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Secular trends in types of cardiovascular disease in the West of Scotland

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ABSTRACT

Objective Historical reductions in cardiovascular disease (CVD) due to lifestyle and treatment improvements are now threatened by factors such as increasing obesity and diabetes, but the relative importance of different risk factors varies by CVD condition. This study describes secular trends in CVD events by individual condition from 2012 to 2022.

Methods In a cohort of 452 094 Greater Glasgow and Clyde residents aged ≥51 years, linked hospital admission and death data were used to ascertain total annual events for ischaemic heart disease (IHD), myocardial infarction (MI), heart failure (HF), atrial fibrillation (AF), stroke, abdominal aortic aneurysm (AAA) and peripheral artery disease (PAD). Poisson regressions with robust standard errors were used to examine the relative change in event rates over time, overall and by subgroup.

Results Overall, the event rate ratios (RRs) for IHD, MI, AF and AAA all fell between 2012 and 2021 after adjustment for age, sex and deprivation. However, on subgroup analysis, the RRs increased between 2012 and 2022 among those aged 51–64 years for HF (RR 1.5), stroke (RR 1.4) and PAD (RR 1.8).

Conclusions Overall declines in most types of CVD mask an increasing burden of events relating to HF, stroke and PAD among individuals aged 51–64 years.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Previous studies on the incidence of cardiovascular diseases showed varying trends over time.

WHAT THIS STUDY ADDS

⇒ Overall fatal, non-fatal and recurrent event rates declined overall, but the rates of heart failure, stroke and peripheral artery diseases were rising among 51–64 years old.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The rise of cardiovascular burden among middle-aged people should be further examined.

INTRODUCTION

Cardiovascular disease (CVD) includes a wide range of conditions affecting the heart and circulatory system including ischaemic heart disease (IHD), heart failure (HF), atrial fibrillation (AF), stroke, peripheral artery disease (PAD) and abdominal aortic aneurysm (AAA). While these conditions share many risk factors,[1] the strengths of associations vary depending on the condition. This, compounded with the secular trend in risk factors[2] by different population subgroups,[3] potentially can lead to diverging secular trends in CVDs in different subgroups.

Previous studies have shown that while the incidence of myocardial infarction (MI) and CVD mortality has decreased over the past few decades, the incidence of HF and ischaemic stroke has increased.[4] These could be, in part, explained by the effectiveness of statin use as a primary prevention to reduce MI-attributed HF (MI being a pathophysiology for HF), higher obesity prevalence and an ageing population. In addition, the management of HF has advanced significantly in recent years, thanks in large part to landmark clinical trials such as PARADIGM-HF,[5] EMPEROR-Reduced[6] and DAPA-HF.[7] These trials have compelling evidence supporting the efficacy of novel therapeutic agents, particularly SGLT2 inhibitors for patients with HF. Moving forward, the impact of these therapies on broader long-term population data will be eagerly anticipated. As a result, the focus has shifted from merely preventing death from CVD to managing and living with the condition. Importantly, most of the existing evidence has been focused on the risk and incidence of diseases, with elusive evidence on burden, which are important as increasing numbers of people live with CVDs.

This study aimed to examine the secular trends in total events, including incident, recurrent and mortality, for CVDs, overall and by population subgroup, in Greater Glasgow

and Clyde (GGC), which has the highest CVD mortality rate under 75 years of age in the UK.[8]

METHODS

We undertook a retrospective cohort study of GGC residents. The West of Scotland Safe Haven extracted and linked hospitalisation (Scottish Morbidity Record 01) and death records between 2012 and 2022. Individual-level pseudonymised data were available on age, sex, area deprivation, dates of hospitalisation and death, and diagnostic and procedure codes.

Study population and data sources

All National Health Service GGC residents aged ≥51 years in 2012 were included. Sex was defined as sex at birth. Age at baseline was categorised as 51–64, 65–79 and ≥80 years. Area deprivation was measured using the 2012 Scottish Index of Multiple Deprivation (SIMD), which was derived from postcode of residence using aggregated Census data applied to small areas with a mean population of 1500 people. Individuals were categorised based on quintiles of the Scottish population, with quintile 1 representing the most deprived areas.

Outcome definitions

The seven outcomes of interest were events (defined as hospitalisation or death) relating to IHD, MI, AF, HF, stroke, AAA and PAD. The conditions were ascertained from relevant disease or procedure codes recorded in any position on hospital records or death certificates (seeonline supplemental file 1). Online supplemental table 2 lists the relevant International Statistical Classification of Disease and Related Health Problems, 10th Revision codes and Office of Population Censuses and Surveys Classification of Interventions and Procedures, Version 4 (OPCS-4) procedure codes. Recurrent hospitalisations in the same individual were included, and unique hospitalisations were defined as the subsequent admission occurring at least 7 days after the previous discharge.

Statistical analyses

The baseline sex and SIMD quintile characteristics of the cohort, broken down by age group, were summarised using frequencies and percentages. The annual event rates of each CVD condition were calculated overall and by age group, sex and SIMD quintile by dividing the number of unique events (hospitalisations and deaths) by the number of population overall or in the relevant subgroup, excluding people who previously died.

Generalised additive models of Poisson distribution with robust SEs were used to estimate the relative change in event rates over time. The number of events was the dependent variable. The event year was the primary independent variable of interest and was modelled using a P-spline.[9] Age group, sex and SIMD quintile were adjusted as covariates. Log-transformed population size was included as an offset in the model. To examine the secular trend in subgroups, P-splines of year by age group, sex and SIMD quintile were also included. Likelihood ratio tests were used to examine the statistical significance between the model with subgroup-specific P-spline and the population overall P-spline.

RESULTS

The cohort comprised 452 094 GGC residents aged ≥51 years in 2012, of whom 240 616 (53.2%) were women, 221 320 (49.0%) were aged 51–64 years, and 64 155 (14.2%) were aged 80 years or above, and 156 927 (34.7%) were living in areas in the most deprived quintile (table 1). Over the study period, we observed increasing crude event rates for PAD (5.0% per annum), HF (2.2% per annum) and stroke (1.7% per annum), declining crude rates for MI (−1.0% per annum) and IHD (−1.0% per annum), and relatively stable rates for AAA (−0.8% per annum) and AF (−0.5% per annum) (figure 1). Following adjustment for age, sex and SIMD quintile, the overall event rates for all outcomes fell, apart from PAD, which increased until 2019 (figure 2A). There were

Table 1 Baseline characteristics of NHS GGC residents aged over 50 years broken down by age group

	Overall		Age 51–64 years		Age 65–79 years		Age ≥80 years	
	n	%	n	%	n	%	n	%
Overall	452 094	100.0	221 320	100.0	166 619	100.0	64 155	100.0
Sex								
Male	211 478	46.8	111 522	50.4	75 664	45.4	24 292	37.9
Female	240 616	53.2	109 798	49.6	90 955	54.6	39 863	62.1
SIMD quintile								
1—most deprived	156 927	34.7	74 772	33.8	58 393	35.0	23 762	37.0
2	78 800	17.4	37 950	17.1	29 102	17.5	11 748	18.3
3	62 311	13.8	30 923	14.0	22 403	13.4	8985	14.0
4	63 046	13.9	31 476	14.2	22 899	13.7	8671	13.5
5—least deprived	91 010	20.1	46 199	20.9	33 822	20.3	10 989	17.1

GGC, Greater Glasgow and Clyde; NHS, National Health Service; SIMD, Scottish Index of Multiple Deprivation.

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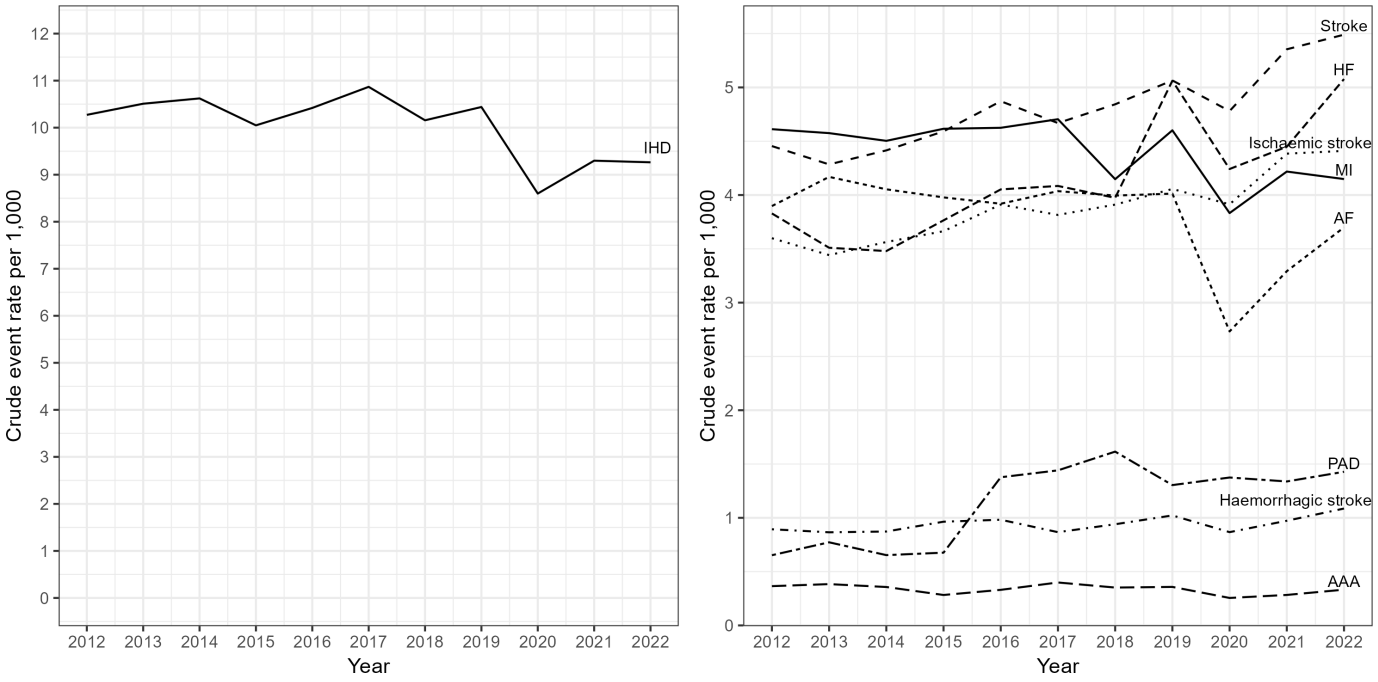

Figure 1 Cardiovascular disease hospitalisation and mortality rates in NHS GGC residents aged 51 or above between 2012 and 2022. AAA, abdominal aortic aneurysm; AF, atrial fibrillation; GGC, Greater Glasgow and Clyde; HF, heart failure; IHD, ischaemic heart disease; MI, myocardial infarction; NHS, National Health Service; PAD, peripheral artery disease.

statistically significant interactions between age group and time trend for all outcomes apart from haemorrhagic stroke. When stratified by population subgroup, there were clear differences by age group whereby, in those aged 51–64 years, there were increasing event rates for stroke, HF and PAD after adjustment for sex and SIMD quintile (figure 2B).

DISCUSSION

Event rates (total hospital admissions and deaths per annum) are a proxy measure of the burden of a condition on affected individuals and the health service. Over the 11-year period studied, event rates declined overall for six of the seven CVD conditions investigated after taking account of sociodemographic factors. While these overall results appeared reassuring, they masked increasing event rates for three of the conditions among people aged 51–64 years.

The finding of worsening trends among people aged 51–64 years was consistent with other studies, noting that most existing studies investigated incident event rates rather than all event rates. For example, a study in Oxfordshire, England, found a declining trend in stroke incidence among people older than 55 years but an increasing trend in younger people.[10] Similarly, another UK study found a declining PAD incidence and prevalence overall and in all age groups studied, except for those aged 50–59 years.[11] Similar trends in IHD and HF incidence were also reported in a UK-wide study.[12] Our findings add to the existing evidence by demonstrating an increasing overall burden in terms of total event rates.

There are several possible reasons why secular trends may be worse in the 51–64 years age group compared with older age groups. First, it could reflect the underlying risk factors. For example, this age group has the highest obesity[13] and smoking prevalence of all ages,[3] both of which are important risk factors for many CVD conditions. Another possible reason could be undertreatment of modifiable risk factors (eg, blood pressure, type 2 diabetes) in this age group. CVD risk prevention models usually include age, meaning that younger age groups are less likely to reach the threshold for primary prevention interventions.[10] There is also evidence that risk factors may be less likely to be measured in this age group.[14] Interestingly, the event rates for the older age group (≥80 years) were stable across the years. This could be due to a combination of the following reasons: (1) participants within that group getting older, increasing the rates requiring hospitalisation and (2) participants who were most vulnerable (ie, requiring more hospitalisation) who died, lowering the rates requiring further hospitalisation.

Similarly, there are several possible explanations for why the trends in this age group vary by CVD condition, including developments in treatment and prevention, the relative importance of different risk factors and the competing effects of one condition on another. Smoking, which is more common in this age group than in older age groups, is a stronger risk factor for PAD,[3] unlike, for example, AF. Improvements in the management of hypertension and angina, including increased prescribing of beta-blockers, calcium-channel blockers

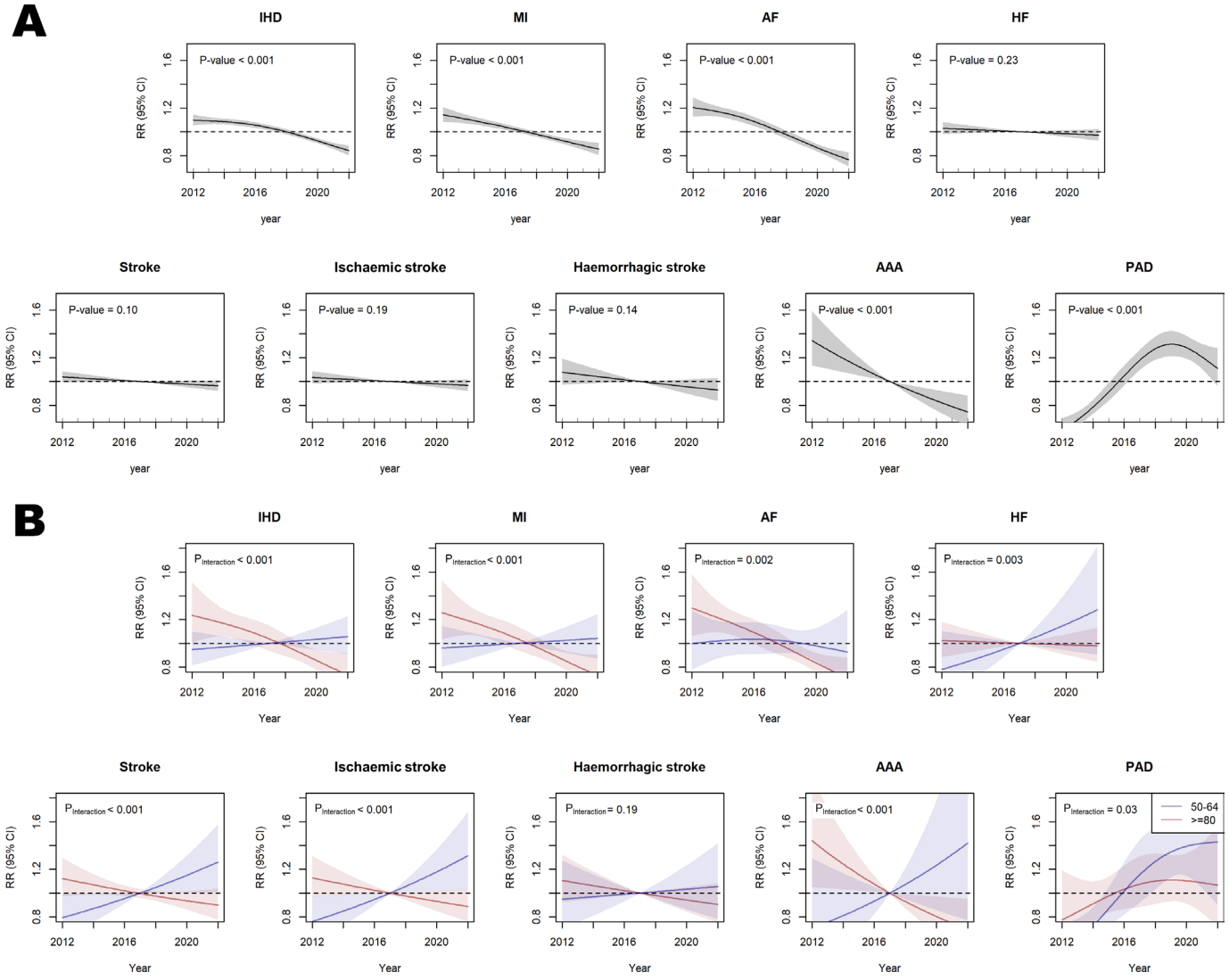

Figure 2 Rate ratios of cardiovascular hospitalisations and deaths over the study period overall (A) and by age group (B), adjusted for age group, sex and SIMD quintile. Rate ratios shown are comparison within age group. AAA, abdominal aortic aneurysm; AF, atrial fibrillation; HF, heart failure; IHD, ischaemic heart disease; MI, myocardial infarction; PAD, peripheral artery disease; SIMD, Scottish Index of Multiple Deprivation.

and ACE inhibitors, have contributed to a reduction in the incidence and case-fatality of IHD and MI,[15] but higher survival rates have, in turn, increased the prevalence of left ventricular systolic dysfunction and, consequently, HF.[16]

The management of acute MI has seen remarkable advancements in recent years, with substantial improvements in both early intervention and post-MI care, including innovations in reperfusion therapies, particularly increasing interest in Chronic Total Occlusion[17] and non-ST elevation MI, the widespread use and update of dual antiplatelet therapy and enhanced postacute care strategies.[18] As a result, survival rates and long-term outcomes for patients who have had an MI have significantly improved globally, which contributes to the epidemiological shift to chronic HF.

In contrast, the management of stroke and PAD has not advanced at the same pace. Despite incremental improvements, the overall therapeutic progress for patients who had a stroke has been slower compared with MI. While reperfusion therapies for stroke have shown significant promise in improving acute outcomes, their use remains limited by door-to-needle time, and there have been relatively few breakthroughs in poststroke recovery or prevention of long-term disability.

Similarly, in PAD, while there have been advances in endovascular interventions, the overall therapeutic landscape has remained relatively stagnant, with limited innovation in medical therapies that could alter the natural history of the disease. There have been no large-scale breakthroughs in translational therapies in these areas to the same extent seen in MI.

The strengths of this study include an unselected population of people aged 51 years or above in a region with the highest CVD incidence in the UK. This study also complements the existing literature, which mostly

focused on incidence rather than the overall burden to the healthcare system. While overall event rate is a reasonable proxy for burden, additional information such as length of hospital stay and costs would be needed to estimate burden more precisely. The findings of this study may not be generalisable to other parts of the UK. Lastly, age effect and survival bias may have contributed to age-stratified secular trends.

CONCLUSIONS

Overall, event rates related to most CVDs have reduced over time. However, among people aged 51–64 years, events due to HF, stroke and PAD have increased. Future studies should examine whether this could drive an overall rise in CVD burden over time, and whether this age group requires more focused CVD prevention and management.

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Contributors JP and FKH designed the study. AK and JMF drafted the manuscript. FKH analysed the data. All authors interpreted the data and critically revised the manuscript. FKH is the guarantor of this study.

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Competing interests None declared.

Patient consent for publication Not applicable.

Ethics approval Study approval was granted by the National Health Service (NHS) GGC Privacy and Advisory Committee (IRAS Project ID 321198, REC reference 22/WS/1063).

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Data availability statement Data may be obtained from a third party and are not publicly available. Data request can be made to the West of Scotland SafeHaven. We do not have permission to share data to third parties.

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