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Completion of registration of risk factor variables during telephone vs on-site follow-up after myocardial infarction: a nationwide observational study in 101 199 patients from contemporary clinical practice in Sweden

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ABSTRACT

Objectives The objective of this study was to assess the completeness of registration of secondary preventive variables comparing on-site visits with telephone consultations during follow-up after myocardial infarction.

Design This was an observational study based on the Swedish quality registry SWEDEHEART.

Setting and outcome measures We analysed the proportion of missing values for major secondary preventive target data registered at the 2-month and 1-year follow-up visits, during 2006–2022 (n=101 199). χ^2 tests were used to compare differences in data registration comparing on-site visits with telephone consultations. Patient characteristics and time trends in the proportion of missing values were also analysed.

Results Baseline characteristics for patients with on-site visits and telephone consultations were similar. At the 2-month follow-up, the proportion of missing data registered at on-site visits compared with telephone consultations was systolic blood pressure 2.4% (n=1729) vs 28.0% (n=5462), low-density lipoprotein cholesterol 9.1% (n=6525) vs 32.6% (n=6360), weight 20.1% (n=14 343) vs 43.0% (n=8401) and haemoglobin A1c for patients with diabetes mellitus 39.4% (n=4594) vs 69.4% (n=2225), p for all <0.0001. The differences were similar at the 1-year follow-up. Self-reported measures such as smoking status, level of physical activity and current medication had a low proportion of missing data (≤2.1%) for both follow-up modalities.

Conclusion Registration of secondary preventive variables was less complete at telephone consultations compared with on-site cardiac rehabilitation follow-up visits, which might indicate lower quality of care during telephone follow-up. Further analysis on the possible impact of lack of registration of secondary preventive variables on patient outcomes is warranted.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This study has an advantage in terms of inclusiveness and nationwide scope of data, encompassing all first-time patients with myocardial infarction registered in SWEDEHEART who attended a cardiac rehabilitation follow-up visit from 2006 to 2022.
⇒ The study included major modifiable cardiovascular risk factors, blood pressure, low-density lipoprotein cholesterol, smoking habits, self-reported physical activity, overweight, obesity, central obesity and secondary preventive medication.
⇒ The results are descriptive; thus, we cannot draw conclusions on cause or effect.
⇒ The ability to compare our data with other survey and audit data is constrained by variations in patient selection criteria, disparate rates of participation in cardiac rehabilitation, differences in the timing of follow-up, variations in measurement methods, and discrepancies in definitions.

INTRODUCTION

Cardiac rehabilitation (CR) after myocardial infarction (MI) is a secondary preventive programme that includes risk factor management with optimisation of cardioprotective medication; exercise training; physical activity, nutritional and tobacco counselling; patient education; and psychosocial and vocational management.[1 2] The evidence supporting the effectiveness of CR in reducing recurrent cardiovascular events and mortality is robust, and participation carries the highest recommendation and level of evidence in current guidelines.[3 4] Despite this, poor patient participation is a well-known problem within CR.[5 6] Remotely delivered CR, such as telerehabilitation, has been suggested as one possible solution to increase participation.[1]

During the SARS-CoV-2 pandemic in Sweden, an increasing proportion of patients with MI in CR was followed remotely, mainly

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by telephone.[7–9] This trend has been sustained at several CR centres even after the end of pandemic restrictions.[9] Some questions have been raised as to the quality of telephone consultations compared with on-site visits. One issue to consider is whether caregivers address all aspects of the follow-up and record data as thoroughly during telephone consultations as during on-site visits. Prior studies have shown that during telephone consultations, important information may be missed, and fewer data points were collected.[10–12] Not comprehensively collecting data during CR can undermine its goal and cardioprotective potential. If information on risk factors is not collected, the risk factors cannot be properly managed.

The SWEDEHEART registry is a comprehensive national quality registry on cardiac disease, including data that encompass CR following MI, including secondary prevention interventions and goal achievement.[13] Data from CR have been collected since 2005. The SWEDEHEART database provides a foundation for research on cardiac diseases and has resulted in a range of scientific articles published, influencing the management of heart disease worldwide.[14]

The aim of this study was, first, to compare the completeness of registration of secondary preventive variables in the SWEDEHEART registry, during on-site vs telephone follow-up post-MI; second, to analyse patient characteristics among patients subject to follow-up by the two modalities and third, to analyse trends in completeness of registration of recorded variables over time. We hypothesised that data based on telephone consultations are registered to a lesser extent compared with on-site follow-up.

METHODS

Patient population and setting

The present study is a retrospective, registry-based, observational study design. The inclusion criteria were (1) having a Swedish national identification number, (2) age over 18 years, (3) first time MI (ICD codes I21, I22 and I23) and (4) having available follow-up data entered in the SWEDEHEART registry between 1 January 2006 and 31 December 2022. Until 2018, it was mandatory to register patients <75 years of age; whereafter, the age limit for mandatory registration was increased to <80 years. Registration of older patents is optional.

Data collection

The SWEDEHEART registry records patient characteristics, treatments and outcomes from all coronary care units treating patients with acute MI, representing an unselected population of patients with MI in Sweden.[13 15] The registry first records baseline patient data during hospitalisation for acute MI. Referrals to CR are then automatically generated through the electronic registry system. Secondary preventive follow-up variables are subsequently collected during outpatient visits at CR centres. Follow-up occurs at two prespecified time points, at 2 months (time frame 6–10 weeks) and at 1 year (time frame 11–14 months) post-MI. During follow-up visits, approximately 80 secondary preventive variables are collected per patient per follow-up visit. These include results of blood samples (cholesterol profile, fasting plasma glucose and haemoglobin A1c (HbA1c), all analysed according to local hospital routines), systolic and diastolic blood pressure (BP), weight and waist circumference. Self-reported variables such as quality of life, level of physical activity and dietary habits are also collected as well as smoking status and current medication. For physical activity, 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.[14] For dietary habits, patients answer a four-item questionnaire quantifying the amount of fruits, vegetables, fish and sweets consumed per week.[14] For quality of life and mental health, patients answer the EuroQol-5 Dimension (EQ-5D) questionnaire where they rate their mobility, self-care, usual activities, pain or discomfort, and anxiety or depression,[16] as well as a four-item questionnaire of mental health which aims to rate the level of anxiety and/or depression.[14] A list of variables included in the study is presented in online supplemental table 1.

Data are collected from electronic medical records and by self-report and entered into the registry online. Data validity is continuously monitored, with sampling confirming >95% agreement with source data from medical records.[13 15]

Socioeconomic data were collected from Statistics Sweden, a government agency that produces official statistics.[17] Information on comorbidities at baseline (diabetes mellitus) was collected from the National Board of Health and Welfare.[18]

Exposure and outcome variables

Exposure was defined as having an on-site visit or telephone consultation during CR follow-up. The primary outcome was the proportion of missing data in the dataset at the 2-month and 1-year follow-up visits. Secondary outcomes were the characteristics of patients attending on-site visits or telephone consultations as well as the extent of missing variables up during different time periods: 2006–2009, 2010–2014, 2015–2019 and 2020–2022 (period of SARS-CoV-2 pandemic restrictions). Missing variables were defined as no registered value or variable registered as 'unknown'.

Statistical analysis

Data are presented as numbers and proportions or medians and interquartile ranges for categorical and continuous variables, respectively. Graphical verification with histograms and quantile–quantile plots for continuous variables was used to test normality. As data were skewed and consisted of several outliers, nonparametric tests were performed. To compare proportions of missing

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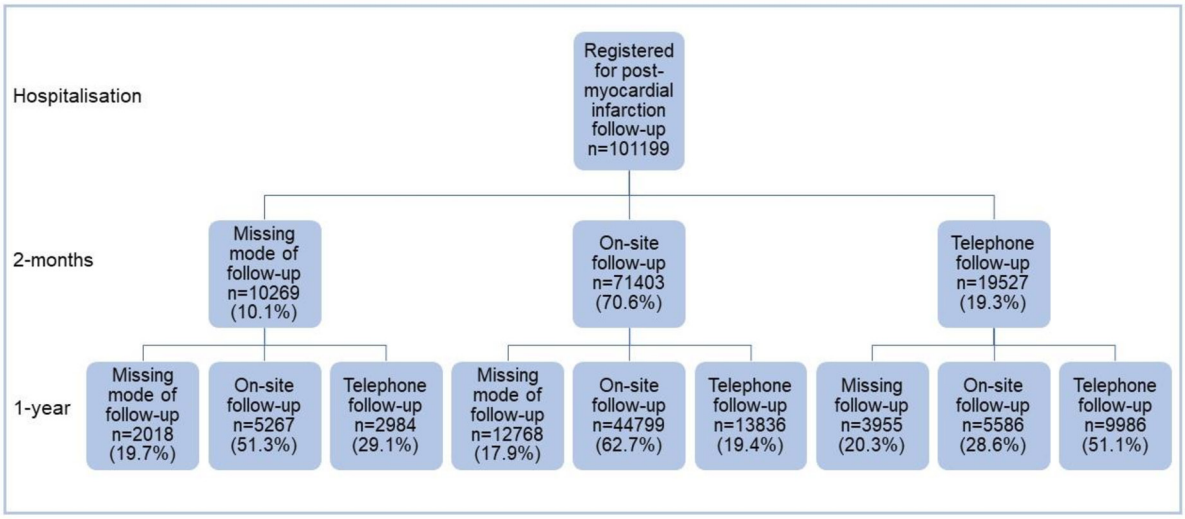

Figure 1 Flowchart of patients registered in the SWEDEHEART registry with first-time myocardial infarction between 2006 and 2022, and their modes of follow-up. Results are presented as counts (n) and percentages.

data and patient characteristics, the χ^2 test was applied for categorical variables and Mann–Whitney U test for continuous variables. Trend tests were performed to compare time periods using Cochrane–Armitage trend test. A two-sided p value of <0.05 was considered statistically significant. Data were analysed using SAS V.9.4 (SAS Institute, Cary, North Carolina).

Ethical considerations

In Sweden, the requirement for patients to provide signed informed consent to be included in quality registries has been waived. Instead, during hospital admission, patients are informed verbally and in writing that their data will be collected and entered in the SWEDEHEART registry. Patients can request to have their information removed from the registry at any time. It is rare for patients to opt-out, with fewer than 10 cases per year.[9 14] The study was conducted in accordance with the Declaration of Helsinki and received approval from the Swedish Ethical Review Authority (registration number 2019–04277).

RESULTS

Patient characteristics and flow

A flowchart of included patients is shown in figure 1. A total of 201 396 patients suffered a first-time MI during the study period. Out of these, 101 199 had a registered follow-up in SWEDEHEART. The number of patients with a registered follow-up modality at 2 months was 90 930 and at 1 year was 82 458. The most common mode of follow-up was on-site, both at 2 months (n=71 403, 70.6%) and at 1 year (n=55 652, 55.0%). The most common combination of follow-up modalities was on-site at 2 months followed by on-site at 1 year (n=44 799, 44.3%). Of those who had a telephone consultation at 2 months (n=19 527, 19.3%), 9986 (51.1%) had a subsequent telephone consultation at 1 year.

Baseline characteristics for patients attending a 2-month post-MI visit are shown in table 1. Overall, patients were predominantly male (n=66 532, 73.3%), and the mean age was 62.9±9.3 years. Baseline characteristics for patients followed up on-site vs by telephone were similar. For those followed up on-site slightly, more were retired (51.6% vs 47.3%), more were working (41.6% vs 38.9%) and a larger proportion was born outside of Scandinavia (13.2% vs 8.2%), compared with those followed up by telephone (table 1).

Proportion of missing variables during follow-up

The number (%) of missing data for a selection of collected variables at 2-month and 1-year follow-up visits is shown in tables 2 and 3 and online supplemental table 2. At the 2-month follow-up, systolic BP (SBP) was missing for 2.4% of patients with on-site visits, for 28.0% of patients with telephone consultations (p<0.0001) and 1.6% vs 27.1% (p<0.0001) at the 1-year follow-up, respectively. There were similarly large differences in missing values for diastolic BP (DBP). For low-density lipoprotein cholesterol (LDL-C), 9.1% of values were missing for patients who had an on-site visit at 2 months and 32.6% for patients who had a telephone consultation (p<0.0001), the corresponding numbers were 4.9% and 26.0% (p<0.0001) at the 1-year follow-up. Unlike BP and LDL-C which are mandatory to register during follow-up, the registration of HbA1c has been optional until 2021 after which it became mandatory. For HbA1c, in patients with known diabetes mellitus, the proportions of missing values were 39.4% during on-site visits and 69.4% during telephone consultations (p<0.0001) at 2 months and 28.7% and 52.6% (p<0.0001) at 1 year, respectively. Similarly, fasting plasma glucose, which is not mandatory to register, was more often missing during telephone consultations compared with on-site visits (tables 2 and 3, and online supplemental table 2).

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Table 1 Baseline characteristics during hospitalisation for myocardial infarction for patients with a follow-up at 6–10 weeks (2006–2022)

	On-site follow-up (n=71 403)	Telephone follow-up (n=19 527)	Overall (n=90 930)
Age (years)			
n	71 403	19 527	90 930
missing	0	0	0
Mean (SD)	62.78 (9.33)	63.45 (9.13)	62.93 (9.29)
Sex			
Male, n (%)	52 497 (73.5)	14 127 (72.3)	66 624 (73.3)
Female, n (%)	18 906 (26.5)	5400 (27.7)	24 306 (26.7)
Smoking status			
Never smoked, n (%)	25 621 (35.9)	7089 (36.3)	32 710 (36.0)
Former smoker,* n (%)	23 880 (33.4)	6598 (33.8)	30 478 (33.5)
Current smoker, n (%)	20 266 (28.4)	5346 (27.4)	25 612 (28.2)
Missing, n (%)	1636 (2.3)	494 (2.5)	2130 (2.3)
LDL-C (mmol/L)			
n	59 987	16 806	76 793
Missing	11 416	2721	14 137
Mean (SD)	3.21 (1.08)	3.26 (1.10)	3.22 (1.09)
Systolic blood pressure (mm Hg)			
n	70 666	18 529	89 195
Missing	737	998	1735
Mean (SD)	150.80 (27.79)	150.98 (27.68)	150.84 (27.76)
Diastolic blood pressure (mm Hg)			
n	68 289	18 172	86 461
Missing	3114	1355	4469
Mean (SD)	88.25 (16.46)	88.78 (16.67)	88.36 (16.51)
Infarct type			
NSTEMI, n (%)	41 230 (57.7)	11 496 (58.9)	52 726 (58.0)
STEMI, n (%)	30 173 (42.3)	8031 (41.1)	38 204 (42.0)
Left ventricular function			
Normal (≥50%), n (%)	42 181 (59.1)	11 929 (61.1)	54 110 (59.5)
Mild dysfunction (40–49%), n (%)	13 479 (18.9)	3455 (17.7)	16 934 (18.6)
Moderate dysfunction (30–39%), n (%)	6243 (8.7)	1612 (8.3)	7855 (8.6)
Severely abnormal (<30%), n (%)	1698 (2.4)	453 (2.3)	2151 (2.4)
Missing, n (%)	7802 (10.9)	2078 (10.6)	9880 (10.9)
Diabetes mellitus			
Yes, n (%)	13 590 (19.0)	3867 (19.8)	17 457 (19.2)
Sociodemographic data			
Country of birth			
EU except the Scandinavia, n (%)	2157 (3.0)	470 (2.4)	2627 (2.9)
Europe except Scandinavia and EU, n (%)	2669 (3.7)	457 (2.3)	3126 (3.4)
Outside of Europe, n (%)	4652 (6.5)	689 (3.5)	5341 (5.9)
Scandinavia except Sweden, n (%)	3219 (4.5)	1067 (5.5)	4286 (4.7)
Sweden, n (%)	58 698 (82.2)	16 843 (86.3)	75 541 (83.1)
Missing, n (%)	8 (0.0)	1 (0.0)	9 (0.0)

Continued

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Table 1 Continued

	On-site follow-up (n=71 403)	Telephone follow-up (n=19 527)	Overall (n=90 930)
Employment			
On sick leave, n (%)	2168 (3.0)	555 (2.8)	2723 (3.0)
Pensioner, n (%)	33 773 (47.3)	10 081 (51.6)	43 854 (48.2)
Student/other, n (%)	444 (0.6)	68 (0.3)	512 (0.6)
Unemployed, n (%)	1529 (2.1)	347 (1.8)	1876 (2.1)
Working, n (%)	29 709 (41.6)	7599 (38.9)	37 308 (41.0)
Missing, n (%)	3780 (5.3)	877 (4.5)	4657 (5.1)
Marital status			
Married, n (%)	40 820 (57.2)	11 097 (56.8)	51 917 (57.1)
No partner/divorced/widow/widower, n (%)	30 412 (42.6)	8392 (43.0)	38 804 (42.7)
Missing, n (%)	171 (0.2)	38 (0.2)	209 (0.2)
Education			
Primary school education<9 years, n (%)	11 667 (16.3)	3330 (17.1)	14 997 (16.5)
Primary school education 9 years, n (%)	8710 (12.2)	2426 (12.4)	11 136 (12.2)
Secondary education, n (%)	33 173 (46.5)	9384 (48.1)	42 557 (46.8)
Post-secondary education/postgraduate education, n (%)	17 042 (23.9)	4246 (21.7)	21 288 (23.4)
Missing, n (%)	811 (1.1)	141 (0.7)	952 (1.0)
Household disposable income			
High, n (%)	29 095 (40.7)	7621 (39.0)	36 716 (40.4)
Low, n (%)	18 052 (25.3)	5075 (26.0)	23 127 (25.4)
Medium, n (%)	24 081 (33.7)	6790 (34.8)	30 871 (34.0)
Missing, n (%)	175 (0.2)	41 (0.2)	216 (0.2)

*Self-reported smoking cessation ≥1 month.
LDL-C, low-density lipoprotein cholesterol; NSTEMI, non-ST-elevation myocardial infarction; STEMI, ST-elevation myocardial infarction.

Generally, self-reported variables had fewer missing values at both on-site visits and telephone consultations than laboratory data and data based on physical examinations. Smoking status and current medication, for instance, had ≤1% missing values during all registered follow-ups (tables 2 and 3, and online supplemental table 2).

As for questionnaires on diet and mental health, the completeness was considerably lower at both on-site and telephone follow-up. Still, also for these variables, completeness at on-site follow-up visits was higher than at telephone visits (online supplemental table 2).

Characteristics of patients with different follow-up modalities

The characteristics of the included patients are displayed in tables 2 and 3, and online supplemental table 2. At the 2-month follow-up, patients with on-site visits had higher BP (SBP 130.3±17.7and DBP 76.3±10.0mm Hg) compared with those followed up via telephone (SBP 129.4±17.2and DBP 76.0±10.0mm Hg), p for SBP<0.0001and p for DBP=0.0008 (table 2). The differences in BP at 1year were similar (table 3).

At the 2-month follow-up, the number of active smokers was similar (10.5% in both groups), but at 1year, the number of active smokers in the group that was followed up on-site was higher (12.3%) compared with those followed up via telephone (11.9%), p<0.0001. At 2months and 1year, patients who were followed up on-site reported a lower number of days being physically active but had, to a larger extent, participated in an exercise-training programme (tables 2 and 3, and online supplemental table 2).

Temporal trends in completeness of registration

The percentage of patients who had on-site follow-up visits increased until 2020, when SARS-CoV-2 pandemic restrictions started, after which an increase in the use of telephone consultations was observed (figure 2).

Temporal trends in the proportion of missing variables are displayed in online supplemental table 3 (2-month follow-up) and online supplemental table 4 (1-year follow-up). Completeness of registration during telephone consultations for SBP and LDL-C improved over time. From 2006 to 2009, for SBP, the percentage

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Table 2 Registered variables during 2-month follow-up after myocardial infarction (2006–2022)

	On-site follow-up n=71 403	Telephone follow-up n=19 527	p-Value*	p-Value for relative difference in missing values†
Systolic blood pressure (mm Hg)				
n	69 674	14 065	<0.0001	<0.0001
Missing, n (%)	1729 (2.4)	5462 (28.0)		
Mean (SD)	130.28 (17.66)	129.44 (17.23)		
Diastolic blood pressure (mm Hg)				
n	69 576	14 034	0.0008	<0.0001
Missing, n (%)	1827 (2.6)	5493 (28.1)		
Mean (SD)	76.32 (9.97)	76.03 (10.01)		
LDL-C (mmol/L)				
n	64 032	13 010	0.0004	<0.0001
Missing, n (%)	6525 (9.1)	6360 (32.6)		
Mean (SD)	1.90 (0.74)	1.93 (0.75)		
Weight (kg)				
n	57 060	11 126	0.0392	<0.0001
Missing, n (%)	14 343 (20.1)	8401 (43.0)		
Mean (SD)	83.29 (15.73)	82.96 (15.57)		
Body mass index (kg/m^2)				
n	53 417	10 307	0.0028	<0.0001
Missing, n (%)	17 986 (25.2)	9220 (47.2)		
Median (IQR)	26.9 (24.5, 29.9)	26.8 (24.4, 29.7)		
Waist circumference (cm)				
n	44 577	5857	0.1372	<0.0001
Missing, n (%)	26 826 (37.6)	13 670 (70.0)		
Mean (SD)	100.30 (12.85)	100.10 (12.92)		
Smoking‡				
Never smoked, n (%)	25 156 (35.2)	6860 (35.1)	0.1179	0.043
Former smoker, n (%)	38 114 (53.4)	10 520 (53.9)		
Current smoker, n (%)	7606 (10.7)	2030 (10.4)		
Missing, n (%)	527 (0.7)	117 (0.6)		
HbA1c (mmol/mol) for patients with diabetes mellitus				
n	7055	981	0.2217	<0.0001
Missing, n (%)	4594 (39.4)	2225 (69.4)		
Median (IQR)	55.0 (48.0, 66.0)	55.0 (48.0, 65.0)		
Fasting plasma glucose (mmol/L) for patients with diabetes mellitus				
n	8193	1216	0.9953	<0.0001
Missing, n (%)	3456 (29.7)	1990 (62.1)		
Median (IQR)	7.9 (6.7, 9.8)	7.8 (6.7, 9.9)		
Number of physical activity occasions >30 min during the last 7 days				
n	70 290	19 111	<0.0001	<0.0001
Missing, n (%)	1113 (1.6)	416 (2.1)		
Mean (SD)	4.00 (2.65)	4.28 (2.61)		

*χ^2 test for category variables and Mann–Whitney U test for continuous variables.
†χ^2 test.
‡Self-reported smoking cessation ≥1 month.
HbA1c, haemoglobin A1c; LDL-C, low-density lipoprotein cholesterol.

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Table 3 Registered variables during 1-year follow-up after myocardial infarction (2006–2022)

	On-site follow-up n=55 652	Telephone follow-up n=26 806	p-Value*	p-Value for relative difference in missing values†
Systolic blood pressure (mm Hg)				
n	54 771	19 536	<0.0001	<0.0001
Missing, n (%)	881 (1.6)	7270 (27.1)		
Mean (SD)	130.13 (16.05)	129.14 (15.47)		
Diastolic blood pressure (mm Hg)				
n	54 716	19 498	<0.0001	<0.0001
Missing, n (%)	936 (1.7)	7308 (27.3)		
Mean (SD)	76.57 (9.66)	75.79 (9.63)		
LDL-C (mmol/L)				
n	52 294	20 026	<0.0001	<0.0001
Missing, n (%)	2708 (4.9)	6979 (26.0)		
Mean (SD)	1.94 (0.80)	1.89 (0.80)		
Weight (kg)				
n	45 985	15 518	<0.0001	<0.0001
Missing, n (%)	9667 (17.4)	11 288 (42.1)		
Mean (SD)	84.08 (15.94)	83.40 (15.94)		
Body mass index (kg/m^2)				
n	42 931	14 463	<0.0001	<0.0001
Missing, n (%)	12 721 (22.9)	12 343 (46.0)		
Median (IQR)	27.1 (24.6, 30.1)	26.9 (24.5, 30.0)		
Waist circumference (cm)				
n	38 263	6243	0.0002	<0.0001
Missing, n (%)	17 389 (31.2)	20 563 (76.7)		
Mean (SD)	100.80 (12.79)	100.26 (13.41)		
Smoking‡				
Never smoked, n (%)	19 440 (34.9)	9462 (35.3)	<0.0001	<0.0001
Former smoker, n (%)	29 178 (52.4)	13 966 (52.1)		
Current smoker, n (%)	6851 (12.3)	3188 (11.9)		
Missing, n (%)	183 (0.3)	190 (0.7)		
HbA1c (mmol/mol) for patients with diabetes mellitus				
n	7290	2283	0.1987	<0.0001
Missing, n (%)	2937 (28.7)	2532 (52.6)		
Median (IQR)	54.0 (46.0, 65.0)	53.0 (46.0, 64.0)		
Fasting plasma glucose (mmol/L) for patients with diabetes mellitus				
n	7750	2233	0.309	<0.0001
Missing, n (%)	2477 (24.2)	2582 (53.6)		
Median (IQR)	7.8 (6.6, 9.6)	7.7 (6.5, 9.5)		
Number of physical activity occasions >30 min during the last 7 days				
n	55 126	26 253	<0.0001	<0.0001
Missing, n (%)	526 (0.9)	553 (2.1)		
Mean (SD)	3.61 (2.64)	3.82 (2.62)		

*χ^2 test for category variables and Mann–Whitney U test for continuous variables.
†χ^2 test.
‡Self-reported smoking cessation ≥1 month.
HbA1c, haemoglobin A1c; LDL-C, low-density lipoprotein cholesterol.

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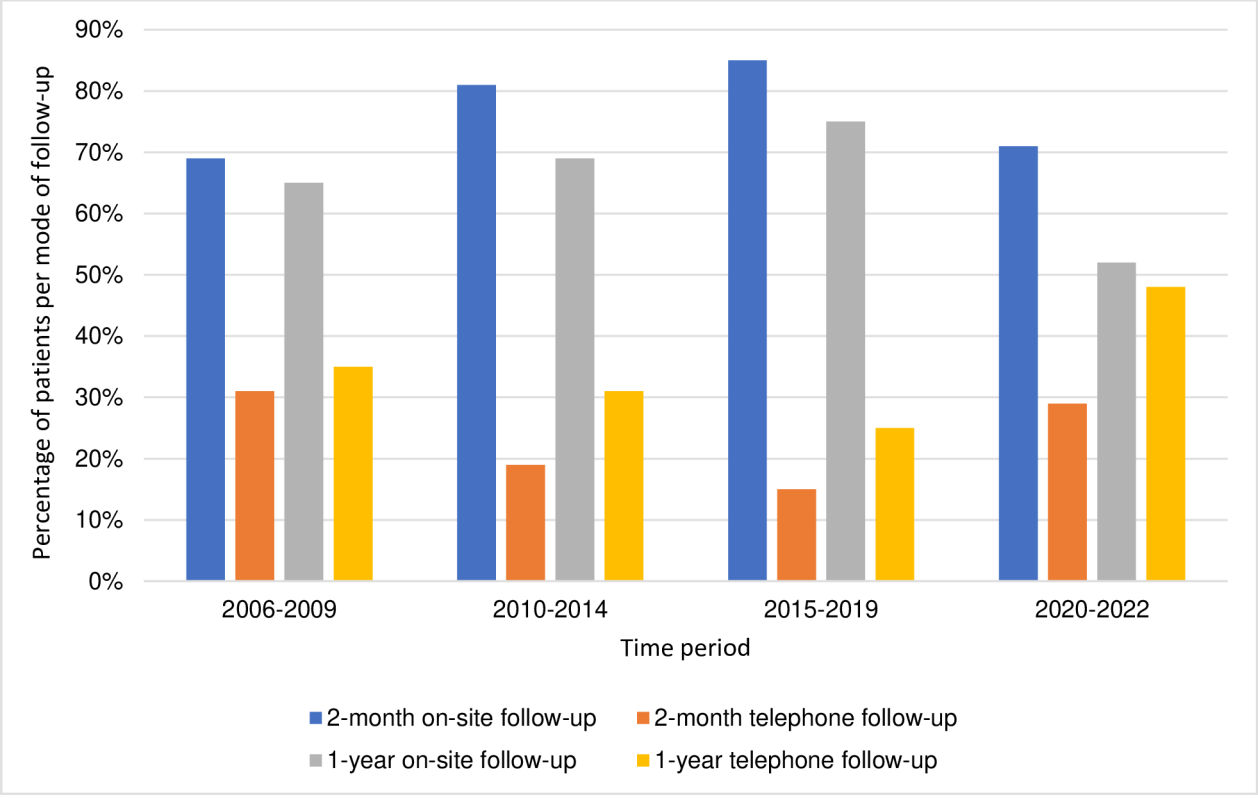

Figure 2 Percentages of postmyocardial infarction patients followed up on-site or by telephone during different time periods.

of missing values on-site at the 2-month follow-up was 3.1% compared with 49.3% for telephone consultations. This gap decreased to 5.1% vs 20.9%, respectively, in 2020–2022. For the 1-year follow-up, from 2006 to 2009, the differences were even larger, 0.8% of variables were missing for on-site visits vs 58.1% for telephone consultations. Again, the gap decreased in 2020–2022 to 5.4% and 16.3% missing values, respectively. Similar trends were observed for DBP (online supplemental tables 3 and 4). For LDL-C, similar patterns were observed; however, completeness of registration improved for both on-site and telephone follow-up over time. From 2006 to 2009, for LDL-C, the percentage of missing values at the on-site 2-month follow-up visits was 24.2% compared with 57.7% for telephone consultations. In 2022, the corresponding numbers were 4.8% and 15.6%. Similar trends were observed at the 1-year follow-up for LDL-C, with significant improvements in the level of registration over time (online supplemental table 4). For weight, from 2006 to 2009, 12.6% of values were missing for the 2-month on-site visits compared with 50.1% for telephone consultations. Then, during 2020–2022, the corresponding percentages were 32.9% and 49.0%. This, in turn, affected the registration of BMI, for which completeness of registration was even poorer. For waist circumference, the completeness of registration also decreased over time. Taking the 2-month follow-up visit as an example again, from 2006 to 2009, 31.9% of values were missing during on-site visits and 72.3% were missing during telephone consultations; the corresponding numbers from 2020 to 2022 were 63.0% and 84.1%.

From 2006 to 2009, for self-reported health (measured by the EQ-5D visual analogue scale), the percentage of missing values at the 2-month follow-up was 0.1% both during on-site and telephone follow-up, but in 2022–2022, the percentages had increased to 8.2% and 8.9%, respectively (online supplemental table 3).

DISCUSSION

The present study is a nationwide observational registry study analysing real-life data spanning 16 years of CR and including 101 199 patients with post-MI. Our findings clearly demonstrate that secondary preventive variables are more thoroughly registered during on-site visits when compared with telephone consultations.

During most of the period studied, on-site follow-up visits were the most common mode of CR follow-up, although the use of telephone consultations increased since the year 2020. This was attributed to the SARS-CoV-2 pandemic restrictions which limited person-to-person contacts, particularly for those with underlying medical conditions including coronary artery disease, diabetes mellitus and obesity.[19 20]

Our results showed that during telephone consultations, information on BP and LDL-C was lacking to a significantly larger extent than at on-site visits. It is well established that BP and LDL-C are major causal factors to cardiovascular disease, and appropriately treating them

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is given the highest recommendation in current guidelines.[3 4] Appropriately treating these risk factors without knowing their actual values is not possible, making the large observed number of missing values during telephone consultations in our study a cause for concern. When looking at different time periods, we observed that the completeness of registration of both BP and LDL-C improved over time. Still, during the last time period we analysed (2020–2022) when telephone follow-up became more frequent, we saw that the level of missing values for these important risk factors was still between 12% and 21% for telephone consultations compared with ≤6% for on-site visits.

Diabetes is also an important risk factors for cardiovascular disease, and it is recommended that all patients with MI should be screened for diabetes mellitus.[3 21] Registration of fasting plasma glucose and HbA1c was deficient, even when only accounting for patients with diabetes mellitus. However, these results should be interpreted with caution as it is not mandatory to register fasting plasma glucose and registration of HbA1c became mandatory in 2021. Despite poor registration in general, it was still clear that both fasting plasma glucose and HbA1c were registered more frequently at on-site visits compared with telephone consultations. For fasting plasma glucose, the registration improved over time for telephone consultations but worsened for on-site visits, reasons for which are unclear. For HbA1c, the level of registration improved over time for both on-site and telephone follow-up, but still, during the last time period (2020–2022), up to a third of patients with diabetes who were followed up by telephone had no registered HbA1c.

Information on current medication was thoroughly registered, with levels of missing variables being less than 1% for both on-site and telephone follow-up. One of the purposes of a CR is to adjust doses of cardioprotective medication; however, this is not possible if information on BP, blood lipids or fasting glucose levels/HbA1c is not available during the consultation.

Reporting of weight, waist circumference and BMI, which is not mandatory, was substandard. Although reporting was better during on-site follow-up, the number of missing values was high at both modes of follow-up, and a lack of improvement over time was observed. A large proportion of patients with post-MI is overweight,[5 9] which was also observed in our study. Overweight and obesity contribute directly to cardiovascular risk factors, including dyslipidaemia, type 2 diabetes, hypertension and sleep disorders, and reduction of weight for overweight and obese patients is highly recommended.[3 22] A survey of people with obesity and healthcare professionals from the United Kingdom showed that healthcare professionals' perception of patients lack of interest and motivation in losing weight was reported as top reasons for not discussing weight with patients and that in almost half the cases, the patient initiated the discussion themselves.[23] From our results, we cannot conclude that weight loss is not discussed during follow-up, but the suboptimal reporting of data does indicate that there is room for improvement.

Other lifestyle-related self-reported variables were more thoroughly registered, including information on smoking status and level of physical activity. Quality of life measured by EQ-5D was generally well recorded; however, we observed a trend of increasing missing values over time.

Baseline characteristics for patients followed up on-site vs by telephone were similar. Patients followed up on-site were more often born outside of Scandinavia. It has been previously demonstrated that those who do not speak the native language are less likely to use telephone consultations.[24] This might have been the case in our study as well. Although we did not have information on spoken language, country of birth might potentially have served as an indicator. For those who were retired, telephone consultations were more common and vice versa for those who were working. Our data did not include the reason for mode of follow-up (ie, preferred by patient or healthcare provider). In contrary to our findings, previous studies from primary care have showed that patients over 65 years of age were less likely to choose telemedicine over office visits.[25 26]

During the 2-month and 1-year follow-up visits, patients followed up on-site had higher BP compared with those followed up by telephone. The reliability of the data obtained by telephone may, however, have been affected by the mode of measurement or lack of understanding of self-measurement techniques.[27] Also, self-report bias may affect these as well as every other variables collected during telephone consultations.[28] Another potential explanation could be that patients with a history of hypertension or higher baseline BP might be prioritised for on-site follow-up. Finally, white coat hypertension might be a part of the explanation.[29] Weight and BMI were also higher in patients followed up on-site. Studies have consistently found that self-reported weight and BMI tend to be lower than values obtained from actual measurements, especially for older adults (≥60 years).[30 31]

Remote follow-up, such as telephone consultations, provides various potential benefits, such as improved accessibility to healthcare, less transportation barriers and expenses.[32 33] However, not reporting important risk factors does indicate that the risk factors are not addressed during the follow-up visit, undermining the potential beneficial effect of CR to prevent future cardiovascular events and increase quality of life. It is important to consider patient perception and preferences. In a recent study on patient preferences on the use of remote follow-up within primary care patients described that for minor medical issues, remote follow-up was acceptable, but for severe medical conditions, patients preferred a face-to-face or video consultations, prioritising the ability to see the healthcare provider.[34] Perhaps the key is to design flexible CR programmes, allowing for a combination of remote and on-site follow-up, including video consultations,

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considering patient preferences and the complexity of their medical conditions.

Quality registries play an important role in shaping the progress of healthcare. They serve as important sources of information that can guide medical decision making and improve patient outcomes.[35 36] In recent decades, the adoption of national cardiac registries has shown significant expansion. However, methods employed to guarantee the completeness of data are inconsistent.[37] Poor completeness of registration in healthcare quality registries can have negative impacts on patient care, and efforts to ensure completeness of data should be made a priority.[38 39] Suggestions to improve the completion of registration might include direct feedback to centres on proportions of registered patients in which all mandatory items are registered or promoting a regular review of data to enable the identification of trends related to missing data or quality issues, facilitating the implementation of corrective measures.[39 40]

Strengths and limitations

This study has a significant advantage in terms of inclusiveness and nationwide scope of data, encompassing all first-time patients with MI registered in SWEDEHEART who attended a CR follow-up visit from 2006 to 2022. However, it does not include patients with recurrent MI, which together with the previously described age limits in the registry may affect generalizability. The approximately 10% of registered patients where data on mode of follow-up were missing might have been site-specific rather than missing at random, potentially causing bias. Also, our data do not give information as to the reason for the choice of mode of follow-up. The results of our study are descriptive which makes it impossible to draw conclusions on causality. Also, associations between incomplete data registration and patient outcomes are at this point speculative and may have been affected by confounding factors, which were not taken into account in the current analysis. However, a continued analysis on patient outcomes by our group is currently underway.

The ability to compare our data with other survey and audit data is constrained by several factors, including variations in patient selection criteria, disparate rates of participation in CR, differences in the timing of follow-up, variations in measurement methods (such as questionnaires or self-report) and discrepancies in definitions (such as the definition of physical inactivity and smoking cessation).

CONCLUSION

Our study showed that registration of essential secondary preventive variables was less complete when following patients by telephone after MI as compared with on-site visits. This was particularly evident for laboratory findings and findings that required a physical examination. The omission of key variables in CR could compromise the overall quality and completeness of the clinical assessments and impede the ability to provide optimal patient care. An analysis on associations with patient outcomes is underway.

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Contributors According to CRediT, author contributions were the following: HÖM: Conceptualization, Methodology, Writing – Original, Writing - Review and Editing, Project administration. MB: Conceptualization, Methodology, Writing - Review and Editing. ME: Conceptualization, Methodology, Writing - Review and Editing. EH: Conceptualization, Methodology, Writing - Review and Editing. NH: Methodology, Formal analysis. ML: Conceptualization, Methodology, Writing - Review and Editing, Supervision. ML acted as guarantor. In this study, ChatGPT, an instance of the GPT (Generative Pre-trained Transformer) language model developed by OpenAI, was utilised to assist with English language tasks, including sentence construction (correct phrasing) and synonym searching.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by the Swedish Ethical Review Authority (registration number 2019-04277). In Sweden, the requirement for patients to provide signed informed consent to be included in quality registries has been waived. Instead, during hospital admission, patients are informed verbally and in writing that their data will be collected and entered in the SWEDEHEART registry. Patients can request to have their information removed from the registry at any time.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. The data used in this study are 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 Centre (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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