intravenous thrombolytic therapy for acute myocardial infarction: a quantitative review of 23 randomised trials, Lancet 361 (9351) (2003) 13–20.
[27] I. Ranasinghe, et al., Comparative effectiveness of population interventions to improve access to reperfusion for ST-segment-elevation myocardial infarction in Australia, Circ. Cardiovasc. Qual. Outcomes 5 (4) (2012) 429–436.
[28] Migration Yorkshire, South Yorkshire Local Migration Profile, Available from: www.migrationyorkshire.org.uk/userfiles/attachments/pages/634/southyorkshirelmpsummary-nov2013.pdf 2013, Accessed date: 1 October 2018.
[29] R. Gnavi, et al., Gender, socioeconomic position, revascularization procedures and mortality in patients presenting with STEMI and NSTEMI in the era of primary PCI. Differences or inequities? Int. J. Cardiol. 176 (3) (2014) 724–730.
[30] S. Agarwal, et al., Outcomes and resource utilization in ST-elevation myocardial infarction in the United States: evidence for socioeconomic disparities, J. Am. Heart Assoc. 3 (6) (2014), e001057.
[31] L. Jakobsen, et al., Dimensions of socioeconomic status and clinical outcome after primary percutaneous coronary intervention, Circ. Cardiovasc. Interv. 5 (5) (2012) 641–648.
[32] S. Fournier, et al., Influence of socioeconomic factors on delays, management and outcome amongst patients with acute myocardial infarction undergoing primary percutaneous coronary intervention, Swiss Med. Wkly. 143 (2013) w13817.
[33] S. Pancholy, et al., Association between health insurance status and in-hospital outcomes after ST-segment elevation myocardial infarction, Am. J. Cardiol. 120 (7) (2017) 1049–1054.
[34] C.M. Yong, et al., Socioeconomic inequalities in quality of care and outcomes among patients with acute coronary syndrome in the modern era of drug eluting stents, J. Am. Heart Assoc. 3 (6) (2014), e001029.
[35] M. Osler, et al., Socioeconomic status and trends in risk factors for cardiovascular diseases in the Danish MONICA population, 1982–1992, J. Epidemiol. Community Health 54 (2) (2000) 108–113.
[36] G.A. Kaplan, J.E. Keil, Socioeconomic factors and cardiovascular disease: a review of the literature, Circulation 88 (4 Pt 1) (1993) 1973–1998.
[37] K.K. Hyun, et al., The effect of socioeconomic disadvantage on prescription of guideline-recommended medications for patients with acute coronary syndrome: systematic review and meta-analysis, Int. J. Equity Health 16 (1) (2017) 162.
[38] N.M. Hawkins, et al., The UK National Health Service: delivering equitable treatment across the spectrum of coronary disease, Circ. Cardiovasc. Qual. Outcomes 6 (2) (2013) 208–216.
[39] W. King, et al., Equity in healthcare for coronary heart disease, Wales (UK) 2004–2010: a population-based electronic cohort study, PLoS One 12 (3) (2017), e0172618.
[40] J.A. Doll, et al., Rationale and design of the Affordability and Real-world Antiplatelet Treatment Effectiveness after Myocardial Infarction Study (ARTEMIS): a multicenter, cluster-randomized trial of P2Y12 receptor inhibitor copayment reduction after myocardial infarction, Am. Heart J. 177 (2016) 33–41.
[41] J. Fang, et al., Awareness of heart attack symptoms among US adults in 2007, and changes in awareness from 2001 to 2007, Futur. Cardiol. 7 (3) (2011) 311–320.
[42] J.R. Emberson, et al., Social class differences in coronary heart disease in middle-aged British men: implications for prevention, Int. J. Epidemiol. 33 (2) (2004) 289–296.
[43] A.V. Diez-Roux, Bringing context back into epidemiology: variables and fallacies in multilevel analysis, Am J Public Health 88 (1998) 216–222.