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Influence of socioeconomic status on the referral process to cardiac rehabilitation following acute coronary syndrome: a cross-sectional study

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ABSTRACT

Objective To evaluate the association between socioeconomic status (SES) and referral to cardiac rehabilitation (CR) after incident acute coronary syndrome (ACS) by dividing the referral process into three phases: (1) informed about CR, (2) willingness to participate in CR, (3) and assigned CR setting.

Design Cross-sectional study.

Setting Department of Cardiology at a Danish University Hospital from 1 January 2011 to 31 December 2014.

Participants A total of 1229 patients assessed for CR during hospitalisation with ACS were prospectively registered in the Rehab-North Register from 2011 to 2014. SES was assessed using data from national registers, concerning: personal income, occupational status, educational level and civil status. Patients were excluded if one of the following criteria was fulfilled: (1) missing data on SES, or (2) acceptable reason for not informing patients about CR (treatment with coronary artery bypass grafting, transfer to another hospital, still under treatment or death).

Main outcome measures Outcomes were defined by dividing the referral process into three phases: (1) informed about CR, (2) willingness to participate, and (3) assigned CR setting (in-hospital/community centre) after ACS.

Results A total of 854 (69.5 %) patients were referred to CR. After adjustment for age, gender, ACS diagnosis (ST-elevated myocardial infarction, non-ST-elevated myocardial infarction, unstable angina pectoris) and comorbidity, high income had the strongest association of referral to CR in all three phases (informed about CR: OR 2.17, 95% CI 1.01 to 4.64; willingness to participate in CR: OR 1.55, 95% CI 1.02 to 2.35; assigned in-hospital CR: OR 1.47, 95% CI 0.91 to 2.36). Educational level showed similar tendencies, however not statistically significant. The results did not vary according to gender.

Conclusion This is the first study to investigate the referral process to CR using a three-phase structure. It suggests income and education to influence all phases in the referral process to CR after ACS.

Strengths and limitations of this study

- This is the first study to investigate the referral process to cardiac rehabilitation (CR) using a three-phase structure (informed about CR, willingness to participate in CR and assigned CR setting) which provides better knowledge in understanding why social inequality persists in referral to CR.
- Socioeconomic variables were provided by highly validated Danish register data using the unique 10-digit civil registration number that is given to all Danish citizens.
- Multivariable logistic regression analyses were used to minimise potential confounding.
- Data were not gathered for specific scientific purposes and it cannot be ruled out that not all patients admitted with acute coronary syndrome were identified. However, such loss was considered unsystematic and unintended and should not pose a problem for bias introduction.

INTRODUCTION

Low socioeconomic status (SES) is associated with higher risk of developing ischaemic heart disease (IHD) and poorer subsequent outcome, including higher risk of recurrent cardiovascular events and cardiac-related mortality.[1–5] Cardiac rehabilitation (CR) is an important step to reduce disease outcomes and is an integral part of IHD care as it aims to improve quality of life as well as patients' physical, psychological and social functioning.[4]

CR comprises exercise therapy, psychological consulting, treatment-targeted therapy and lifestyle-changing modules (dietary modification and smoking cessation).[4] The programme is a coordinated effort made by cardiologists, nurses, physiotherapists, dietitians and, eventually, occupational therapists. If needed, psychologists, social workers or priests may be included as well.[4]

The efficacy of CR in reducing cardiovascular mortality and risk of hospital readmissions is well documented.[6–8] It therefore seems irrational that international research in general continues to find CR

'referral' or 'participation and completion' rates to be unsatisfactory.[9–13]

Different socioeconomic characteristics (income, educational level, occupational status, civil status) are shown to be associated with CR underutilisation.[14] Low income and educational level have irrespectively of type of healthcare system repeatedly been associated with limited participation and completion rate.[11 15] It is consequently of major importance to eliminate the socioeconomic differences in CR if the inequality in IHD burden is to be reduced.

Obstacles in referral and participation to CR among patients with lower SES may be due to system-level and personal barriers.[16] System-level barriers cover physician recommendations, the interaction with the healthcare team and misconceptions about CR. Personal barriers include perception about IHD and CR, and belief about the ability to control IHD.[16] However, vulnerable elements in the referral process prone to socioeconomic inequality among patients with acute coronary syndrome (ACS) remain unexplored. By dividing the referral process into three phases, it is possible to evaluate if such inequality is the result of selection of patients at the system level (the process of informing patients about CR and the setting of CR that patients are referred to) rather than the person level (patients' own willingness to participate in CR). To our knowledge, no study has analysed the entire referral process using such three-phase structure while controlling for confounders in a population of patients surviving ACS. Therefore, the objective of this study was to investigate how SES is associated with the patients' chances of (1) being informed about CR, (2) willingness to participate, and (3) assigned CR setting (in-hospital or community centre). Phase 3 was determined by regional guidelines: patients suffering ST-elevated myocardial infarction (STEMI) or complicated non-STEMI (NSTEMI) were offered in-hospital CR whereas patients with uncomplicated NSTEMI and unstable angina pectoris (UAP) were offered CR in a community centre.

METHODS

The study followed the Strengthening the Reporting of Observational Studies in Epidemiology guidelines for cross-sectional studies.[17]

Study design

This population-based study used data from the Rehab-North Register. Its content has previously been described.[18] In short, the Rehab-North Register holds data on all patients hospitalised at the Department of Cardiology, Aalborg University Hospital, from 1 January 2011 to 31 December 2014 with a diagnosis of ACS. All were assessed for eligibility to CR using a questionnaire.[18]

In Denmark, CR fully or partially takes place in-hospital or at community centres. In-hospital CR is reserved for high-risk patients and is structured with a more complex intervention. The Danish Public Health System is tax paid, enabling CR to be free of charge for the patient.

Patient and public involvement

No patients were involved in the design, or conduct, or reporting, or dissemination plans of our research.

Study population

The study population was identified in the Rehab-North Register as patients diagnosed with ACS (International Classification of Diseases 10th Revision: I20.0, I21). The registered diagnosis was verified by linking data from the Rehab-North Register with the Danish National Patient Register (NPR) and the Danish Register of Causes of Death.[19] If any discrepancy arose, the diagnosis registered in the NPR was selected. Patients were excluded if one of the following criteria was fulfilled: (1) missing data on SES, and (2) acceptable reason for not informing patients about CR, including treatment with coronary artery bypass grafting, transfer to another hospital, still under treatment or death. Patients who underwent coronary artery bypass grafting were informed about CR at the thoracic surgery department performing the operation. Patients who were 'transferred to another hospital' received information about CR at other cardiology departments. We were not able to receive confirmation regarding referral to CR in this patient group.

The study population and referral design using three phases is illustrated in figure 1.

Socioeconomic status

Different indicators of SES (personal income, occupational status, educational level and civil status) were chosen due to a priori knowledge about their proposed mechanisms associated to the outcome variable. Ascertainment of socioeconomic variables from national registers was done by linkage of a unique personal number given to all Danish residents.

The Income Statistics Register provided information regarding both disposable personal income (low, medium, high) calculated for the calendar year before disease onset, and occupational status (employed, unemployed/out of workforce) set for the calendar year before disease onset.[20] A person's highest obtained educational level (low, medium, high) was based on the International Standard Classification of Education[21] from the Student's Register,[22] and civil status (married/partnership, divorced/unmarried/widow) from the Civil Registration System (CRS).[23]

Outcomes

Outcomes were defined by dividing the referral process into three phases: (1) informed about CR, (2) willingness to participate, and (3) assigned CR setting (in-hospital/community centre) after ACS.

All outcome information gathering was done during the patients' hospitalisation and included in the questionnaires that founded the Rehab-North Register.

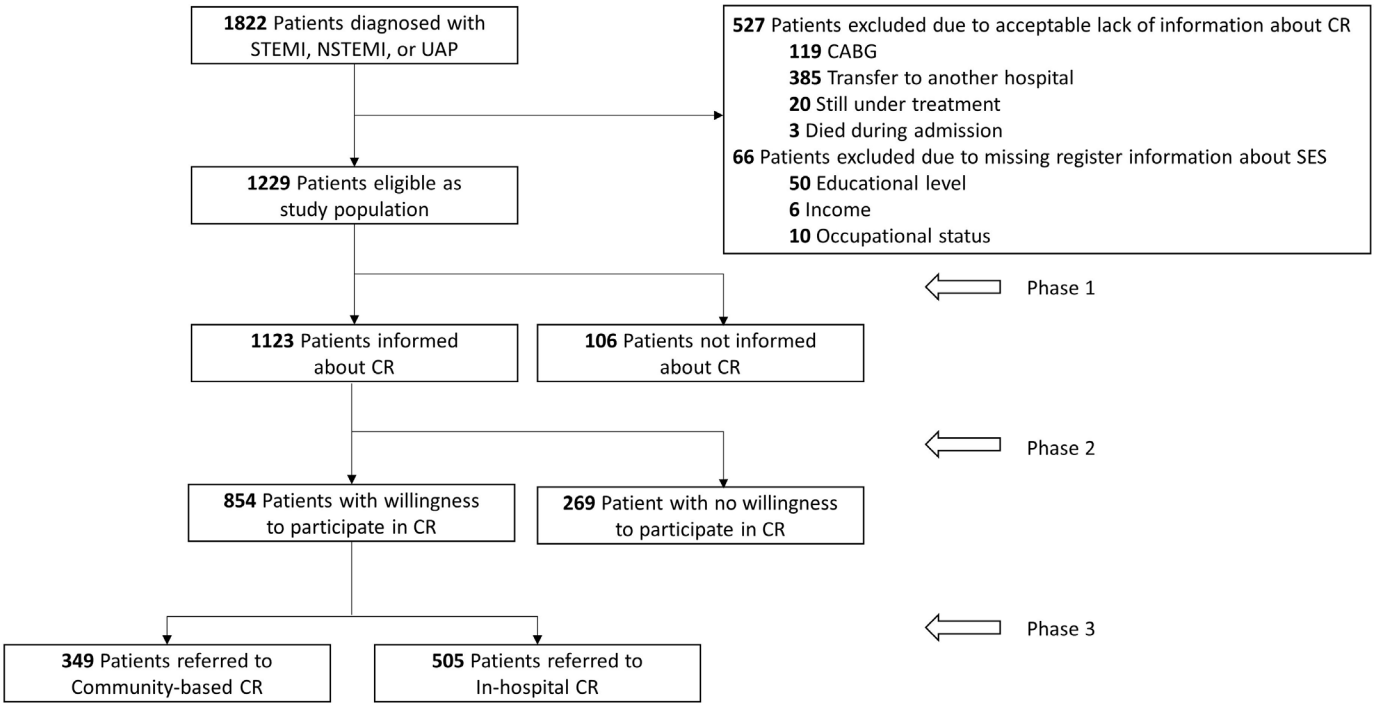

Figure 1 Flow chart of the referral process to cardiac rehabilitation. CABG, coronary artery bypass grafting; CR, cardiac rehabilitation; NSTEMI, non-STEMI; SES, socioeconomic status; STEMI, ST-elevated myocardial infarction; UAP, unstable angina pectoris.

Covariates

The selection of covariates to be included in the multivariable analyses was done based on directed acyclic graph (not shown). Age was registered at time of diagnosis and categorised into three groups: <65 years, 65–74 years and ≥75 years. Information regarding age and gender was gathered from the CRS.[23] Comorbidity diagnoses were defined by the Charlson Comorbidity Index (CCI), but only diagnoses from the year 2011 until hospitalisation were accessible. Comorbidity diagnoses was drawn from the NPR.[24] In general, patients with NSTEMI and UAP are less likely referred to CR compared with patients with STEMI.[25] Therefore, to get an accurate estimate of the impacts of patients' SES on CR referral, ACS diagnosis (STEMI, NSTEMI, UAP) was included as a covariate.[25]

Statistical analysis

Baseline characteristics of study population were summarised by frequencies and percentages. The association between socioeconomic variables and being informed about CR, willingness to participate and assigned CR setting was assessed by crude (model 1) and multivariable logistic regression adjusted for confounders (age, gender, ACS diagnosis, CCI) (model 2). Results were presented in OR with 95% CI. Potential effect modification by gender was assessed by stratification and likelihood ratio tests as studies have found females to experience lower rates of referral to CR compared with males.[10 26] Statistical analyses were performed using Stata software (V.15.1; StataCorp, College Station, TX).

RESULTS

Of the original cohort of 1822 patients diagnosed with ACS, only patients with no missing socioeconomic variables, and no acceptable reasons for not being informed about CR were included in the study (figure 1). This resulted in a study population comprising 1229 patients (73.8% male). The patients' baseline characteristics, stratified by diagnosis, are presented in table 1. Patients with STEMI were relatively younger and still an available workforce with higher income. In the study population, 1123 (91.4%) patients were informed about CR of which 854 (76.0%) subsequently agreed to participate in the programme. Of those, 349 (40.9%) patients were referred to CR in a community centre and 505 (59.1%) patients were referred to in-hospital CR (figure 1).

Phase 1: SES and being informed about CR

Higher income and educational level had positive crude associations with being informed about CR whereas being unemployed/out of workforce or single living had a negative association (table 2). These associations were greatly reduced after adjustment for age, gender, ACS diagnosis and CCI. The adjusted regression analysis found high income to be associated with being informed about CR (OR 2.17, 95% CI 1.01 to 4.64). High educational level was also associated with being informed about CR although the association did not reach statistical significance (OR 1.60, 95% CI 0.72 to 3.54).

Phase 2: SES and willingness to participate in CR

High income, high educational level and being single living (divorced/unmarried/widow) were all associated

Table 1 Characteristics of study population stratified by diagnosis

Characteristics	Full population n=1229	STEMI n=402	NSTEMI n=711	UAP n=116
Male (n, %)	907 (73.8)	322 (80.1)	503 (70.7)	82 (70.7)
Age group (years)				
<65	591 (48.1)	227 (56.5)	308 (43.3)	56 (48.3)
65–74	371 (30.2)	116 (28.9)	215 (30.2)	40 (34.5)
≥75	267 (21.7)	59 (14.7)	188 (26.4)	20 (17.2)
Civil status (n, %)				
Married/partnership	793 (64.5)	253 (62.9)	449 (63.2)	91 (78.4)
Divorced/unmarried/widow	436 (35.5)	149 (37.1)	262 (36.8)	25 (21.6)
Occupational status (n, %)				
Employed	479 (39.0)	195 (48.5)	240 (33.8)	44 (37.9)
Unemployed/out of workforce	750 (61.0)	207 (51.5)	471 (66.2)	72 (62.1)
Educational level (n, %)				
Low	516 (42.0)	144 (35.8)	322 (45.3)	50 (43.1)
Medium	539 (43.9)	201 (50.0)	293 (41.2)	45 (38.8)
High	174 (14.2)	57 (14.2)	96 (13.5)	21 (18.1)
Income, tertile (n, %)				
Low	405 (33.0)	113 (28.1)	251 (35.3)	41 (35.3)
Medium	406 (33.0)	124 (30.8)	247 (34.7)	35 (30.2)
High	418 (34.0)	165 (41.0)	213 (30.0)	40 (34.5)
Charlson Comorbidity Index				
Low (0 point)	1088 (88.5)	358 (89.1)	630 (88.6)	100 (86.2)
Moderate/high (>0 point)	141 (11.5)	44 (10.9)	81 (11.4)	16 (13.8)

NSTEMI, non-STEMI; STEMI, ST-elevated myocardial infarction; UAP, unstable angina pectoris.

with a higher likelihood of willingness to participate in CR in the crude analyses (table 3). Being unemployed/retired was negatively associated with being willing to participate in CR. After adjustment, high income level had the highest OR (OR 1.55, 95% CI 1.02 to 2.35) in relation to willingness to participate. A similar pattern was observed for high educational level although the association was not statistically significant (OR 1.21, 95% CI 0.78 to 1.88). Likewise, being single living was also associated with willingness to participate in CR, although the estimates did not reach statistical significance (OR 1.28, 95% CI 0.93 to 1.76).

Phase 3: SES and assigned CR setting

Table 4 shows the association of SES on being assigned to in-hospital CR compared with CR in a community centre. High income was significantly associated with assignment to in-hospital CR (OR 2.10, 95% CI 1.49 to 2.97) but the association was attenuated after adjustment for confounders (income: adjusted OR 1.47, 95% CI 0.91 to 2.36).

Supplementary analyses

The analyses were stratified by gender in a supplementary analysis. The results were not substantially different from the main analysis (not shown).

The baseline characteristics of patients being excluded from the study population were obtained (online supplementary table S1). After multivariable logistic regression, patients being excluded from the study population have significantly lower SES compared with the patients being included (online supplementary table S2).

DISCUSSION

In this study, the referral process to CR was assessed using a three-phase structure: (1) informed about CR, (2) willingness to participate in CR, and (3) assigned CR setting. After adjustment, high income was the only variable that is statistically significantly associated with referral to CR in phases 1 and 2, and insignificantly associated with phase 3 of the referral process. High educational level had a similar pattern, but the association did not reach statistical significance.

Overall, 69.5% of the patients were referred to CR, which is in accordance with earlier findings (22%–81.5%).[9 10 25 26] Notably, in one study strikingly 86% was referred to CR after usage of a social differentiated intervention programme.[27] However, it would be difficult to

Table 2 Logistic regression model for being informed about cardiac rehabilitation, n=1229

	Full study population n (%)	Informed about CR n (%)	Unadjusted		Multivariable adjusted*	
			OR	95% CI	OR	95% CI
Observations	1229 (100)	1123 (91.4)				
Civil status						
Married/partnership	793 (64.5)	735 (59.8)	1 (ref)		1 (ref)	
Divorced/unmarried/widow	436 (35.5)	388 (31.6)	0.64	0.43 to 0.95	0.76	0.49 to 1.19
Occupational status						
Employed	479 (39.0)	469 (38.2)	1 (ref)		1 (ref)	
Unemployed/out of workforce	750 (61.0)	654 (53.2)	0.15	0.07 to 0.28	0.46	0.20 to 1.07
Educational level						
Low	516 (42.0)	452 (36.8)	1 (ref)		1 (ref)	
Medium	539 (43.9)	505 (41.1)	2.10	1.36 to 3.25	1.17	0.72 to 1.89
High	174 (14.2)	166 (13.5)	2.94	1.38 to 6.26	1.60	0.72 to 3.54
Income, tertiles						
Low	405 (33.0)	342 (27.8)	1 (ref)		1 (ref)	
Medium	406 (33.0)	374 (30.4)	2.15	1.37 to 3.38	1.40	0.86 to 2.28
High	418 (34.0)	407 (33.1)	6.82	3.54 to 13.14	2.17	1.01 to 4.64

*Adjusted for age, gender, acute coronary syndrome (ACS) diagnosis and Charlson Comorbidity Index.
CR, cardiac rehabilitation.

Table 3 Logistic regression model for willingness to participate in cardiac rehabilitation, n=1123

	Full study population n (%)	Willingness to participate in CR n (%)	Unadjusted		Multivariable adjusted*	
			OR	95% CI	OR	95% CI
Observations	1229 (100)	854 (76.0)				
Civil status						
Married/partnership	793 (64.5)	546 (48.6)	1 (ref)		1 (ref)	
Divorced/unmarried/widow	436 (35.5)	308 (27.4)	1.33	0.99 to 1.79	1.28	0.93 to 1.76
Occupational status						
Employed	479 (39.0)	388 (34.6)	1 (ref)		1 (ref)	
Unemployed/out of workforce	750 (61.0)	466 (41.5)	0.52	0.39 to 0.69	0.93	0.62 to 1.40
Educational level						
Low	516 (42.0)	322 (28.7)	1 (ref)		1 (ref)	
Medium	539 (43.9)	405 (36.1)	1.64	1.21 to 2.20	1.36	0.98 to 1.88
High	174 (14.2)	127 (11.3)	1.31	0.87 to 1.99	1.21	0.78 to 1.88
Income, tertiles						
Low	405 (33.0)	229 (20.4)	1 (ref)		1 (ref)	
Medium	406 (33.0)	288 (25.6)	1.65	1.19 to 2.30	1.35	0.94 to 1.94
High	418 (34.0)	337 (30.0)	2.38	1.69 to 3.34	1.55	1.02 to 2.35

*Adjusted for age, gender, acute coronary syndrome (ACS) diagnosis and Charlson Comorbidity Index.
CR, cardiac rehabilitation.

reproduce such a result in an observational study without this specific purpose.

The finding of patients' income and educational level to be associated with all three phases of the referral process to CR may be explained by 'the Nordic Paradox' observed in the Nordic European countries.[28 29] These countries, covering Denmark, Norway, Sweden and Finland, are 'welfare states' with equal access to healthcare which theoretically ought to diminish the importance of patients' level of income and education regarding access to healthcare services. However, this is not the case as inequality (eg, in mortality) persists.[29] Although income inequality is

Table 4 Logistic regression model for assigned cardiac rehabilitation setting, n=854

	Full study population n (%)	Assigned CR setting n (%)	Unadjusted		Multivariable adjusted*	
			OR	95% CI	OR	95% CI
Observations	1229 (100)	505 (59.1)				
Civil status						
Married/partnership	793 (64.5)	317 (37.1)	1 (ref)		1 (ref)	
Divorced/unmarried/widow	436 (35.5)	188 (22.0)	1.13	0.85 to 1.51	1.20	0.84 to 1.69
Occupational status						
Employed	479 (39.0)	268 (31.4)	1 (ref)		1 (ref)	
Unemployed/out of workforce	750 (61.0)	237 (27.8)	0.46	0.35 to 0.61	0.75	0.49 to 1.15
Educational level						
Low	516 (42.0)	177 (20.7)	1 (ref)		1 (ref)	
Medium	539 (43.9)	248 (29.0)	1.29	0.96 to 1.74	0.90	0.63 to 1.30
High	174 (14.2)	80 (9.4)	1.39	0.91 to 2.13	1.20	0.72 to 1.99
Income, tertiles						
Low	405 (33.0)	115 (13.5)	1 (ref)		1 (ref)	
Medium	406 (33.0)	161 (18.9)	1.26	0.89 to 1.78	1.14	0.73 to 1.78
High	418 (34.0)	229 (26.8)	2.10	1.49 to 2.97	1.47	0.91 to 2.36

*Adjusted for age, gender, acute coronary syndrome (ACS) diagnosis and Charlson Comorbidity Index.
CR, cardiac rehabilitation.

smaller in the Nordic countries, this still covers inequality in wealth, housing condition and material living conditions, and is used together with educational level to assess latent socioeconomic factors (health literacy, greater burden of behavioural and biological risk factors, and reduced access to quality care and medication).[30] Thus, our finding may imply such latent socioeconomic factors to be important in the referral process to CR.

We found single living to be potentially associated with the willingness to participate in CR. If such an association is reproducible in later studies, then attention should focus on these patients without a partner, who less often receive referral to CR, which has been attributed to lack of social support.[31]

International studies find younger age, male gender, living with a partner, high educational level and high gross income to be predictors of CR referral.[10 25 31] This inequality in CR referral causes concern as participation helps patients implement needed behavioural changes, which reduces cardiac-related deaths.[6] Patients with low SES often have biological, behavioural and psychosocial disadvantages that may accelerate risk of cardiovascular diseases. Therefore, the need of referral, attendance and completion of CR should be prioritised in this patient group.[1 2]

By splitting the referral process into three phases, new insights regarding importance of taking patients' SES into consideration when referring them to CR were gained. Our results show the importance of being aware of system-level barriers present in the referral process. Moreover, identifying those patients who need more motivation before being willing to enter a CR programme is highly important. In that way, patients are well informed about CR and able to make a well-considered decision regarding participation.

Definition of SES is a conceptual challenge often solved by use of personal/family income, educational level, civil status and/or occupation. There is no consensus on which parameters to use as indicators of SES. It has been argued to use single variables as proxy measurements for SES despite different causal pathways. However, others find it problematic only to estimate SES by one parameter, as this may increase the risk of residual confounding by unmeasured socioeconomic circumstances.[1 32] Moreover, the effect of socioeconomic variables seems rather outcome related and is suggested not to be used interchangeably without thorough consideration.[33] As our central interest was to investigate the impact of SES on the referral process to CR, and therefore use SES as exposure variable, we a priori hypothesised the different variables all to be linked to our outcome measures. The risk of such an approach was the introduction of collinearity. However, research finds educational level, occupation and income to measure different phenomena, to have different causal mechanisms and, in part, to be explained by other socioeconomic parameters.[33 34] Since literature finds income, educational level, occupational status and civil status to be important determinants for referral, participation and completion of CR, it seemed most appropriate to include all variables in order to answer our research questions. The consequence of this approach was that we cannot get a single estimate that illustrates the effect of SES.

Some caution must be taken when interpreting the results of our study. First, data were not gathered for specific scientific purposes and it cannot be ruled out that some patients admitted with ACS were not included in the Rehab-North Register. However, such loss was considered unsystematic and unintended and should not pose a problem for bias introduction. Moreover, the non-response analysis found excluded patients to have lower SES compared with the included study population. As exclusion was due to clinical implications (patients were to receive CR referral elsewhere), this should not pose a problem for participation bias introduction in our study population.

Second, use of register data minimised risk of information bias, due to nationwide good algorithms for correct diagnosis coding. Despite linkage to other registers, risk of residual or unmeasured confounding may be present.[35] Third, there may be a risk of residual or unaccounted confounding, if data on confounding variables were not classified with adequate precision. The CCI variable may be inaccurate which is caused by the limited time frame for inclusion of comorbidities. This increases the risk of unaccounted confounding and should be taken into consideration when interpreting the results.

Participation and completion rates of in-hospital CR and CR in community centres remained unexplored as our study only focused on the referral process to CR.

CONCLUSION

High income and educational level were associated with a larger chance of being informed about CR, willingness to participate in CR and assigned in-hospital CR in patients with ACS.

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Contributors CBG, RE and MLL contributed to study design and acquisition of data. CBG, MBJ and MLL analysed and interpreted the data. SPJ, SR and TH contributed to interpretation. CBG drafted the initial manuscript and all authors critically revised the manuscript and gave final approval.

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Competing interests None declared.

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