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FULL RESEARCH PAPER
CVD risk factors

Twenty-year trends in the prevalence of modifiable cardiovascular risk factors in young acute coronary syndrome patients hospitalized in Switzerland

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Aims Modifiable cardiovascular risk factors (RFs) play a key role in the development of coronary artery disease. We evaluated 20-year trends in RF prevalence among young adults hospitalized with acute coronary syndromes (ACS) in Switzerland.

Methods and results Data were analysed from the Acute Myocardial Infarction in Switzerland (AMIS) Plus registry from 2000 to 2019. Young patients were defined as those aged <50 years. Among 58 028 ACS admissions, 7073 (14.1%) were young (median 45.6 years, IQR 42.0–48.0), of which 91.6% had at least one modifiable RF and 59.0% had at least two RFs. Smoking was the most prevalent RF (71.4%), followed by dyslipidaemia (57.3%), hypertension (35.9%), obesity (21.7%), and diabetes (10.1%). Compared with older patients, young patients were more likely to be obese (21.7% vs. 17.4%, $P < 0.001$) and active smokers (71.4% vs. 33.9%, $P < 0.001$). Among young patients, between 2000 and 2019, there was a significant increase in the prevalence of hypertension from 29.0% to 51.3% and obesity from 21.2% to 27.1% (both $P_{trend} < 0.001$) but a significant decrease in active smoking from 72.5% to 62.5% ($P_{trend} = 0.02$). There were no significant changes in the prevalence of diabetes ($P_{trend} = 0.32$) or dyslipidaemia ($P_{trend} = 0.067$).

Conclusion Young ACS patients in Switzerland exhibit a high prevalence of RFs and are more likely than older patients to be obese and smokers. Between 2000 and 2019, RF prevalence either increased or remained stable, except for smoking which decreased but still affected approximately two-thirds of young patients in 2019. Public health initiatives targeting RFs in young adults in Switzerland are warranted.

Lay summary

- We evaluated the prevalence of risk factors (RFs) among young patients admitted with ACS in Switzerland between 2000 and 2019.
- Young ACS patients in Switzerland exhibited a high prevalence of RFs.
- There was a significant increase in the prevalence of hypertension and obesity.
- Despite a significant decrease, active smoking remained the most prevalent RF.
- These findings strongly suggest that public health initiatives targeting RFs in young adults in Switzerland are warranted.

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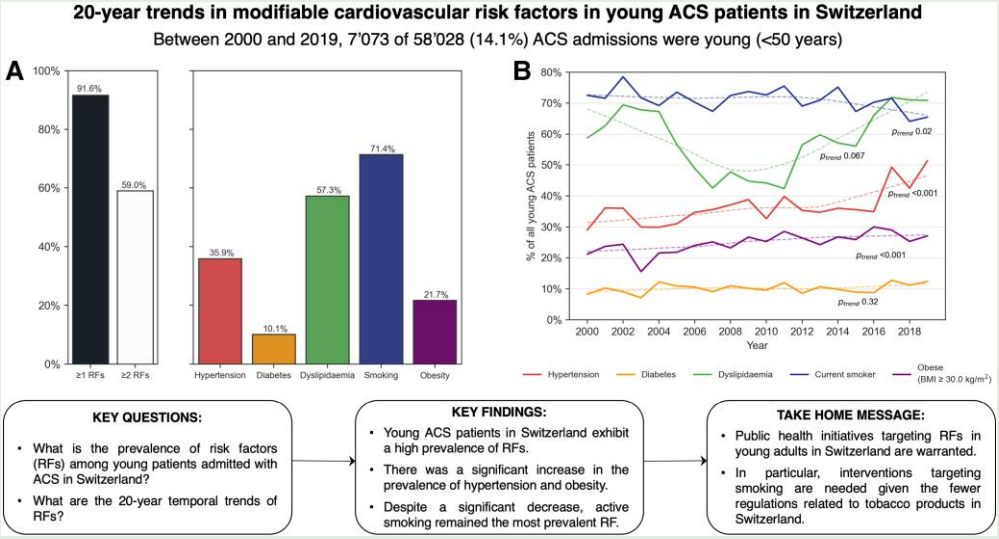
Graphical Abstract



Keywords Risk factors • Cardiovascular disease prevention • Acute coronary syndromes

Introduction

Coronary artery disease (CAD) is a pathology that affects mainly older individuals. Modifiable cardiovascular risk factors (RFs) play a key role in the development of CAD, and their prevalence is on the rise in young adults.

Over the past three decades, the global prevalence of both hypertension and diabetes has been increasing in young adults.[1,2] Sedentary lifestyles and poor dietary habits have resulted in an increased prevalence of obesity. In the UK, a three-fold increase in obesity among young adults in the past two decades has been observed.[3] Cigarette smoking doubles the risk of CAD and triples the risk of sudden cardiac death.[4] Furthermore, it increases the risk of myocardial infarction (MI) disproportionately in younger smokers making it an important modifiable RF in this patient group.[5] Yet, despite declining global rates, smoking remains prevalent among young adults.[6]

In Switzerland, smoking is less regulated compared with other European countries, and it remains a major public health concern. Switzerland ranks second bottom in the latest iteration of the Tobacco Control Scale (TCS) Europe, focusing on policies related to the taxation of tobacco products, smoking in public places, and advertising.[7] In a 2015 report from the World Health Organization (WHO), Switzerland ranked second only to Luxembourg as the European country with the most affordable tobacco products.[8] In the context of less strict tobacco regulation, primary and secondary prevention measures become increasingly important.

In the specific context of CAD, recent studies from the USA and Canada have demonstrated a concerning prevalence of modifiable RFs among young patients presenting with MI.[9–11] Approximately 85–90% of young patients presenting with MI have at least one modifiable cardiovascular RF at the time of presentation.[9] Furthermore, time series analyses have demonstrated important increases in the prevalence of RFs over the past two decades.[9,11]

The importance of identifying and treating cardiovascular RFs has been emphasized by the latest European guidelines on cardiovascular disease prevention.[12] A better understanding of the prevalence and trends of cardiovascular RFs forms an important basis for the implementation of primary and secondary prevention strategies. Moreover, young patients represent a patient group where preventative measures are likely to be particularly beneficial, with the potential for significant reductions in the lifetime burden of cardiovascular disease.

However, the majority of available data on the prevalence of RFs and their temporal trends is focused on older adults, with limited available data on younger patients. Furthermore, to date, no study has specifically evaluated this research question in Switzerland, a European nation with particularly lax tobacco regulation. For this reason, we sought to determine the prevalence and trends of modifiable cardiovascular RFs in young patients presenting with acute coronary syndromes (ACS) in Switzerland over the 20-year period from the year 2000 to the end of the year 2019.

Methods

AMIS Plus Registry

The AMIS Plus Registry has been collecting data on ACS patients from 84 of the 106 acute cardiac care hospitals in Switzerland since 1997. All participating hospitals have either a catheterization laboratory or direct access to a centre providing percutaneous coronary intervention (PCI) within 90 min for all patients.

Ethics

The Swiss Societies of Internal Medicine, Cardiology, and Intensive Care Medicine founded the AMIS Plus Registry project. A steering committee that includes members of the founding medical societies guides the project. This study complied with the Declaration of Helsinki regarding investigations on humans and was approved by the Swiss National Ethical Committee for Clinical Studies; the Board for Data Security and all cantonal ethic committees approved the registry.

Data collection

Investigators at participating centres collect data for the registry by using identical web-based data entry systems. The case record form has 300 items that address medical history, cardiovascular RFs, symptoms, initial out-of-hospital management, clinical presentation, early in-hospital management, reperfusion therapy, hospital course, diagnostic tests used or

planned, length of stay, and discharge medication and destination. A data co-ordinating centre checks data for plausibility and consistency. Central data monitor returned incomplete questionnaires to the participating centres for completion. In addition, external monitoring is performed in randomly selected hospitals using randomly selected cases. This approach helped to minimize data loss and warrant a consistent data quality (<1% overall and 0% for therapeutic interventions).

Patient enrolment and definitions

Patients were enrolled in the registry if they received a final diagnosis of ACS [unstable angina (UA), non-ST-elevation myocardial infarction (NSTEMI), or ST-elevation myocardial infarction (STEMI)], defined as symptoms or electrocardiographic changes compatible with AMI and cardiac markers (either creatine kinase MB fraction at least twice the upper limit of normal or troponin I or T above individual hospital cut-off levels for MI), with a further subdivision based on ECG characteristics into NSTEMI or STEMI. Unstable angina was defined as typical symptoms of ischaemia without elevation of biomarkers. The present study included all patients with ACS entered into the AMIS Plus Registry between 1 January 2000 and 31 December 2019 from the participating hospitals. The definition of 'young' in the context of ACS varies in the literature between <45 years and <55 years.[13] For the purpose of the present study, we defined patients as 'young' if they were aged <50 years, with 'older' patients defined as those ≥50 years. Dyslipidaemia, arterial hypertension, and diabetes were considered if the patients were previously treated for such a condition and/or diagnosed by a physician. Patients were defined as obese if the body mass index (BMI) was ≥30 kg/m2 and as smokers if the patients were smokers at the time of the cardiovascular event. A family history of premature CAD was defined as a patient having a first-degree male relative with an ACS before the age of 55 years or a first-degree female relative with an ACS before the age of 65 years.

Statistical analysis

The results are presented as percentages for categorical variables. Data were analysed using the non-parametric Pearson χ 2 test or Fisher exact test where appropriate. In cases of missing data, instead of an imputation procedure, we provide the number of patients with a characteristic and the number of patients with available data (n). Continuous normally distributed variables are expressed as means ± 1 SD and compared using the Student's two-tailed unpaired *t*-test. Continuous non-normally distributed variables are expressed as median and interquartile ranges (IQR) and analysed using the Mann–Whitney *U* test. Temporal trends were analysed using linear-by-linear association. To facilitate the visualization of trends, locally weighted scatterplot smoothing (LOWESS) regression lines were added to time series plots. Graphs were plotted in python using matplotlib and seaborn. A *P*-value < 0.05 was considered significant. IBM SPSS Statistics (version 26, IBM Corp. Armonk, NY, USA) was used for statistical analyses.

Results

Among 58 028 patients enrolled in the registry during the study period, 7073 (14.1%) were classified as young (aged <50 years) (median age 45.6 years IQR 42.0–48.0) with the remaining 50 955 patients classified as older patients (≥50 years) (median age 68.8 years IQR 60.0–77.7) (*Table 1*).

Prevalence of cardiovascular risk factors: young vs. older patients

In a pooled analysis of the whole 20-year period, compared with older patients, young patients were more likely to be male (86.8% vs. 72.0%, $P < 0.001$) and to have a family history of CAD (43.1% vs. 31.5%, $P < 0.001$) (*Table 1*). With regard to modifiable cardiovascular RFs, younger patients had lower rates of hypertension (35.9% vs. 65.7% $P < 0.001$), diabetes (10.1% vs. 22.2%, $P < 0.001$), and dyslipidaemia (57.3% vs. 62.2%, $P < 0.001$) but were more likely to be obese (BMI > 30 kg/m^2) (21.7% vs. 17.4%, $P < 0.001$) and to be active smokers (71.4% vs. 33.9%, $P < 0.001$).

Among young patients, 91.6% had at least one modifiable RF at the time of presentation, with 59.0% having at least two RFs (*Figure 1*).

Clinical presentation and in-hospital outcomes: young vs. older patients

Summing over the whole study period, the clinical presentation of ACS in young patients differed significantly compared with their older counterparts with higher rates of STEMI (63.8% vs. 53.7%) and corresponding lower rates of NSTEMI (33.0% vs. 41.8%) and UA (3.2% vs. 4.5%) ($P < 0.001$) (*Table 1*).

At the time of admission, compared with older patients, young patients were less likely to be on antiplatelet therapy (aspirin 17.6% vs. 40.1%, P2Y12 inhibitor 5.9% vs. 9.6%, both $P < 0.001$), as well as other cardiac medications such as beta-blockers (15.6% vs. 32.4%, $P < 0.001$), angiotensin-converting enzyme inhibitors (9.9% vs. 22.6%, $P < 0.001$), angiotensin II receptor blockers (6.7% vs. 19.0%, $P < 0.001$), and calcium channel blockers (4.8% vs. 15.8%, $P < 0.001$) (see Supplementary material online, *Table S1*). Young patients were also significantly less likely to be on statin therapy (16.2% vs. 30.4%).

Young patients were more likely to be treated with PCI (92.5% vs. 91.5%, $P = 0.012$) but were less likely to undergo coronary artery bypass grafting (CABG) (3.5% vs. 6.6%, $P < 0.001$), a finding that correlated with an overall lower rate of multi-vessel CAD (41.6% v 62.5%, $P < 0.001$) (*Table 1*).

In-hospital outcomes were more favourable in young patients with lower rates of mortality (1.8% vs. 5.9%, $P < 0.001$) when summing outcomes over the whole 20-year period. In addition, young patients had significantly shorter hospital stays [4.0 days (IQR 2.0–7.0) vs. 5.0 days (IQR 2.0–9.0), $P < 0.001$].

Temporal trends in acute coronary syndromes and outcomes

The proportion of female sex among young ACS patients remained stable throughout the study period (2000: 13.3% vs. 2019: 13.2%, P_{trend} 0.73). In-hospital mortality was low and unchanged over time (2000: 1.0% vs. 2019: 0.5%, P_{trend} 0.86).

Temporal trends in modifiable cardiovascular risk factors among young patients

Among young patients between 2000 and 2019, temporal linear-by-linear association revealed a significant increase in the prevalence of hypertension from 29.0% to 51.3% ($P_{trend} < 0.001$) (*Figure 2*). There was an increase in prevalence of diabetes from 8.2% to 12.5%; however, this did not reach statistical significance (P_{trend} 0.32) (*Figure 2*). The incidence of dyslipidaemia decreased from 58.7% in 2000% to 42.4% in 2011 before increasing to 70.9% in 2019, resulting in an overall increase over the 20-year period that was non-significant (P_{trend} 0.067) (*Figure 2*). Although the percentage of young patients taking statins at the time of admission was 16.2% over the whole study period, the percentage decreased between the start and the end of the study period (P_{trend} 0.007) (see Supplementary material online, *Figure S1*).

With regard to BMI, between 2000 and 2019, there was a significant increase in the prevalence of patients that were either overweight or obese (BMI 25–29.9 kg/m^2) from 64.3% to 69.6% (P_{trend} 0.003) (*Figure 3*). This was driven primarily by increasing rates of obesity (BMI >30 kg/m^2) from 21.2% to 27.1%, with a corresponding decrease in the proportion of patients with a normal BMI (18–25 kg/m^2) from 35.3% to 30.0% ($P_{trend} < 0.001$).

Table 1 Patient characteristics

	Total population (*N* = 58028)	<50 years (*n* = 7073)	≥50 years (*n* = 50 955)	*P*-value
Female (*n*, %)	15 210/58 028 (26.2)	936/7073 (13.2)	14 274/50 955 (28.0)	<0.001
Hypertension (*n*, %)	34 243/55 150 (62.1)	2386/6643 (35.9)	31 857/48 507 (65.7)	<0.001
Diabetes (*n*, %)	11 504/55 606 (20.7)	689/6789 (10.1)	10 815/48 817 (22.2)	<0.001
Dyslipidaemia (*n*, %)	32 015/51 989 (61.6)	3677/6422 (57.3)	28 338/45 567 (62.2)	<0.001
FH of CAD (*n*, %)	12 509/37 842 (33.1)	2124/4925 (43.1)	10 385/32 917 (31.5)	<0.001
Previous MI (*n*, %)	9234/53 349 (17.3)	591/6441 (9.2)	8643/46 908 (18.4)	<0.001
Previous PCI (*n*, %)	7542/45 970 (16.4)	507/5540 (9.2)	7035/40 430 (17.4)	<0.001
Previous CABG (*n*, %)	2558/46 330 (5.5)	45/5572 (0.8)	2513/40 758 (6.2)	<0.001
Smoking (*n*, %):				<0.001
Never	17 561/51 751 (33.9)	1083/6742 (16.1)	16 478/45 009 (36.6)	
Former	14 132/51 751 (27.3)	847/6742 (12.6)	13 285/45 009 (29.5)	
Current	20 058/51 751 (38.8)	4812/6742 (71.4)	15 246/45 009 (33.9)	
BMI (*n*, %):				<0.001
<25	15 179/51 190 (29.7)	1655/6367 (26.0)	13 524/44 823 (30.2)	
25–30	26 838/51 190 (52.4)	3328/6367 (52.3)	23 510/44 823 (52.5)	
>30	9173/51 190 (17.9)	1384/6367 (21.7)	7789/44 823 (17.4)	
ACS type (*n*, %):				<0.001
Unstable angina	2501/58 028 (4.3)	227/7073 (3.2)	2274/50 955 (4.5)	
NSTEMI	23 645/58 028 (40.7)	2335/7073 (33.0)	21 310/50 955 (41.8)	
STEMI	31 882/58 028 (54.9)	4511/7073 (63.8)	27 371/50 955 (53.7)	
PCI with stenting (*n*, %)	33 788/36 885 (91.6)	4588/4958 (92.5)	29 200/31 927 (91.5)	0.012
CABG (*n*, %)	3493/56 283 (6.2)	240/6855 (3.5)	3253/49 428 (6.6)	<0.001
Multi-vessel disease (*n*, %)	23 788/39 780 (59.8)	2130/5123 (41.6)	21 658/34 657 (62.5)	<0.001

FH, family history; CAD, coronary artery disease; MI, myocardial infarction; PCI, percutaneous coronary intervention; CABG, coronary artery bypass graft; BMI, body mass index; NSTEMI, non-ST elevation myocardial infarction; STEMI, ST elevation myocardial infarction.

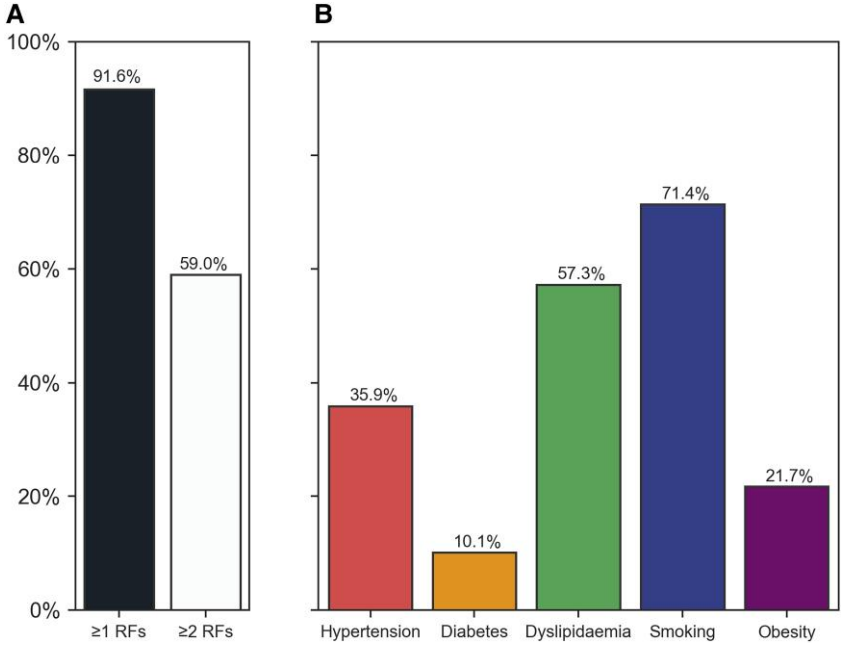


Figure 1 Prevalence of modifiable cardiovascular risk factors in young adults (<50 years) in Switzerland presenting with acute coronary syndromes between 2000 and 2019. (*A*) Percentage of patients with ≥1 RFs or ≥2 RFs. (*B*) Prevalence of major modifiable cardiovascular RFs. RF = risk factor.

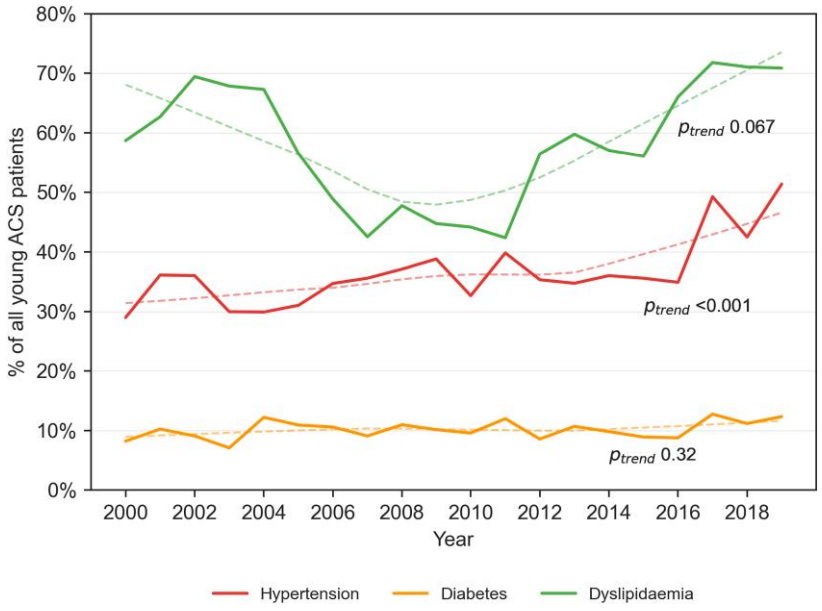


Figure 2 Trends in the prevalence of hypertension, diabetes, and dyslipidaemia at the time of presentation of acute coronary syndromes in adults <50 years of age between 2000 and 2019.

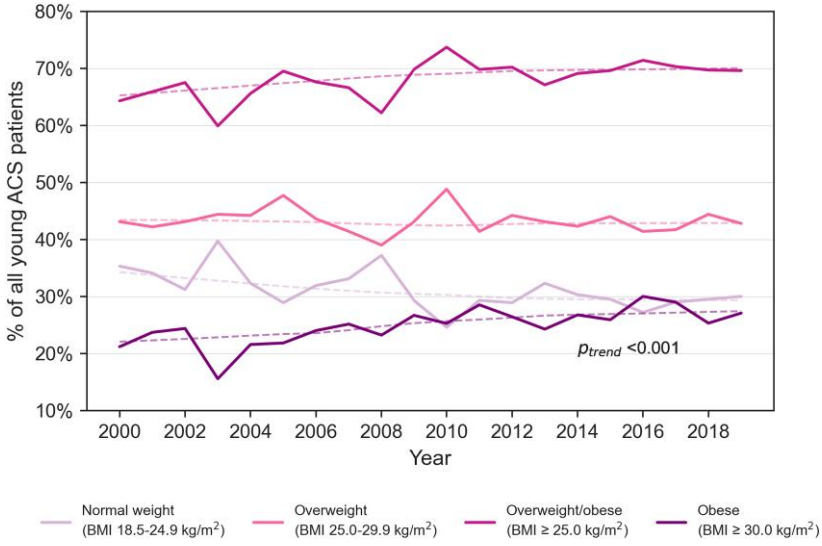


Figure 3 Trends in the prevalence of obesity at the time of presentation of acute coronary syndromes in adults <50 years of age between 2000 and 2019.

The prevalence of active smoking decreased significantly from 72.5% to 62.5% (P_{trend} 0.02). In line with this finding, there was a corresponding increase in the percentage of patients that had never smoked from 14.1% to 22.4% (*Figure 4*).

Gender differences in risk factor temporal trends among young acute coronary syndrome patients

The RF trend data stratified by gender is shown in Supplementary material online, *Figure S2*. Among men ($n = 6137/7073$, 86.8% of the young ACS population), there was a significant increase in the prevalence of hypertension from 26.6% in 2000 to 51.9% in 2019 ($P_{trend} < 0.001$). There was an increase in prevalence of diabetes from 5.4% in 2000 to 11.8% in 2019; however, this did not reach statistical significance (P_{trend} 0.084). Overall, the incidence of dyslipidaemia varied significantly from 59.2% in 2000 to 72.8% in 2019 (P_{trend} 0.029). With regard to BMI, there was a significant increase in the prevalence of patients that were obese from 18.6% in 2000 to 27.4% in 2019 ($P_{trend} < 0.001$). However, the prevalence of active smoking decreased significantly from 72.8% to 64.5% ($P_{trend} < 0.001$).

Among women ($n = 936/7073$, 13.2% of the young ACS population), with the exception of dyslipidaemia which varied overall from 55.6% to

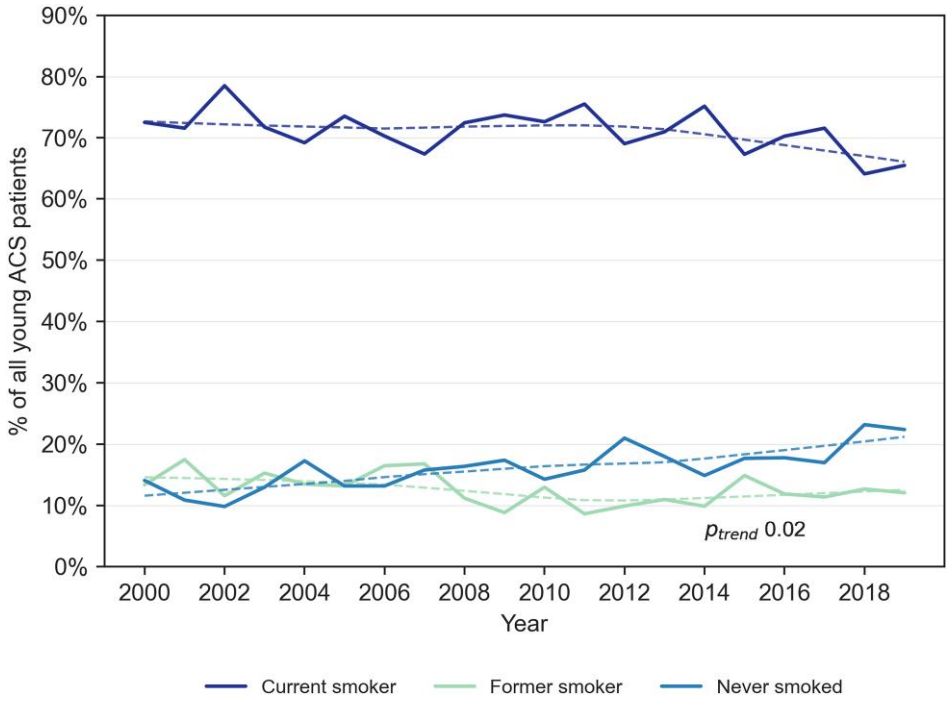


Figure 4 Trends in the prevalence of smoking at the time of presentation of acute coronary syndromes in adults <50 years between 2000 and 2019.

58.3% (P_{trend} 0.002), there were no significant trends noted in other RFs (diabetes, P_{trend} 0.134; hypertension, P_{trend} 0.446; obesity, P_{trend} 0.548; smoking, P_{trend} 0.103).

Discussion

This study is the first to assess temporal trends in RFs specifically among young ACS patients in Switzerland, leveraging data from AMIS Plus, the largest contemporary and nationally representative registry of ACS admissions in Switzerland. It builds on previously published data on RFs among general ACS patients in Switzerland.[14]

A growing epidemic of cardiovascular risk factors in young adults

Our study identified a concerning prevalence of modifiable RFs in young ACS patients with over 90% having at least one modifiable RF at the time of presentation and approximately 60% having two or more RFs. These prevalence rates are in line with recently published data from the USA, suggesting that Switzerland shares this worrying epidemic of cardiovascular RFs in young ACS patients.[9,13,15,16]

Of particular note was the prevalence of hypertension, which was present in more than one in three young ACS patients, a figure substantially higher than prevalence rates reported in similarly aged healthy individuals (~10%).[17] Hypertension is a well-established RF for CAD and its associated adverse outcomes, with the INTERHEART study estimating an 18% population-attributable risk of a first MI.[5] The overall prevalence figure in this study was lower than that reported in recent data on young MI patients from North America (approximately one in two);[9,11] however, our study demonstrated a striking ~80% increase in its prevalence since the year 2000.

Obesity is associated with other cardiovascular RFs such as hypertension and diabetes[18,19] and is equally recognized as an independent predictor of CAD.[20,21] One in five patients were also found to be obese (with two-thirds being overweight or obese), figures similar to those reported in young ACS patients in the USA.[9] More concerning still was the significant increasing trend in obesity over the 20-year period with an ~30% increase since the year 2000.

The correlation between dyslipidaemia and premature CAD is well established.[22] Furthermore, the INTERHEART study estimated that dyslipidaemia accounted for 49% of the population-attributable risk of a first MI.[5] Although it exhibited no significant increase in prevalence over the study period, dyslipidaemia was the second most prevalent RF among young ACS patients, affecting more than one in two patients.

Diabetes was the RF with the lowest prevalence, affecting approximately 1 in 10 ACS patients, a rate six-fold higher than that reported in similarly aged healthy individuals from another European study.[17] We noted a small, non-significant increase in its prevalence over the study period. However, even this small increase in prevalence is concerning due to the tendency of diabetics to accumulate a greater burden of other atherogenic RFs than their non-diabetic counterparts.[22] Furthermore, given the important link between obesity and diabetes, we hypothesize that the increasing prevalence of diabetes noted in this study may in part be explained by the increasing prevalence of obesity in this population.

Smoking was the single most prevalent RF in this young ACS population, with >70% of patients being active smokers at the time of admission. Reassuringly, we found a significant decrease in the prevalence of active smoking of approximately 14% over the study period, correlating with a significant increase in the percentage of patients that had never smoked before. These findings mirror the decreasing rates of smoking seen both in Switzerland and globally in recent decades.[23] Yet, in 2019, the prevalence of smoking in the general population in Switzerland was

estimated at 21%[8] indicating that, despite decreasing rates of smoking over the last 20 years, young ACS patients are considerably more likely to be active smokers than members of the general population. Given its well-established contribution to the risk of cardiovascular disease, these findings suggest that smoking remains a key target for both primary and secondary prevention in Switzerland.

Interestingly, despite the increasing prevalence of RFs in young ACS patients, the proportion of all ACS patients that were young adults decreased over the study period. A possible explanation for this finding was that the proportion of older patients presenting with ACS increased disproportionately over the same time period, possibly reflecting an ever-ageing general population.

Gender differences in young acute coronary syndrome patients

Our data highlight that around one-quarter of ACS patients as a whole are women. Among young patients, women represent an even smaller proportion of ACS admissions in Switzerland (13.2%), and this percentage remained stable throughout the 20-year period.

With regard to temporal trends in RFs, given that men represented the majority of the patients in the young ACS cohort, the trends noted in the overall analysis were also noted among male patients. However, the absence of clear temporal trends in RFs among female patients was due to the small sample size.

Primary prevention: the need for earlier screening for modifiable risk factors in young adults

The identification and management of cardiovascular RFs is of paramount importance in the prevention of atherosclerotic cardiovascular diseases (ASCVDs) such as CAD. Our data provide strong evidence for the need for early screening of RFs before the first manifestation of CAD.

The latest European guidelines recommend a global, systematic CVD assessment in individuals with any major RF.[12] For men >40 years of age or women >50 years of age, without a known RF, systematic or opportunistic RF screening is only weakly recommended (Class IIB recommendation). As for men <40 years of age and women <50 years of age with no known RFs, systematic screening is strongly discouraged (Class III recommendation). Such recommendations likely result in the under-recognition of RFs in the young and the subsequent underestimation of their cardiovascular risk.

Yet, subclinical atherosclerosis is a progressive condition that begins with the development of fatty streaks as early as during childhood.[24] López–Melgar *et al.* demonstrated that its development and progression occur in a relatively short time frame in apparently healthy middle-aged patients.[17] Moreover, its progression correlates independently with almost all cardiovascular RFs.

These findings provide a strong argument for the need for, at the very least, the opportunistic screening for RFs in all young adults. This could additionally include the use of imaging such as coronary calcium scoring or carotid ultrasound in selected individuals.[12] Of note, the use of a family history of ASCVD (often the only apparent RF in young individuals) as the only trigger for the screening for other RFs is likely flawed given that less than half of this young ACS population had a family history of CAD.

Secondary prevention: the need for aggressive risk factor control

Current guidelines provide aggressive targets in the management of RFs in patients with established ASCVD such as CAD.[12,25,26] Adherence to such recommendations reduces adverse outcomes and is arguably more important in young patients where effective secondary preventative measures can result in significant lifetime reductions in the morbidity and mortality associated with ASCVD.[27] Although adherence rates are generally high, our data highlight the importance of a systematic, global evaluation of RFs following the diagnosis of ASCVD, and the subsequent establishment of a guideline-based management plan (including regular follow-up) to ensure that targets are achieved.

Smoking in Switzerland

Tobacco consumption is the most common cause of preventable death in Switzerland with ~9500 people dying every year from smoking-related non-communicable diseases.[28] The costs of addiction to the Swiss economy has been estimated at almost CHF 12 billion, with tobacco consumption being responsible for half of these costs.[28] As such, smoking remains a significant public health concern.

An important driver of these statistics is the presence of fewer regulations related to the sale and use of tobacco products, making Switzerland an outlier compared with other European nations. This is best illustrated by its ranking in the TCS Europe. The TCS quantifies the implementation of tobacco control policies at country level, namely, (i) price increases through higher taxes on cigarettes and other tobacco products; (ii) bans/restrictions on smoking in public and workplaces; (iii) better consumer information; (iv) comprehensive bans on the advertising; (v) large, direct health warning labels on cigarette boxes and other tobacco products; and (vi) treatment to help dependent smokers stop. In the latest version of the TCS released in 2019, Switzerland ranked second bottom in Europe, with only Germany scoring lower. An important contributor to this evaluation is the affordability of cigarettes; Switzerland ranked second only to Luxembourg as the European country with the most affordable tobacco products according to the WHO in 2015.[8] Furthermore, Switzerland has particularly lax laws on the advertising of tobacco products, which remains permitted subject to restrictions, e.g. advertising on radio and television and advertising aimed specifically at minors are banned. The strong presence of international tobacco companies in Switzerland likely plays a key role in the state of current tobacco regulation.

This context highlights the significant challenges facing public health policies aimed at tackling smoking in young adults in Switzerland in general, as well as the worryingly high rates among ACS patients in this study.

Future directions

Beyond improved screening for modifiable RFs in young patients, there may be a role for polygenic risk scores (PRS) in the primary prevention of ASCVD. Data from the CARDIA study demonstrated the power of a PRS in the prediction of CAD when added to conventional RFs.[29] The application of such scores could result in the reclassification of patients as high risk and ultimately change their management.[30] For example, Natarajan *et al.* found that patients with high genetic risk (as determined by a PRS) had a greater burden of subclinical atherosclerosis and derived the most benefit from statin therapy in the prevention of a first coronary event.[31] Recent work has demonstrated other modifiable factors that influence the development and clinical manifestation of CAD such as alcohol consumption and influenza vaccination.[32,33] Such factors could also be considered as part of strategies to prevent ASCVD.

Limitations

Our study has some limitations. Firstly, despite AMIS Plus representing the largest and most representative ACS registry in Switzerland, with the inclusion of the vast majority of acute cardiac centres in Switzerland, participation is voluntary, and thus the registry does not include every ACS admission in the country. As a result, we cannot

exclude the possibility that a selection bias has been introduced. Secondly, given the long study period, we cannot exclude the possibility that screening practices and definitions of some RFs may have changed over time and thus affected their prevalence. Thirdly, only in-hospital outcome data were available thus not allowing the analysis of the long-term outcomes of these patients. Finally, this study only concerns patients hospitalized with ACS in Switzerland; patients not surviving until hospital admission are not included in this analysis. As a result, we are unable to report on the possible influence of improvements in pre-hospital care resulting in the percentage of these 'missing' patients decreasing over the study period.

Conclusion

Among young adults in Switzerland admitted with ACS, the prevalence of modifiable RFs was high. With the exception of smoking, the prevalence rates of RFs either increased or remained stable between 2000 and 2019. Despite a decreasing prevalence of active smoking, >70% of young ACS patients were active smokers. This suggests a need for improved public health initiatives targeting cardiovascular RF in young adults as part of both primary and secondary prevention.

Author contributions

Study conception and design were undertaken by TM and SF. Data collection was undertaken by AMIS Plus including H.R., M.R., F.E., G.P., R.J., and D.R. Data analysis and interpretation of results was performed by T.M., A.H., F.F.W., D.R., and S.F. The manuscript was prepared by T.M. and S.F. All authors reviewed the results and approved the final version of the manuscript.

Supplementary material

Supplementary material is available at *European Journal of Preventive Cardiology*.

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Data availability

The data underlying this article will be shared on reasonable request to the corresponding author.

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