CURRENT MEDICAL RESEARCH AND OPINION
2025, VOL. 41, NO. 3, 447–453
https://doi.org/10.1080/03007995.2025.2482674
Article /2482674

Taylor & Francis
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RESEARCH LETTER

A population-based study of incident prescribing for hypercholesterolaemia and hypertension in Scotland: is the healthcare system recovering from the impact of COVID-19?

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ABSTRACT

Background: COVID-19 pandemic caused significant disruptions in healthcare services, with previous studies estimated that the early months of the pandemic led to a substantial decline in new prescriptions for hypercholesterolemia and hypertension. The long-term recovery of healthcare systems in addressing these gaps remains uncertain. We aimed to assess the recovery of the healthcare system in Scotland regarding the initiation of treatments for hypercholesterolemia and hypertension post-COVID-19 pandemic.

Method: This retrospective cohort study analysed prescription data from January 2020 to December 2022 in Scotland, as well as In-hours encounters with general practitioners. Incident prescribing patterns for drugs used in the treatment of hypercholesterolemia and hypertension were compared against pre-pandemic averages from 2018 to 2019. Data were stratified by health regions and socioeconomic status.

Results: New treatment initiations for drugs used in the treatment of hypercholesterolemia and hypertension significantly increased from mid-2021 onwards, surpassing pre-pandemic levels. By December 2022, there were approximately 40,000 and 60,000 additional new treatments for drugs used to treat hypercholesterolemia and hypertension, respectively, compared to the expected numbers based on 2018–2019 averages. The stratified analysis showed a relatively higher increase in less deprived quintiles. GP encounter activities mirrored trends in new antihypertensive and lipid-lowering initiations, with a significant reduction starting in March 2020 due to the first COVID-19 lockdown. Encounter rates gradually recovered from May 2020, reaching near pre-pandemic levels by March 2021. Notably, the encounter rate slopes during the reference period (2018–2019) and post-recovery phase (May 2021–December 2022) showed no significant difference [–0.7 (95% CI: −4.0, 2.5) vs. 0.9 (95% CI: −3.1, 4.9)].

Conclusions: The observed increase in new treatments for drugs to treat hypercholesterolemia and hypertension suggests recovery of the healthcare system in Scotland following the COVID-19 pandemic. These higher prescribing rates post-pandemic hypothesise potential long-term sequelae associated with COVID-19. The findings demonstrate the potential for improved pharmacotherapy strategies that address both the backlog of untreated cases and new-onset conditions linked to COVID-19. This underscores the need for ongoing surveillance and flexible healthcare responses to manage emerging health challenges effectively. Additionally, our findings suggest novel research areas that could offer a more comprehensive understanding of the COVID-19 pandemic's influence on the prescribing patterns of these widely used medications.

ARTICLE HISTORY
Received 13 August 2024
Revised 26 February 2025
Accepted 13 March 2025

KEYWORDS
Hypercholesterolemia; hypertension; COVID-19 recovery; pharmacotherapy; healthcare system

Introduction

COVID-19 pandemic significantly disrupted healthcare services worldwide, impacting the diagnosis and management of chronic diseases, including cardiovascular conditions. In our previous study published in "*Nature Medicine*"[1], we analysed incident prescribing patterns for hypercholesterolemia and hypertension across England, Scotland, and Wales, revealing a substantial decline in new diagnoses and treatment initiations during the early months of the pandemic. Our findings estimated that approximately 500,000 hypertension diagnoses were missed in Great Britain between March 2020 and July 2021, with potentially severe long-term cardiovascular

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Supplemental data for this article can be accessed online at https://doi.org/10.1080/03007995.2025.2482674.

consequences. This was projected to result in an additional 13,662 cardiovascular disease (CVD) events, including 2,281 myocardial infarctions and 3,474 strokes, assuming these individuals remained untreated throughout their lifespan. Additionally, there was an observed decline in the incident use of lipid-lowering medications by 16,744 patients per month during the first half of 2021, relative to the corresponding period in 2019. However, it remains uncertain whether the trend of missed diagnoses persisted beyond July 2021 or if the healthcare system has since recovered and successfully addressed these gaps. This follow-up study aimed to analyse incident prescribing patterns for hypercholesterolemia and hypertension in Scotland from January 2020 to December 2022, thereby assessing the long-term recovery of the healthcare system post-pandemic. Understanding this is crucial, as ongoing issues with missed diagnosis or non-diagnosis require immediate intervention.

Method

A follow-up retrospective cohort study was conducted using prescription data dispensed in the Scottish community setting, employing a methodology consistent with that described in our previous "*Nature Medicine*" publication[1] where the detailed methodology is fully documented and described. The analysis period was extended from January 2020 to December 2022, providing an additional 17 months of observation beyond the end date of the original study[1], to assess the long-term recovery and impact of COVID-19 on prescribing patterns,. Anti-hypertensive medications and medications to treat hypercholesterolaemia were identified through the legacy classification hierarchy of the British National Formulary (BNF) Chapter 2 (Cardiovascular System)[2] and approved name, using patient-level data from the Prescribing Information System (PIS)[3] which contains information on all medications dispensed in the primary care setting in Scotland including medication name, strength, prescription date, and dispensing date. For anti-hypertensive medications, we excluded those anti-hypertensive medications that would not normally be used for hypertension (e.g. loop diuretics) as well as those not likely to be used as a first line/early treatment for hypertension (e.g. alpha-blockers). Additionally, we have analysed the monthly volume of all In-hours encounters conducted by general practitioners (GPs) in general practice (ambulatory) primary care centres (both as total counts and rates per 1,000 population), using publicly available data from Public Health Scotland[4]. This analysis provided essential context to our assessment of prescribing patterns by interpreting them within the broader landscape of GP encounter activities, offering a more comprehensive understanding of the changes in prescribing trends over the study period.

Incident or newly initiated patients were defined as those patients without an anti-hypertensive medication or medications to treat hypercholesterolaemia in the 12 months prior to the index date (defined as the first prescription for a patient during the study period) for incident patients with hypertension and hypercholesterolaemia, respectively. The study outcome was the monthly number of newly initiated patients in Scotland on treatments for hypercholesterolemia and hypertension, overall and stratified by Scottish Index of Multiple Deprivation (SIMD)[5] and health regions (NHS Health Boards) during the study period. This was evaluated and compared against the average monthly treatment initiations during the corresponding months in 2018 and 2019. Furthermore, the annual cumulative number of new initiations of antihypertensive and hypercholesterolaemia treatments over the period 2020–2022 was compared with the average for 2018 and 2019. These were the sum of the differences between the observed and expected number of patients. Descriptive statistics were used to summarise the data. In this study, we used the SIMD to stratify prescribing patterns by socio-economic status. The SIMD is a widely used measure of area-based socio-economic deprivation in Scotland. It ranks small geographical areas, known as data zones, from the most deprived to the least deprived, based on seven key dimensions: income, employment, education, health, housing, crime, and access to services. This index allows for the comparison of socio-economic inequalities in health outcomes and healthcare access. By stratifying our findings by SIMD quintiles, we aimed to explore whether the impact of the COVID-19 pandemic on prescribing patterns varied across different levels of deprivation.

Results

Overall prescribing trends

Between January 2020 and December 2022, the initiation of antihypertensive and lipid-lowering therapies in Scotland showed distinct patterns influenced by the COVID-19 pandemic. During the early phase of the pandemic (March 2020 to December 2020), the number of new prescriptions for both antihypertensive and lipid-lowering medications was significantly lower than expected when compared to the pre-pandemic baseline (2018–2019) (Figures 1 and 2). Specifically, approximately 10,000 fewer new initiations of lipid-lowering medications (Figure 3) and a little over 10,000 fewer new antihypertensive initiations were observed by December 2020 (Figure 3). However, from mid-2021 onwards, a marked increase in new treatment initiations was noted, surpassing pre-pandemic levels (Figure 3). By December 2022, there were approximately 40,000 additional new initiations for lipid-lowering medications and nearly 60,000 additional new antihypertensive initiations compared to the expected numbers based on the 2018–2019 averages (Figure 3).

GP encounters and prescribing trends

The trends in prescribing closely mirrored GP encounter activities. GP encounters significantly declined from March 2020, coinciding with the first national lockdown, and gradually recovered from mid-2020 onwards (Figure 4). By March 2021, encounter rates had returned to levels comparable to the pre-pandemic period. Importantly, the slope of encounter rates during the reference period (2018–2019) and the

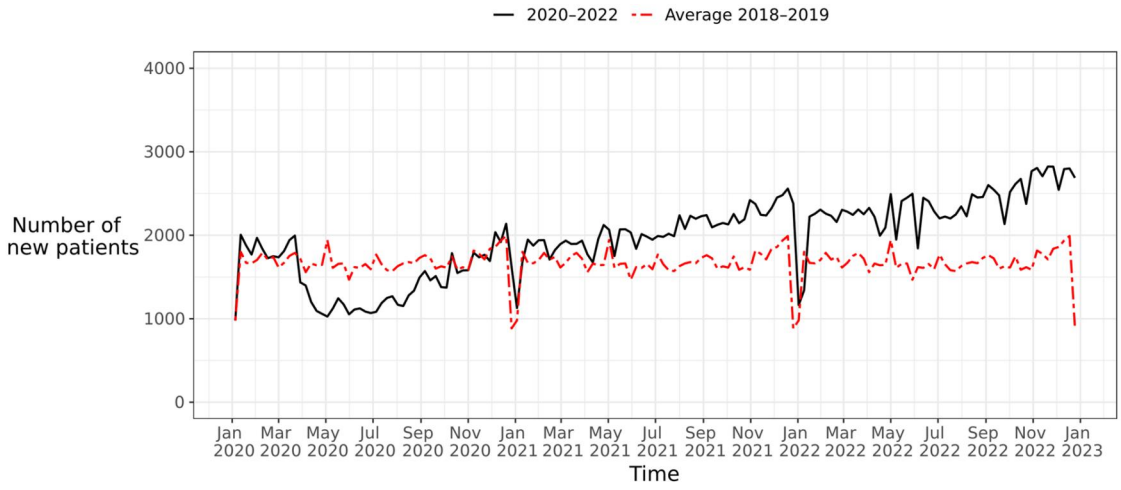

Figure 1. Number of patients starting a new treatment course for selected lipid-lowering drugs in Scotland, January 2020 to December 2022.

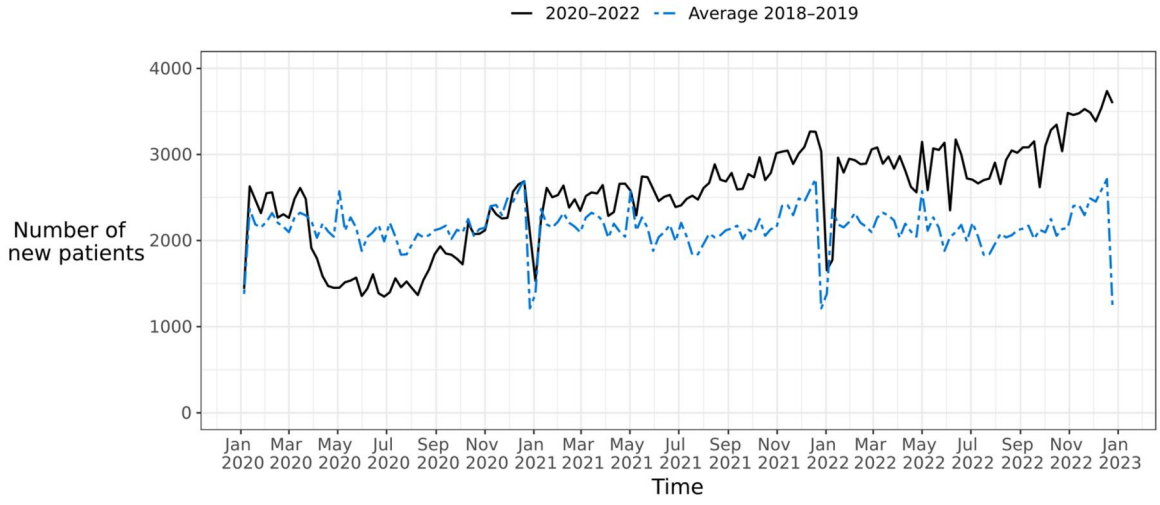

Figure 2. Number of patients starting a new treatment course for selected antihypertensive drugs in Scotland, January 2020 to December 2022.

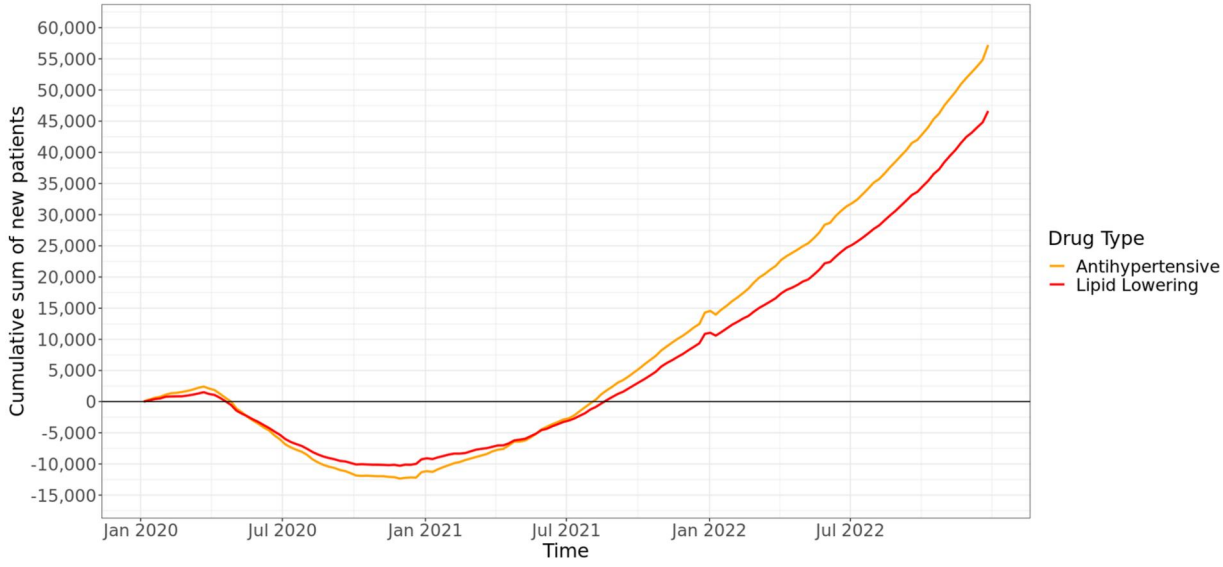

Figure 3. Total observed number of patients starting a new treatment course for selected antihypertensive or lipid-lowering drugs in Scotland from january 2020-December 2022 compared to the expected numbers based on the average for 2018 and 2019.

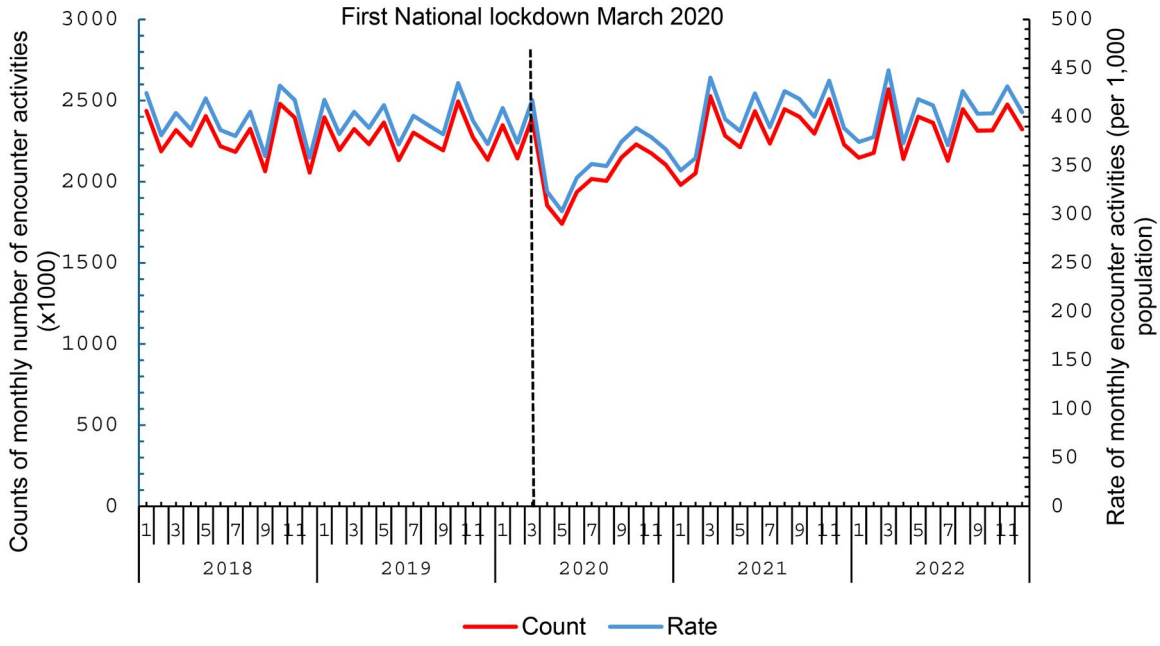

Figure 4. Monthly number of all encounters with general practitioners at primary care (ambulatory) clinics in Scotland, january 2018 to December 2022.

post-recovery phase (May 2021–December 2022) showed no significant difference [–0.7 (95% CI: −4.0, 2.5) vs. 0.9 (95% CI: −3.1, 4.9)].

Stratification by socio-economic status and health regions

Overall, the stratified analysis for new treatment initiations for hypercholesterolaemia by individual NHS Boards and by SIMD 2020 quintiles showed a similar pattern across most NHS Board and SIMD deprivation quintiles (Supplementary File 1 and 2). However, the results do seem to suggest that during 2022 the relative increase compared with the baseline average of 2018 and 2019 is higher for the least deprived quintiles than for the most deprived quintiles. The actual numbers of new initiations are higher in the more deprived quintiles compared with the less deprived, but this is against higher baseline rates.

Discussion

Overall, across lipid-lowering and antihypertensive medications, by December 2022 there were 40,000 and 60,000 additional new treatments compared with what would have been expected based on the expected average number of new patients in 2018 and 2019, suggesting a recovery of the healthcare system in Scotland following the COVID-19 pandemic. Moreover, the higher-than-anticipated prescribing rates observed post-pandemic may suggest a compensatory rebound effect, where patients who had postponed healthcare during the pandemic are now seeking medical attention. It could be also hypothesised that this trend could be attributed to the long-term sequelae of COVID-19, arising either directly from the infection or indirectly through factors associated with the pandemic, such as unhealthy lifestyle choices, increased anxiety, and heightened stress levels during lockdown. However, these higher prescribing rates might also reflect the fulfilment of a previously unmet healthcare need, although these hypotheses warrant further investigation. The former two explanation are particularly important because COVID-19 infections have been linked to the development of new-onset high blood pressure and hyperlipidaemia. COVID-19 has been associated with an increase in both systolic and diastolic blood pressure, potentially leading to new onset hypertension[6,7]. The COVID-19 virus may also play a role in the development of these conditions, with a reciprocal interaction between COVID-19 and hypertension being suggested[8]. Furthermore, the pandemic has also negatively impacted the lifestyle and management of patients with hyperlipidaemia[9]. Emerging evidence supports the hypothesis of COVID-19-induced cardiometabolic effects. Studies[10,11] have demonstrated an increased incidence of dyslipidaemia and alterations in lipid profiles, particularly low HDL-c and high triglycerides, among COVID-19 survivors, which were associated with increased disease severity and mortality. These findings suggest that heightened cardiovascular risk post-pandemic may contribute to the observed rise in lipid-lowering therapy initiations. Similarly, Banach et al. (2020)[12] highlighted disruptions in routine lipid management during the pandemic, emphasising the need for continued lipid-lowering therapy to mitigate cardiovascular risks. The increased initiations observed in our study could reflect delayed management of dyslipidaemia during the pandemic, aligning with these recommendations. Moreover, studies by Wang et al. [13] and Mostaza et al.[14] have underscored the prognostic value of lipid ratios in predicting COVID-19 severity and mortality, particularly among high-risk groups such as diabetics and the elderly. These findings suggest that altered lipid profiles in post-COVID-19 patients may influence the observed prescribing patterns.

Another likely potential explanation for the observed increase in the prescribing of antihypertensive and lipid-

lowering medications post-pandemic could be differences in patient demographics and case mix compared to the pre-pandemic period. Notably, our findings indicate that the overall number and rate of GP encounters remained relatively stable and comparable between the post-recovery phase (July 2021–December 2022)—a period in which higher-than-expected prescribing rates for new antihypertensive and lipid-lowering initiations were observed (Figure 3)-and the pre-pandemic reference period (2018–2019). This suggests that while the total number of patients seeking care has not significantly changed, the characteristics of these patients might have shifted. It is possible that the patients presenting post-pandemic had a different demographic profile (age, gender), a higher burden of comorbidities and cardiovascular risk factors (e.g. smoking, obesity, dyslipidaemia or pre-existing high-risk conditions, some of which may represent direct or indirect sequelae of COVID-19, as previously discussed), or were generally sicker compared to those seen before the pandemic. These factors could have naturally led to higher prescribing rates for antihypertensive and lipid-lowering medications. Unfortunately, due to data limitations and unavailability of information, we were unable to adjust for these potential differences in patient characteristics. Future research using patient-level data from general practice records will be essential to further investigate these factors and their contribution to the observed trends. However, this interpretation remains hypothesis-generating rather than a definitive causal conclusion or association and warrants further investigation, with rigorous validation needed through patient-level data, including analysis of detailed GP clinic records, to accurately assess the prevalence and incidence patterns of hypertension and hypercholesterolemia as well as case mix of the patients. Importantly, it should be noted that the observed increase in new antihypertensive initiations (regardless of the underlying cause) does not necessarily indicate a rise in new hypertension cases, as many antihypertensive agents are prescribed for multiple indications, including diabetic nephropathy, heart failure, and myocardial infarction.

The outliers observed in Figures 1 and 2, particularly the recurrent dips in January for the years 2020–2022, likely resulted from a combination of factors particularly the recurrent dips in January for the years 2020, 2021, and 2022, likely resulted from a combination of factors. First, seasonal effects and healthcare demand patterns play a significant role, as January often experiences a reduction in non-urgent healthcare activity due to winter pressures on the healthcare system, such as managing peaks in respiratory infections and flu. This seasonal demand could lead to delays in elective consultations and follow-ups, including those for chronic conditions like hypertension. Secondly, the observed declines in January 2021 and 2022 were likely exacerbated by the residual impact of the COVID-19 pandemic. In January 2021, the UK's third national lockdown further restricted access to routine healthcare, while in January 2022, the Omicron variant surge increased COVID-19 cases, leading to additional strain on NHS resources. This strain, compounded by staffing shortages and capacity constraints, likely diverted resources toward COVID-19 care, and contributed to limited healthcare access and patient hesitancy, with some individuals deferring routine care due to infection concerns. Finally, the impact of the holiday season cannot be overlooked, as January follows the reduced-service period in December, resulting in a backlog that can delay new patient assessments and treatment initiations at the start of the year. Notably, similar January dips in prescribing patterns were observed during the reference period of 2018–2019, suggesting that seasonal factors and healthcare demand patterns are the primary drivers of these outliers, although these might have been exacerbated to a certain extent by the pandemic-related disruptions."

It is worth noting that both hypercholesterolaemia and hypertension are largely detected opportunistically as part of health screening. Lipid-lowering therapy as well as some antihypertensive medications are also widely used for primary prevention of cardiovascular events in patients with other conditions, notable type 2 diabetes especially when evidence is showing that COVID-19 pandemic has been associated with an increased incidence of new-onset hyperglycaemia and diabetes[15]. Examining and linking individual patient-level prescribing records with the diagnosis of type 2 diabetes might provide further insights into the drivers behind the observed increase in lipid-lowering and antihypertensive treatments. In terms of stratification by health regions and deprivation, this further analysis confirms that, at least for hypercholesterolaemia medications, the overall picture seen nationally is consistent across most NHS Boards and socioeconomic deprivation groups.

The findings in this study should be interpreted in light of significant healthcare workforce challenges experienced during and post the pandemic. The fluctuations in workforce availability, particularly due to staff absences, redeployment, and burnout, likely affected chronic disease care access and contributed to the observed reductions in new hypertension and hypercholesterolemia treatment initiations during the early phases of the pandemic. The NHS workforce in Scotland faced unprecedented challenges during the COVID-19 pandemic, which significantly impacted service delivery, particularly in non-urgent areas such as chronic disease management. According to the NHS Recovery Plan 2021–2026[16], the pandemic led to a 41% reduction in new outpatient activity, primarily due to workforce shortages and redeployment to urgent COVID-19 care. Recognising this strain, the NHS Recovery Plan outlines commitments to rebuild and expand the workforce, aiming to increase capacity across NHS Scotland by 10% above pre-pandemic levels, with recruitment initiatives including an additional 1,500 staff for new National Treatment Centres by 2026[16]. Since the launch of the NHS Recovery Plan, there has been significant progress including increasing in staffing by 8.9% since the onset of the pandemic as well as recruitment of additional 277 GPs and over 3,220 primary care team members[17]. This expanded workforce has certainly played a crucial role in addressing backlogs, recovery and restoring routine care services which can be observed in our study findings of the higher-than-anticipated prescribing rates observed post-pandemic.

Strengths and limitations

This study leveraged comprehensive population-level prescription data from Scotland over an extended period (2018–2022), allowing for a robust evaluation of pre-pandemic, pandemic, and post-pandemic trends in antihypertensive and lipid-lowering therapy initiations. The longitudinal design and stratified analyses by socioeconomic status and health regions enhance the temporal validity and granularity of the findings. However, several limitations must be acknowledged. The study's reliance on community prescription data may not capture prescriptions issued in secondary or private healthcare settings, potentially introducing selection bias and leading to an underestimation of overall prescribing rates. However, the impact of this limitation is likely minimal, as the initiation of antihypertensive and lipid-lowering therapies predominantly occurs in primary care settings. Moreover, private healthcare constitutes a small proportion of healthcare provision in Scotland, further reducing the likelihood of significant bias. Additionally, the absence of patient-level demographic and clinical data limited our ability to adjust for confounders such as age, comorbidities, and cardiovascular risk factors, introducing residual confounding. This could either overestimate or underestimate the association between the pandemic and prescribing trends, depending on differences in patient case mix between the pre- and post-pandemic periods. Despite these limitations, the study's use of national prescription data ensures broad generalisability, while the extended study period provides robust temporal insights into pre-pandemic, pandemic, and post-pandemic trends, contributes to the growing body of evidence on the long-term impact of COVID-19 on cardiovascular health. Although the findings suggest a significant recovery in cardiovascular disease prevention and management post-pandemic, the lack of patient-level data limits causal interpretations. Consequently, these observations should be considered hypothesis-generating.

To align with the journal's format, we focused on delivering a concise introduction and methodology that provides necessary background information while establishing a clear link to our prior "*Nature Medicine*" publication[1]. In terms of the introduction, as this study was a direct follow-up, our intention was to provide context for the rationale behind extending the analysis period and examining prescribing trends within Scotland, rather than conducting an extensive appraisal of the wider literature.

Conclusions

Our study provides important insights into the long-term recovery of the healthcare system in Scotland following the COVID-19 pandemic, as evidenced by the substantial increase in the initiation of antihypertensive and lipid-lowering therapies post-pandemic. These findings possibly suggest that the healthcare system has not only rebounded but has also potentially addressed a backlog of untreated cases. However, the observed higher-than-expected prescribing rates may also reflect changes in patient demographics, case mix, or potential long-term sequelae associated with COVID-19, including new-onset hypertension and dyslipidaemia, especially in the light of the similar GP encounters rates in 2018–2019 compared with post-pandemic recovery phase (July 2021–December 2022). However, due to the absence of patient-level demographic and clinical data, the findings should be interpreted as hypothesis-generating rather than conclusive, warranting further investigation with detailed patient-level data to better understand the drivers behind the observed trends.

Transparency

Declaration of funding

This work was not funded.

Declaration of financial/other relationships

The authors have no relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript. This includes employment, consultancies, honoraria, stock ownership or options, expert testimony, grants or patents received or pending, or royalties.

Peer reviewers on this manuscript have no relevant financial or other relationships to disclose.

Author contributions

All authors substantially contributed to the design, performance, analysis, reporting of the work and interpreting the relevant literature as well as had been involved in writing the manuscript and/or revised it for intellectual content. Further contributions include data collection, management and analysis: M. Millar, U. Nnabuko; interpretation of results: all authors; and final approval: all authors.

Acknowledgements

None.

Data availability statement

The data that support the findings of this study are not publicly available due to privacy and security concerns. The data involve anonymised patient-level information that is stored in a restricted and secure environment. Access to these data is limited to the research team and is subject to specific permission requirements to ensure the confidentiality and security of the patient data in accordance with relevant regulations and institutional policies within Public Health Scotland.

Ethics statement

The study adhered to the principles outlined in the Declaration of Helsinki. Ethical approval was not necessary as this investigation was classified as a service evaluation study conducted within Public Health Scotland. It utilised anonymized data generated during routine care and complied with standard NHS Scotland protocols to ensure the absence of any risk to individual patients. Consequently, informed consent was not required. Furthermore, no identifiable information was used in the analyses.

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