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Temporal trends in cardiovascular risk factors, lifestyle and secondary preventive medication for patients with myocardial infarction attending cardiac rehabilitation in Sweden 2006–2019: a registry-based cohort study

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ABSTRACT

Objectives Registries have been highlighted as means to improve quality of care. Here, we describe temporal trends in risk factors, lifestyle and preventive medication for patients after myocardial infarction (MI) registered in the quality registry Swedish Web-system for Enhancement and Development of Evidence-based care in Heart disease Evaluated According to Recommended Therapies (SWEDEHEART).

Design A registry-based cohort study.

Setting All coronary care units and cardiac rehabilitation (CR) centres in Sweden.

Participants Patients attending a CR visit at 1-year post-MI 2006–2019 were included (n=81 363, 18–74 years, 74.7% men).

Outcome measures Outcome measures at 1-year follow-up included blood pressure (BP) <140/90 mm Hg, low-density lipoprotein-cholesterol (LDL-C)<1.8 mmol/L, persistent smoking, overweight/obesity, central obesity, diabetes prevalence, inadequate physical activity, and prescription of secondary preventive medication. Descriptive statistics and testing for trends were applied.

Results The proportion of patients attaining the targets for BP<140/90 mmHg increased from 65.2% (2006) to 86.0% (2019), and LDL-C<1.8 mmol/L from 29.8% (2006) to 66.9% (2019, p<0.0001 both). While smoking at the time of MI decreased (32.0% to 26.5%, p<0.0001), persistent smoking at 1 year was unchanged (42.8% to 43.2%, p=0.672) as was the prevalence of overweight/obesity (71.9% to 72.9%, p=0.559). Central obesity (50.5% to 57.0%), diabetes (18.2% to 27.2%) and patients reporting inadequate levels of physical activity (57.0% to 61.5%) increased (p<0.0001 for all). From 2007, >90.0% of patients were prescribed statins and approximately 98% antiplatelet and/or anticoagulant therapy. Angiotensin-converting enzyme inhibitor/angiotensin receptor blocker prescription increased from 68.7% (2006) to 80.2% (2019, p<0.0001).

Conclusions While little change was observed for persistent smoking and overweight/obesity, large improvements were observed for LDL-C and BP target achievements and prescription of preventive medication for Swedish patients after MI 2006–2019. Compared with published results from patients with coronary artery disease in Europe during the same period, these improvements were considerably larger. Continuous auditing and open comparisons of CR outcomes might possibly explain some of the observed improvements and differences.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The major strengths of the study are the broad representability and national coverage of data including all patients<75 years of age who suffered a myocardial infarction (MI) and were followed in the Swedish quality registry SWEDEHEART.
⇒ Major modifiable cardiovascular risk factors were included; blood pressure levels, low-density lipoprotein cholesterol levels, smoking habits, self-reported physical activity, overweight, obesity, central obesity, as well as prescription of secondary preventive medication.
⇒ The major limitations of the study are the lack of data on MI patients not attending CR and on those≥75 years of age.
⇒ Also, comparing our data with other survey and audit data is limited by differences in patient selections, different rates of CR participation, time of follow-up, and differences in measurement methods.

INTRODUCTION

Treating cardiovascular risk factors and adopting healthy behaviours after myocardial infarction (MI) is the most effective way to reduce recurrent cardiovascular events.[1 2] Based on abundant and continuously accumulating evidence, the European Society

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of Cardiology (ESC) regularly publishes guidelines on cardiovascular disease prevention in clinical practice.[3] Secondary prevention is usually provided through cardiac rehabilitation (CR)—a complex intervention entailing the optimal use of cardio-protective medication, exercise training, behavioural modification, patient education, and psychosocial counselling.[4] In the latest ESC prevention guidelines, participation in CR post-MI is given the highest possible recommendation and level of evidence.[3] Still, implementing the guidelines in clinical practice has proven to be a challenge, with goal attainment in CR being far from optimal.[5 6] Especially it seems challenging to reach lifestyle associated targets such as being adequately physically active and active smokers at the time of the MI being abstinent from smoking. Furthermore, only marginal improvements have been observed in goal attainment for blood pressure (BP) and low-density lipoprotein cholesterol (LDL-C) during the last 10 years despite increasing availability of more effective pharmacotherapy.[5]

Systematically monitoring quality of care, structure and process of delivery within CR has been highlighted as a possible way to increase prevention target attainment.[7–11] The Swedish Web-system for Enhancement and Development of Evidence-based care in Heart disease Evaluated According to Recommended Therapies (SWEDEHEART) is a nationwide quality registry that records patient characteristics, treatments and outcomes of consecutive patients with MI admitted to coronary care units in Sweden.[12] Registration of CR quality and process-based metrics for patients after an MI started in 2005. Since 2006, data have been collected for patients under the age of 75 at two routine follow-up visits within CR—at 2 months and 1 year post-MI.[13 14] Referrals to CR are automatically generated through the electronic registry system for all MI patients and since 2016 more than 75% of all eligible patients, who are alive at 1 year after the acute event, attend the 1-year CR follow-up visit.[15] Data from SWEDEHEART are available online and are updated continuously, facilitating open comparisons between CR programmes in the country.[16]

The objective of this study was to describe temporal trends 2006–2019 in risk factor prevalence, lifestyle and prescription of secondary preventive medication at 1 year after MI for patients attending CR in Sweden, hypothesising that a national quality registry can contribute to improving outcomes in CR.

METHODS

Patient population and settings

In this retrospective registry-based cohort study, data on all patients (1) with a Swedish national identification number, (2) aged 18–74 years, (3) admitted for a first time or recurrent MI (ICD codes I21, I22 or I23) and (4) having a 1-year CR follow-up visit registered in SWEDEHEART between 1 January 2006 and 31 December 2019 were used. Since patients with recurrent MI are included in SWEDEHEART, the same patient can be registered on several occasions, although not more than once per year since each individual patient can only generate one SWEDEHEART-based follow-up per year. Until 2018, it was mandatory to register patients <75 years of age, while registration of those 75 years or older was optional. For this reason, we chose to apply the age limit of 18–74 years throughout the whole period in the current study. No other exclusion criteria were applied.

Patient and public involvement statement

Patients were not involved in the design or conduct of the current study. The SWEDEHEART registry's steering group has, however, included a patient representative for many years. The steering group is involved in decisions concerning variables included in the registry and how results generated from registry data are disseminated to the general public.

Data collection

Hospitalisation data

Detailed description of the SWEDEHEART registry has previously been published.[12 13] In short, the registry includes more than 100 variables collected during hospitalisation, describing patient characteristics and acute MI care.[12] These include age, sex, smoking status (current smoker, previous smoker (stopped smoking >1 month) or never smoker), history of diabetes, hypertension, atherosclerotic cardiovascular disease (MI, percutaneous coronary intervention (PCI), coronary artery by-pass grafting (CABG) or stroke), and current pharmacotherapy, collected from electronic medical records and by self-report. Data on race/ethnicity are not available in SWEDEHEART. Height (cm) and weight (kg) are collected, measured during hospitalisation or self-reported, and body mass index (BMI, kg/m^2) is calculated. Waist circumference is not measured during hospitalisation. Systolic and diastolic BP (mm Hg) are registered. Blood samples collected include total cholesterol, triglycerides, LDL-C, high-density lipoprotein cholesterol (HDL-C), fasting plasma glucose and HbA1c (for patients with diabetes only). In SWEDEHEART, estimated LDL-C according to the Friedewald formula: LDL-C=total cholesterol−HDL-C−(0.45×triglycerides) is used to minimise interlaboratory differences in LDL-C.[17] In case of triglycerides >4.5 mmol/L or missing values on total cholesterol, HDL-C or triglycerides, directly measured LDL-C, is used instead. In the SWEDEHEART user manual, it is recommended that laboratory measures are performed according to local laboratory routines.

CR data

Approximately 80 variables are collected at CR visits at 2 months (time frame 6–10 weeks) and 1 year (time frame 11–13 months) post-MI.[13] These include weight and waist circumference, systolic and diastolic BP, blood samples (lipids, fasting plasma glucose, and in patients with diabetes HbA1c), smoking status and current

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pharmacotherapy. Additionally, patients report how many days during the last week they have been physically active for a minimum of 30 min (at least 10 min at a time) at an intensity that will induce shortness of breath and a slightly increased pulse, corresponding to a brisk walk.

All data in SWEDEHEART are registered online. Data validity is continuously monitored, with sampling confirming >95% agreement with data from medical records.[12 13]

Exposure and outcome variables

Exposure in this study was defined as the calendar year of the 1-year follow-up visit. Outcome variables at 1-year follow-up included the following: BP <140/90 mm Hg (both systolic and diastolic BP targets fulfilled, same goal irrespective of diabetes status); LDL-C <1.8 mmol/L; diabetes prevalence; persistent smoking (proportion of smokers at the time of MI who were still smoking at 1-year follow-up); inadequate physical activity (being physically active (as defined above) <5 days/week); overweight/obesity (BMI ≥25 kg/m^2); central obesity (waist circumference ≥102 cm for men and ≥88 cm for women); prescription of secondary preventive medication: lipid-lowering drugs (statins and/or ezetimibe), ACE inhibitors (ACEi) or angiotensin receptor blockers (ARB), beta blockers, antiplatelet agents (acetylsalicylic acid and/or P2Y$_{12}$-receptor antagonists) and anticoagulants (warfarin or direct oral anticoagulants). Registration of the use of proprotein convertase subtilisin/kexin 9 inhibitors started in SWEDEHEART in 2017. As information on use prior to 2017 was not available as well as the use being minimal in the first years (0.5%–1.5%), we decided to include only statins and ezetimibe in the definition of lipid-lowering therapy.[15]

Statistical analysis

The distribution of continuous variables was assessed by visual inspection of histograms and Q-Q plots. Most continuous variables were non-normally distributed and are presented as medians (quartile 1, quartile 3), apart from delta values which are presented as means±SD. Data for categorical variables are presented as percentages. Trend tests were performed using Cochrane-Armitage trend test for categorical variables and Wilcoxon type test for continuous variables. To compare data between years 2006 and 2019, χ^2 test was used for categorical variables and Wilcoxon rank sum test for continuous variables. Outcomes were analysed as dichotomised variables. Median values for continuous outcome variables and mean delta values between baseline (time of index event) were also analysed. For waist circumference, delta was based on the 2-month and 1-year follow-up visit measurements. No imputation was performed on missing data. Data were analysed using SAS V.9.4 (SAS Institute, Cary, North Carolina). A two-sided p value of<0.05 was considered statistically significant.

RESULTS

Patient characteristics during hospitalisation

Between 2006 and 2019, 81 363 MI cases were registered in SWEDEHEART, representing 78 679 individual patients 18–74 years of age at the time of the acute event who subsequently attended a 1-year follow-up registry visit within CR. Patients were predominantly men, the proportion increasing slightly during the period from 73.5% in 2006 to 75.2% in 2019 (p trend <0.0001). The median (q1, q3) age was 63.0 (57.0, 69.0) years in 2006 and 65.0 (58.0–70.0) years in 2019 (p trend <0.0001). Further patient characteristics are seen in figure 1 and online supplemental table S1–S3. The most prominent changes observed during the period were a decrease in the proportion of smokers from 32.0% to 26.5% (p trend <0.0001), an increase in the proportion of overweight and obese patients (BMI ≥25 kg/m^2) from 70.7% to 74.1% (p trend <0.0001), and an increase in the use of lipid-lowering drugs (statins and/or ezetimibe) (24.5% to 28.6%, p trend=0.004) or antihypertensive drugs (ACEi/ARB, beta blockers, diuretics and/or calcium channel blockers) (47.6% to 51.2%, p trend <0.0001) prior to admission (figure 1). The proportion of patients being revascularised (by PCI or CABG) during hospitalisation and the proportion being prescribed statins, ezetimibe, ACEi/ARB and P2Y$_{12}$-receptor antagonist therapy at discharge increased during the observed period (p trend <0.0001 for all), while the proportion receiving beta blockers at discharge was decreased (p trend <0.0001) (online supplemental table S3).

BP, lipids and diabetes

The proportion of patients achieving BP <140/90 mm Hg at the 1-year follow-up visit increased from 65.2% in 2006 to 86.0% in 2019 (p trend <0.0001) (figure 2). Regarding LDL-C, 29.8% were treated to the <1.8 mmol/L target in 2006, increasing to 66.9% in 2019 (p trend <0.0001), with 30.4% having an LDL-C of <1.4 mmol/L in 2019 (figure 2). Mean delta values for systolic and diastolic BP and LDL-C between hospitalisation and 1-year follow-up also increased during the observed period (p for trend <0.0001 for all) (figure 3). The 1-year median systolic blood pressure, diastolic blood pressure, total cholesterol, LDL-C and triglycerides decreased over the period, while HDL-C remained unchanged (online supplemental table S4).

The prevalence of diabetes at the 1-year follow-up increased from 18.2% in 2006 to 27.2% in 2019 (p trend <0.0001) (figure 4). Between 2006 and 2013, there was a minimal difference between the prevalence of diabetes at hospitalisation and at 1-year follow-up (±1%-point). Since 2014, however, the difference increased, in 2019, being 4.6%-points higher at the 1-year follow-up. HbA1c (patients with diabetes only) at the 1-year follow-up decreased from 56 mmol/mol to 52 mmol/mol (p trend <0.0001) while the delta value between hospitalisation and 1 year remained unchanged (online supplemental tables S4–S5). Fasting glucose at 1-year (all patients) increased

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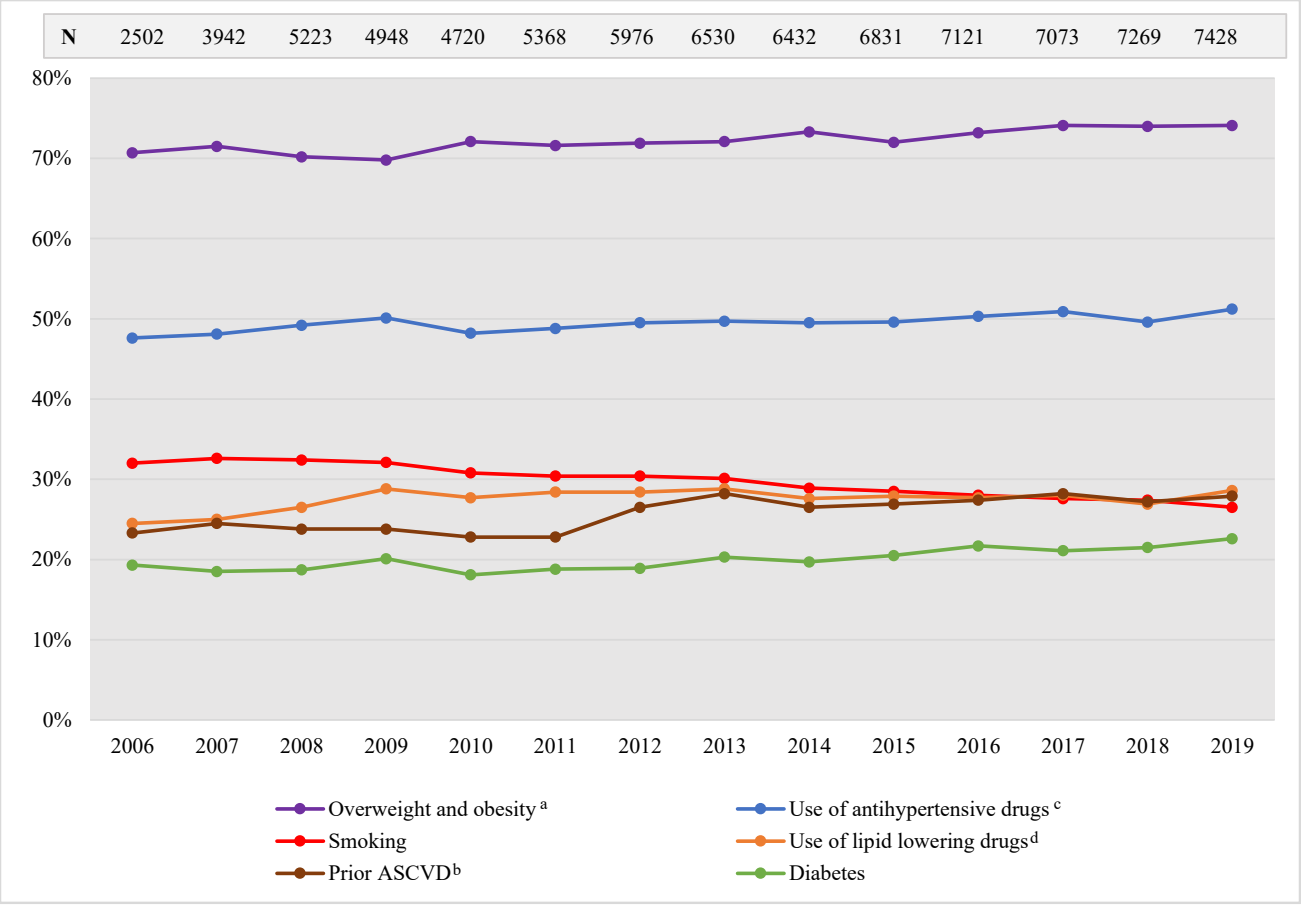

Figure 1 Patient characteristics as registered during MI hospitalisation for patients attending the 1-year follow-up visit within CR in Sweden 2006–2019. [a]BMI≥25 kg/m^2; [b]prior MI, PCI, CABG or stroke; [c]ACE inhibitors/ARB, beta blockers, diuretics and/or calcium channel blockers; [d]statins and/or ezetimibe. ACEi, ACE inhibitor; ARB, angiotensin receptor blocker; ASCVD, atherosclerotic cardiovascular disease (MI, PCI, CABG or stroke); BMI, body mass index; CABG, coronary artery bypass grafting; MI, myocardial infarction; N, number; PCI, percutaneous coronary intervention.

from 5.7 mmol/L to 6.0 mmol/L over the period (p trend <0.0001) (online supplemental table S4).

Lifestyle

The prevalence of persistent smoking, inadequate physical activity, overweight/obesity and central obesity at 1-year post-MI is seen in figure 4. Persistent smoking, that is, the proportion of smokers at the time of MI who were still smoking at the one-year follow-up, remained unchanged over the period (42.8% in 2006 and 43.2% 2019, p trend=0.672). The proportion of patients reporting inadequate physical activity increased during the observed period from 57.0% to 61.5% (p trend <0.0001). While the prevalence of patients who were overweight or obese at hospitalisation increased, the proportion at 1-year follow-up was similar (71.9% to 72.9%, p trend=0.559). In 2006–2015, an increase in BMI between baseline and 1-year follow-up was observed (between 0.04 kg/m^2 and 0.30 kg/m^2), while in 2016–2019, the difference was negative (between −0.01 kg/m^2 and −0.15 kg/m^2, p trend <0.0001) (online supplemental table S5). The prevalence of central obesity increased from 50.5% in 2006 to 57.0% in 2019 (p trend <0.0001). Yearly median values at 1-year follow-up for number of days during the last week, the patients had been physically active, BMI and waist circumference are shown in online supplemental table S4.

Secondary preventive medication

The use of secondary preventive medication at the 1-year follow-up visit is seen in figure 5. Since 2007, more than 90% of all patients were prescribed statins. Between 4% and 6% of the patients were prescribed ezetimibe prior to 2014 where after its use increased successively to 29.8% in 2019 (p trend <0.0001). Approximately 98% were prescribed either an antiplatelet or anticoagulant therapy throughout the period, with the proportion of patients receiving anticoagulant therapy doubling from 6.4% in 2006 to 12.0% in 2019 (p trend <0.0001). ACEi/ARB prescription increased from 68.7% to 80.2% (p trend <0.0001) while the use of beta blockers decreased from 86.4% to 76.7% (p trend <0.0001). The decrease was mostly driven by a decrease in use among patients with preserved ejection fraction (from 85.1% in 2006 to 70.5% in 2019, p for difference <0.0001), while the use

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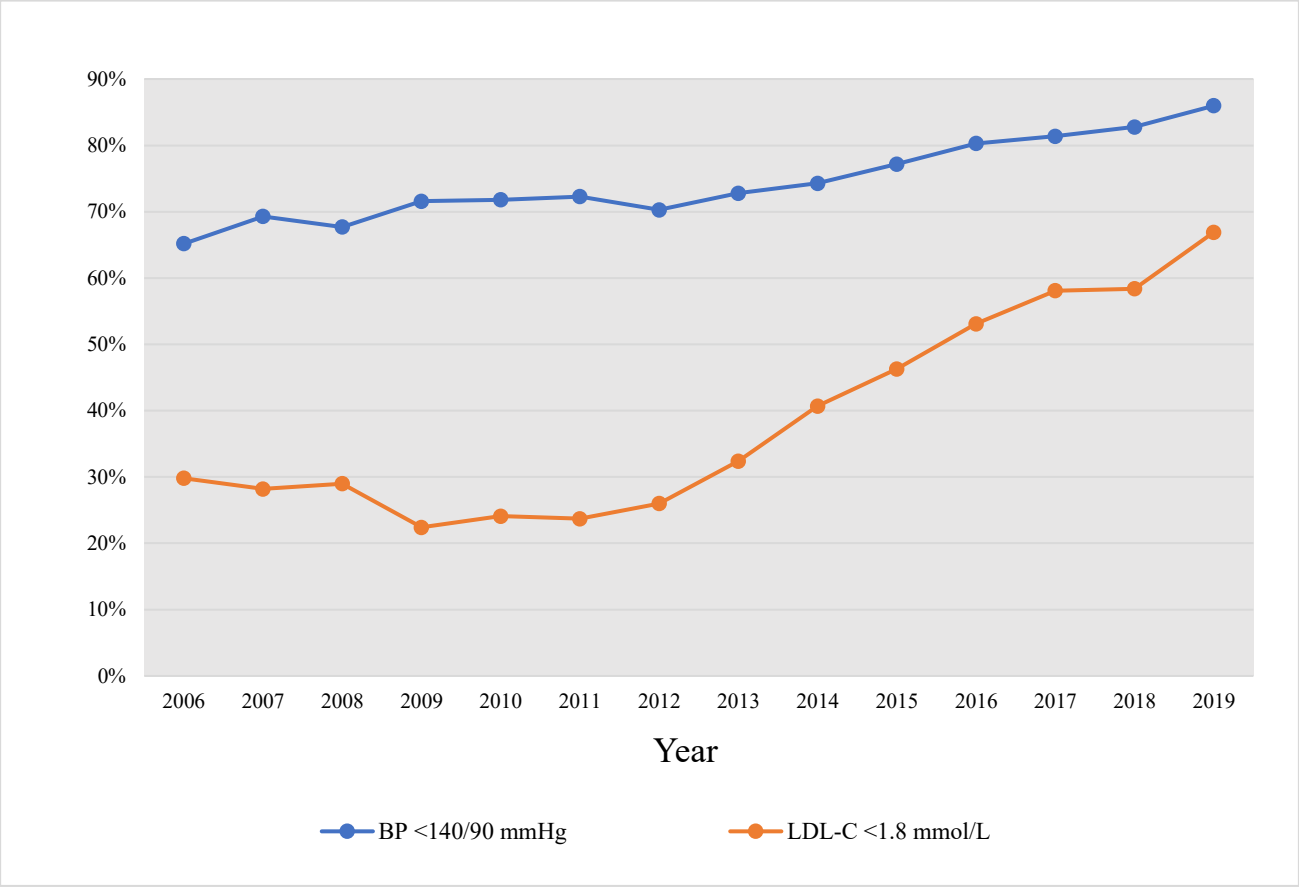

Figure 2 Proportion of patients achieving targets for BP and LDL-C at the 1-year follow-up visit 2006–2019. The p value for trend from 2006 to 2019 was <0.0001 for both BP and LDL-C. BP, blood pressure; LDL-C, low-density lipoprotein cholesterol.

in patients with reduced ejection fraction was unchanged (87.8% in 2006 compared with 88.6% in 2019, p for difference=0.540).

DISCUSSION

In this study of temporal trends in risk factor control and use of secondary preventive medication in post-MI patients attending CR in Sweden 2006–2019, a considerable improvement in BP and LDL-C goal achievement and use of evidence-based pharmacotherapy was observed. On the other hand, changes in lifestyle were less encouraging, with the proportion of persistent smokers at 1-year remaining unchanged, and prevalence of inadequate physical activity, central obesity as well as diabetes increasing.

BP, lipids and diabetes

In the EUROASPIRE surveys patients aged 18–79 years with coronary artery disease (CAD) were interviewed and examined at approximately 1 year after a first or recurrent coronary event (acute MI, unstable angina or revascularisation), to determine whether guidelines on CR were followed in clinical practice.[5 6] The III–V surveys were conducted over a period approximately matching our current study period (EUROASPIRE III 2006–2007, IV 2012–2013 and V 2016–2017), the patients had similar initiating events, and the mean age and gender proportions were comparable to the SWEDEHEART population (online supplemental table S6), giving a good opportunity to compare our results to European data. In our study, the proportion of patients achieving the BP goal of <140/90 mm Hg increased from 65.2% to 86.0% between 2006 and 2019, compared with an increase from 44.0% to 58.0% between EUROASPIRE III and V (figure 6).[5 6] As such, the proportion of patients achieving the BP goal was considerably higher (approximately 20% points) during the whole period in SWEDEHEART. There was an even larger difference in the proportion of patients reaching the LDL-C target of <1.8 mmol/L, increasing from 29.8% (2006) to 66.9% (2019) (37% point improvement) in SWEDEHEART, compared with 20.9% versus 29.0% (8% point improvement) between EUROASPIRE III and V (figure 6). One reasonable explanation for the large difference in proportion of patients achieving treatment targets for BP and LDL-C in SWEDEHEART compared with EUROASPIRE could be that all patients in our study participated in CR to some extent, compared with 35%–40% in the EUROASPIRE cohorts.[18 19] Participation in CR has been shown to increase adherence to secondary preventive medication and the proportion of

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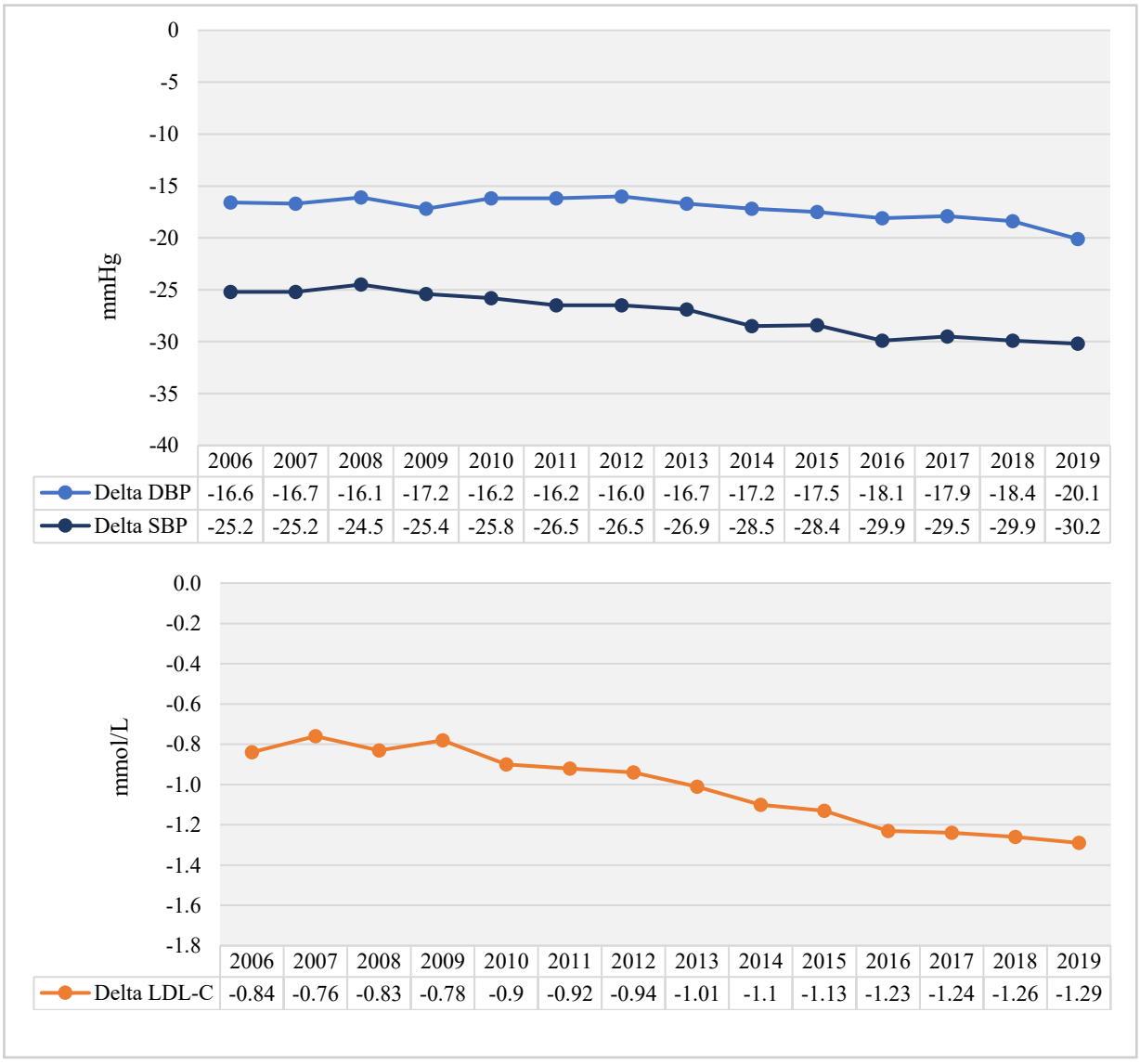

Figure 3 Mean delta values between hospitalisation and the 1-year CR follow-up visit for systolic and diastolic BP (upper panel) and LDL-C (lower panel) by year 2006–2019. The p value for the trend from 2006 to 2019 was <0.0001 for all. DBP, diastolic blood pressure; LDL-C, low-density lipoprotein cholesterol; SBP, systolic blood pressure.

patients reaching risk factor goals[20] as well as improving prognosis.[2] Somewhat contradictory though, data from EUROASPIRE IV on risk factor target achievement showed no difference in the proportion of patients reaching targets for BP and LDL-C when comparing attenders and non-attenders in CR.[19] Another possible explanation could be the higher proportion of patients being prescribed lipid-lowering therapies in our study as compared with EUROASPIRE. Between 2015 and 2019, 94%–95% of patients were prescribed statins and/or ezetimibe, with the corresponding proportion in EUROASPIRE V (2016–2017) being 84%, out of which only 50% were prescribed high-intensity lipid-lowering drugs.[5] In a study using Swedish registry data, the proportion of AMI patients receiving high-intensity statins post-MI during 2014–2016 was 91.3%.[21] An additional explanation for the more pronounced improvement in target attainment in SWEDEHEART compared with EUROASPIRE, as well as a more pronounced use of potent lipid-lowering therapy, might be the possibility of continuous self-audit of publicly available data for CR centres reporting to SWEDEHEART, as only a minority of the countries participating in EUROASPIRE had quality registries or audits comparable to SWEDEHEART. Among patients with CAD attending CR in Austria, where a well-functioning CR registry has been in use since 2001,[7] 85% of patients between 2005 and 2015 reached the systolic BP goal of <140 mm Hg.[22] Similarly, according to annual reports from the Danish CR Database on patients with CAD attending CR, which started in 2015, the proportion of patients reaching the LDL-C goal of <1.8 mmol/L increased from 54% in 2015 to 63% in 2019,[23 24] figures aligning well with our results for the same years. The joint observations from these three registries (SWEDEHEART, Austrian registry and Danish

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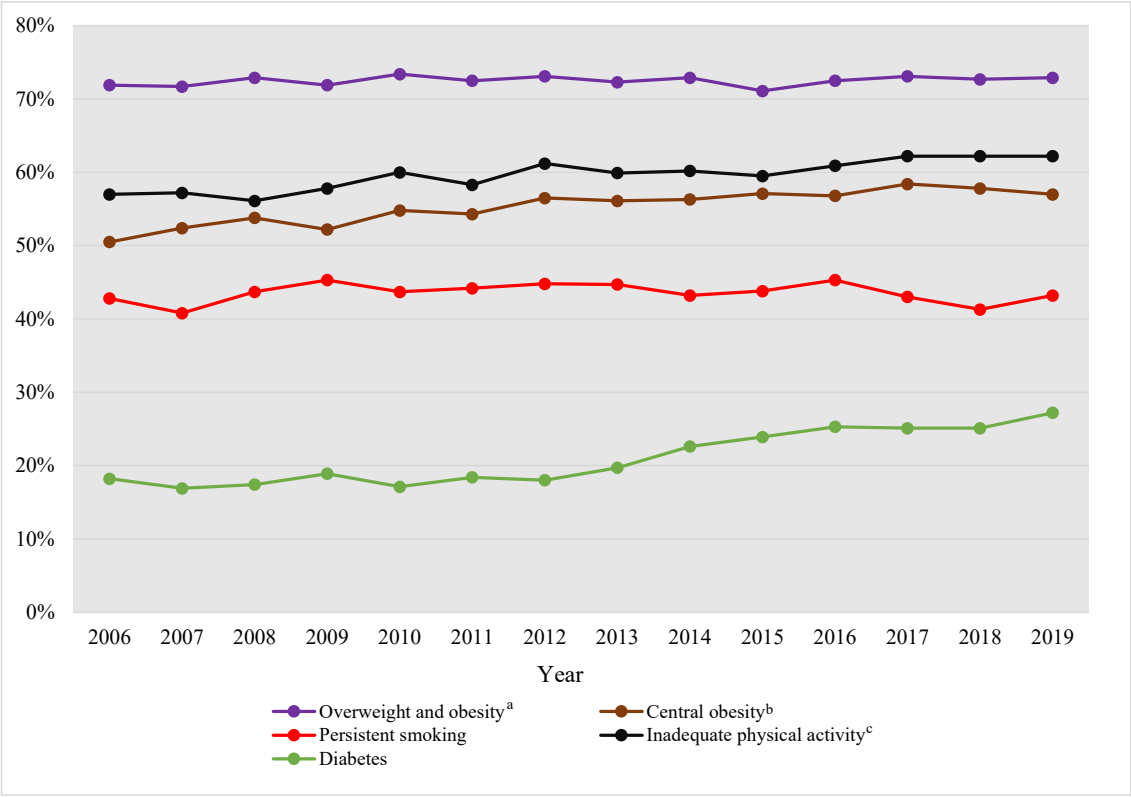

Figure 4 Prevalence of persistent smoking (proportion of active smokers at the time of MI who were still smoking), inadequate physical activity, overweight/obesity, and diabetes at 1-year post-MI. [a]BMI≥25 kg/m^2; [b]waist circumference ≥102 cm for men and ≥88 cm for women; [c]physically active ≥30 min for less than 5 days a week. BMI, body mass index; MI, myocardial infarction.

Registry) support the conclusion that benchmarking at a local and national level, and providing opportunities for open comparisons between centres, can positively impact quality of care.[7 25 26]

An interesting observation in our data was the increased difference in diabetes prevalence between hospitalisation and 1-year follow-up towards the end of the observed period. Also, median HbA1c values among patients with diabetes decreased. This possibly reflects heightened awareness and more structured routines for diagnosing diabetes in patients after an MI, with patients with milder forms of glucose disturbances being diagnosed. More patients being diagnosed should in the long term positively impact prognosis.[27 28] The increase in fasting glucose values in the whole population, paralleled by increased prevalence of central obesity, further underlines the importance of vigilant screening and treatment of diabetes in the post-MI population.

Lifestyle

Approximately, 30% of patients were smokers at the time of the index event in both the SWEDEHEART registry and the EUROASPIRE surveys. The proportion of persistent smokers at 1-year after the event, however, was generally higher in EUROASPIRE than in SWEDEHEART (online supplemental figure S1).[5 29] The fact that Sweden has the lowest proportion of daily smokers in Europe might partly explain the higher success rate for smoking cessation in our data. In contrary with the lack of difference in BP and LDL-C target achievement between CR attenders and non-attenders in EUROASPIRE, there was a substantial difference between attenders and non-attenders in smoking cessation rates, with 47% and 43% of CR attenders being persistent smokers in EUROASPIRE III (2006–2007) and IV (2011–2012), compared with 54% and 53% of the non-attenders.[18 19] The corresponding figures in SWEDEHEART (all patients defined as attenders) during the same years were 42% (2006–2007) and 45% (2011–2012). In both cohorts, however, there was no improvement in smoking cessation rates during the observed periods. The same can be seen in the British National Audits for CR (NACR) 2016–2019[30] and the Danish CR Database 2015–2019.[24] Observational studies have shown that smoking cessation post-MI results in a 36% relative risk reduction in total mortality.[31] The smoking cessation rates among CR attenders in the EUROASPIRE surveys and patients registered in SWEDEHEART, when compared with the considerably higher figures for non-attenders from EUROASPIRE, underline

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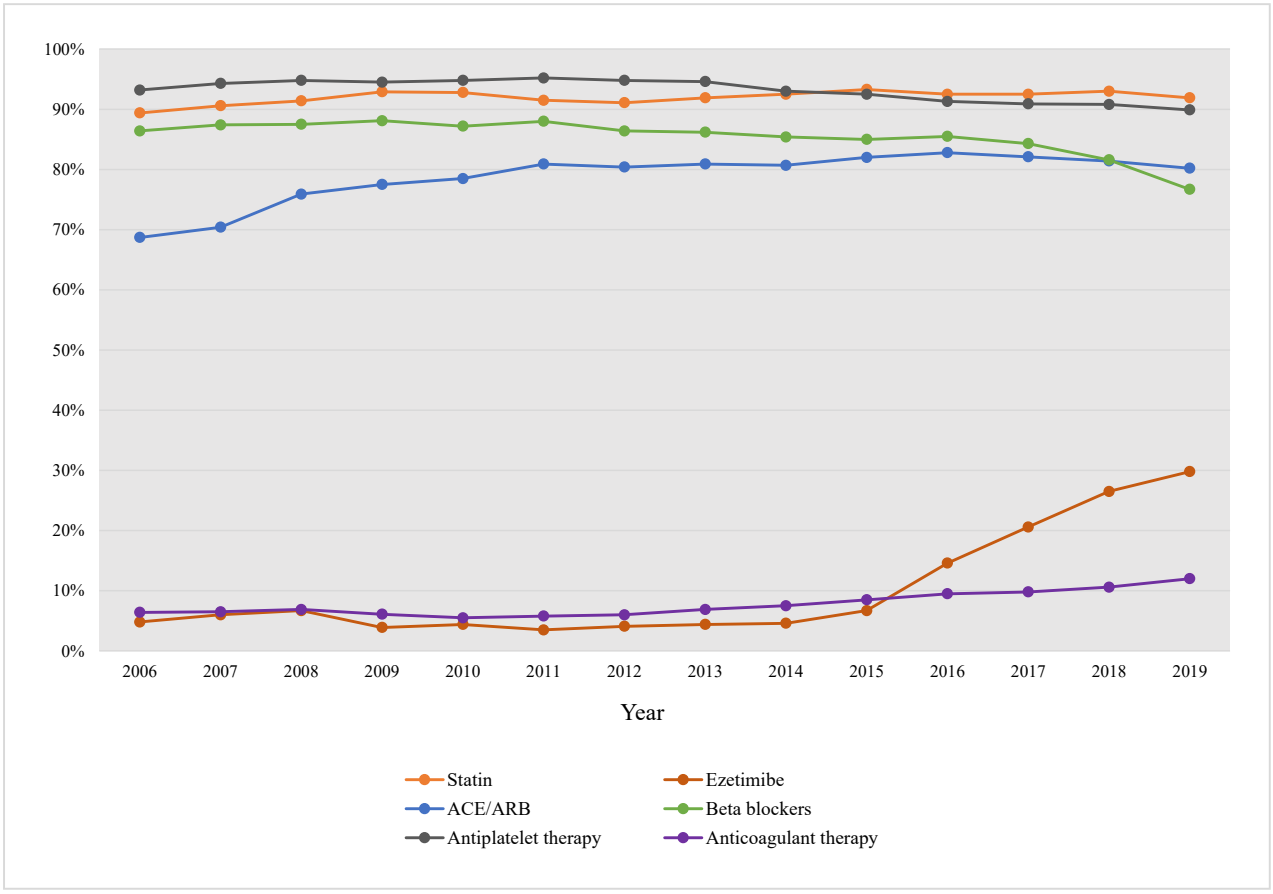

Figure 5 Proportion of patients at 1-year follow-up for each year 2006–2019 treated with statins, ezetimibe, ACEi or ARB, beta blockers, antiplatelet (acetylsalicylic acid or $P2Y_{12}$-receptor antagonists) or anticoagulant therapy (warfarin or direct oral anticoagulants). ACEi, ACE inhibitor; ARB, angiotensin receptor blocker.

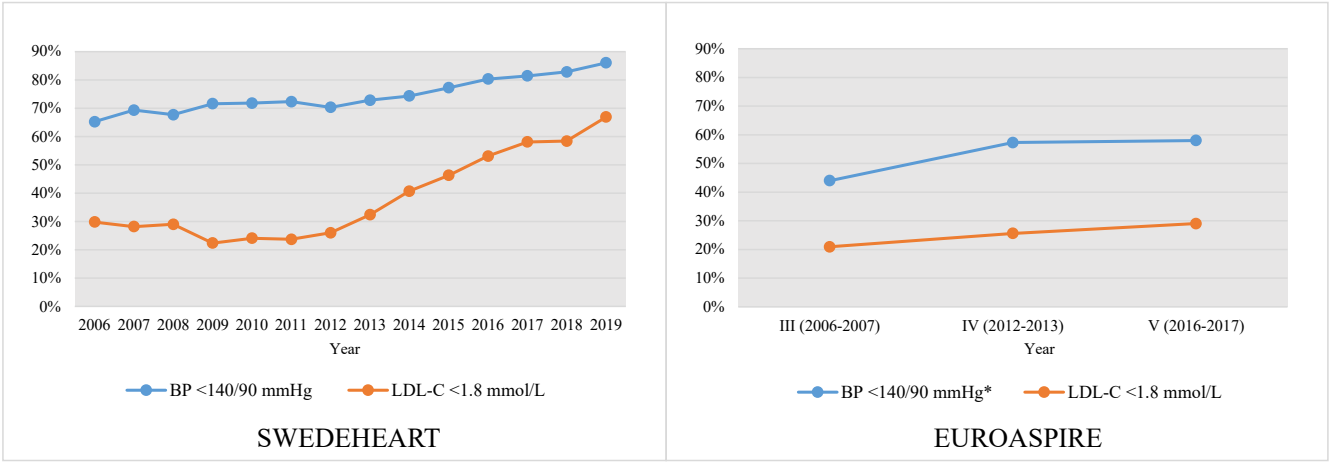

Figure 6 Management of BP and LDL in SWEDEHEART (left panel) and EUROASPIRE (right panel).[5 6] *Different definitions of BP treatment goals for patients with diabetes were adapted in the EUROASPIRE surveys (III<130/80 mmHg, IV 140/80 mmHg, V<140/85 mmHg), while the definition<140/90 mmHg was adapted for patients with and without diabetes in SWEDEHEART. BP, blood pressure; LDL-C, low-density lipoprotein cholesterol.

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the importance of CR attendance for supporting tobacco abstinence. At the same time, it is discouraging to see no improvement in smoking cessation rates in any of the reviewed data sets.

The proportion of patients reporting insufficient physical activity at the 1-year follow-up increased during the observed period. As different questionnaires for assessing physical activity have been used in the surveys and audits cited here, direct comparisons cannot be made. In general, though, in EUROASPIRE, the level of physical activity in all surveys was suboptimal and did not improve between surveys,[5 6] while the proportion of patients classified as physically active increased somewhat in the National Audit for CR (NACR) reports 2016–2019.[30]

While the prevalence of overweight/obesity at the time of the MI increased during the study period, the proportion of overweight/obese patients at the 1-year follow-up visit remained unchanged (72%–73%). This might partly be explained by a slight weight gain between hospitalisation and 1-year follow-up during the first half of the observed period, while a minimal weight loss was observed during the latter half. The clinical relevance of this observation is, however, uncertain. No change in the proportion of obese patients was observed in NACR 2016–2019[30] or the EUROASPIRE surveys, where just over 80% were overweight or obese[5 6] (online supplemental figure S1). The prevalence of central obesity was similar in our study and in EUROASPIRE and increased to the same extent (by approximately 10% points) during the observed period.[5 6]

In a recently published paper based on data from EUROASPIRE IV and V, poor adherence to lifestyle changes was addressed.[20] The authors concluded that while adherence to lifestyle advice was better among patients who had attended CR, an increased focus on behavioural change within CR to address unhealthy lifestyles is strongly needed. With all patients in our cohort having participated in CR to some extent, data on lifestyle being monitored and openly compared annually in the SWEDEHEART registry, and no visible change for the better seen for more than a decade, our results strongly support this conclusion.

Cardioprotective medication

According to our study, the use of lipid lowering drugs was high during the whole period. More than 90% of the patients were prescribed statins at the 1-year follow-up visit throughout the observed period and ezetimibe use increased rapidly after 2015, reaching 29.8% in 2019. In 2015–2109, more than 94% of all patients were prescribed statins and/or ezetimibe. Meanwhile, the use of lipid-lowering therapy, including statins, ezetimibe, fibrates, bile acid sequestrants and nicotinic acid, increased from approximately 80% of patients in EUROASPIRE III to 84% in EUROASPIRE V[5 29 32] (Online supplemental figure S2). In the CR attendance analyses from the EUROASPIRE III and IV surveys, compared with non-attenders, the proportion of CR attenders on lipid-lowering therapy was considerably higher, or 83% versus 78% (EAIII) and 88% versus 85% (EAIV), respectively.[18 19] Data on the use of cardioprotective medication from the Austrian registry or the British NACR have to our knowledge not been published. In annual reports from the Danish CR database, during 2016–2019, between 93% and 96% of CAD patients were prescribed statins at the end of CR.[24] According to our study, the use of ACEi/ARB increased from 64.9% in 2006 to 79.5% in 2019 while patients prescribed ACEi/ARB in EUROASPIRE III was 71% and 75% in EUROASPIRE V (online supplemental figure S2).[5 29 32] In the EUROASPIRE III and IV, the use of ACEi/ARB and BP-lowering medication was significantly higher in CR attenders than in non-attenders, although the difference was not as large as for lipid-lowering treatment.[18 19] While conclusions about the influence of auditing on cardioprotective medication prescription in Sweden are hard to draw, generally it can be concluded that the use of cardioprotective medication in our and other surveys has been high and has increased both in Sweden and Europe in general during the observed period.

Strengths and limitations

The major strength of this study is the broad representability and national coverage of data, with more than 75% of all MI patients under the age of 75 being registered in SWEDEHEART and attending a 1-year CR follow-up visit since 2016. At the same time, a major limitation is the lack of data describing MI patients not attending CR and on those ≥75 years of age and results cannot be generalised to these groups. Even though the mean age in our data was similar to EUROASPIRE, the age range differed somewhat (our data 18–74 years vs 18–79 years in EUROASPIRE), which might have led to a slight overestimation of the results. Also, the coverage on centre level during the first years was low and representability, therefore, not as extensive. Comparing our data with other survey and audit data are limited by differences in patient selections, different rates of CR participation, time of follow-up, differences in measurement methods (ie, questionnaires, self-report) and definitions (ie, physical inactivity).

CONCLUSION

Between 2006 and 2019, an increasing proportion of patients in Sweden reached secondary preventive goals for BP and LDL-C 1 year after an MI. The proportion of patients treated with evidence-based secondary preventive medication also increased. Both levels of BP and LDL-C as well as use of pharmacological treatment were comparable with data from other similar European quality registries and national level audits used for benchmarking. The trends were more favourable than those observed in EUROASPIRE, data from which represents several European countries where audits were not widely available. The results may indicate that national quality registries can contribute to improving outcomes

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in CR and add evidence to the importance of auditing and benchmarking as means to improve quality of care. Less encouraging, no changes were seen the proportion of current smokers at the time of the MI who are abstinent at 1-year, more patients reported inadequate levels of physical activity, and the proportion of patients with central obesity and diabetes increased, as was observed in EUROASPIRE. These observations bare witness of a large unmet need to prioritise patient lifestyle support after an MI, which should be improved to provide patients with adequate risk reduction.

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Patient consent for publication Not applicable.

Ethics approval The need for signed informed consent by patients for inclusion in Swedish quality registries has collectively been waived in Sweden. Upon hospital admission, MI patients are informed verbally and in writing by a nurse or physician about data being collected and entered in the registry. However, all patients have the right to deny registration and the right upon request to be removed from the registry at any time. Opt-out is extremely rare, counting less than ten cases per year. The study complies with the Declaration of Helsinki and was approved by The Swedish Ethical Review Authority (registration number: 2019-04277).

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Data availability statement Data are available upon reasonable request. The data used in this study is based on the SWEDEHEART registry. Access to data from the registry needs to be applied for and third-party data usage is not allowed, irrespective of whether the data contain potentially identifying or sensitive data or not. Instead, given ethical study approval from the Swedish Ethical Review Authority, access to SWEDEHEART data supporting the present findings can be applied for from the Uppsala Clinical Research Center (UCR) in Sweden. Further information can be found on the UCR https://www.ucr.uu.se/en/ and Swedish Ethical Review Authority https://etikprovningsmyndigheten.se/ websites.

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