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Complete List of Authors:	Fu, Yu; Newcastle University Faculty of Medical Sciences, Population Health Sciences Institute Price, Christopher; Northumbria Healthcare NHS Foundation Trust, Haining, Shona; NHS North of England Commissioning Support Unit Gaffney, Bob; NHS North of England Commissioning Support Unit Julien, David; NHS South Tyneside Clinical Commissioning Group Whitty, Paula; Cumbria Northumberland Tyne and Wear NHS Foundation Trust Newton, Julia L.; Newcastle University
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Cardiovascular risk management in primary care for deprived communities before and during the COVID-19 pandemic: an observational study in Northern England

Yu Fu[1,2*], Chris Price[1,2], Shona Haining[3], Bob Gaffney[3], David Julien[4], Paula Whitty[1,5], Julia L Newton[2,6]

[1]NIHR Applied Research Collaborative North East and North Cumbria, Cumbria, Northumberland and Tyne and Wear NHS Foundation Trust, The Clocktower Building, St Nicholas Hospital, Gosforth, Newcastle NE3 3XT, UK

[2]Population Health Sciences Institute, Faculty of Medical Sciences, Newcastle University, Newcastle upon Tyne NE1 4LP, UK

[3]North of England Commissioning Support Riverside House, Goldcrest Way, Newburn Riverside, Newcastle, NE15 8NY UK

[4]NHS South Tyneside Clinical Commissioning Group, Monkton Hall, Monkton Lane, Jarrow, NE32 5NN, UK

[5]NEQOS, North East Quality Observatory Service, Cumbria, Northumberland, Tyne and Wear NHS Foundation Trust, 1st Floor, Ridley House, Henry Street, Gosforth, Newcastle upon Tyne NE3 1DQ, UK

[6]AHSN NENC, Academic Health Science Network for North East North Cumbria, Room 2.13, Biomedical Research Building, Campus for Ageing and Vitality, Nuns' Moor Road, Newcastle upon Tyne NE4 5PL, UK

*Correspondence

Population Health Sciences Institute, Faculty of Medical Sciences, Newcastle University, Newcastle upon Tyne NE1 4LP, UK

E-mail: yu.fu@newcastle.ac.uk

ABSTRACT

Objectives

To compare cardiovascular disease (CVD) risk management for deprived with other general practice (GP) populations in Northern England to England overall, before, and during COVID-19 to identify changes in recorded CVD-related risk factors and conditions and evidence-based lipid prescribing behaviour.

Design

This is a population-based observational study of aggregated practice-level data obtained from publicly accessible datasets. Comparisons between practice populations are not controlled.

Setting

34 practices were identified as in the most deprived communities in North East and North Cumbria (Deep End) compared with the rest of the GPs in the region and England overall.

Participants

Patients ≥16 registered with GP and diagnosed with any form of CVD.

Primary and secondary outcome measures

Practice profiles, CVD-related conditions and risk factors, statin prescribing.

Results

Deep End practices had a smaller, younger, and more deprived population with lower levels of employment and full-time education. They had a higher smoking prevalence. They also had some higher recorded CVD-related conditions than England but lower than the non-Deep End practices. Recorded atrial fibrillation, hypertension, stroke and transient ischaemic attack rates appeared to be lower in the Deep End than the non-Deep End practices but the optimal statin prescribing rate was high. The comparisons of recorded CVD prevalences may be fully confounded by the inability to adjust for age, in particular.

Conclusion

Recorded CVD-related risk factors and conditions remained comparable pre and during COVID-19. These are higher in the Deep End than in England and similar or lower than the non-Deep End, with a higher optimal statin prescribing rate. However, with publicly accessible practice-level data it was not possible to control for age and sex. Therefore more work is needed to estimate the consequences of the pandemic on disadvantaged communities and to further compare whether the findings are replicated in other areas of deprivation.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- CVD risk management is compared for deprived with non-deprived populations in Northern England to England overall pre and during COVID-19.
- CVD-related risk factors and conditions are shown to be comparable pre and during COVID-19.
- Deprived populations have higher CVD-related risk factors and conditions compared to England, which are comparable with non-Deep End practices, highlighting the potential for underdiagnosis.
- A recorded higher rate of evidence based and optimised high-intensity statin prescribing in the region than in England.
- Data analysis undertaken is based on limited data available at the practice level only, without controlling for age, gender, deprivation or ethnicity.

INTRODUCTION

More than seven million people are living with cardiovascular disease (CVD)[1] in the UK. CVD accounts for a quarter of premature mortality and leads to the largest gap in healthy life expectancy[2 3]. CVD morbidity is also a major challenge for health and social care. More than 100,000 admissions per year are caused by heart attacks and more than 100,000 strokes occur in the UK each year. This places a substantial financial burden on the National Health Service (NHS) and wider society, with healthcare costs being estimated at £9 billion and costs to the UK economy at £19 billion per year[1].

Identification and assessment of CVD risk in primary care remain central to clinical guidelines in many countries[4-6]. The overall aim of treatment is to prevent CVD occurrence by reducing these risk factors through optimising lifestyle and drug management. However, CVD has shown significant health inequalities for people with low socioeconomic status. People in the most deprived areas in England were four times more likely to die prematurely due to CVD than those in the least deprived areas from 2017 to 2019[7]. As a result, CVD has been identified as a clinical priority by Core20PLUS5 (a national NHS England and NHS Improvement approach to support the reduction of health inequalities)[8] and the latest NHS Long Term Plan, which included a major ambition to prevent 150,000 heart attacks, strokes, and dementia cases over the next decade[9]. The plan has also defined new actions to address health inequalities in which all national programmes and local areas are required to set out specific measurable goals and mechanisms contributing to reducing health inequalities. The NHS has also set up the national CVD Prevention programme[2] which aims to develop targeted interventions to minimise risk factors by maximising diagnosis and treatment, accompanied by the GP contract to commission a new national CVD prevention audit for primary care[10], in collaboration with the British Heart Foundation, the Stroke Association, Academic Health Science Networks (AHSNs) and (the former) Public Health England (PHE).

CVD and its risk factors are common comorbidities in patients with COVID-19[11-14] and associated with poorer COVID-19 outcomes and higher mortality[15]. There are early indications that COVID-19 restrictions may have led to a significant, unintended reduction in detection and treatment reviews of CVD risk factors. A study in the UK suggested a 43% reduction in new diagnoses of CVD and a 30-52% decrease in prescribing cardiovascular medications between March and May 2020[16]. Evidence is accumulating that the COVID-19 pandemic has also led to worsening of health inequalities[17]. Research pre COVID-19 had already suggested that attendance at CVD screening assessments was lower in individuals with high deprivation scores who are also more likely to have a higher CVD risk[18], indicating potential unmet needs and under-diagnosis of CVD in disadvantaged communities. CVD has also shown a disproportionate impact on people living in different geographic locations. The North East of England, consistently ranked as having the highest poverty levels and the lowest health outcomes[19], has the highest CVD premature mortality, a close second to the North West compounded by the pandemic[20]. With this background, it is important to explore whether existing inequalities have been exacerbated during COVID-19 in the region, and therefore whether individuals in areas of higher deprivation face widening disadvantages and worse CVD outcomes going forward.

Using publicly available data, this study aimed to compare CVD-related risk factors and conditions, and other practice characteristics, in the most deprived general practice populations in the North East and North Cumbria (NENC) region with other practices in the region and England. The study also aimed to compare the periods before and during the COVID-19 pandemic to identify changes in 1) CVD-related risk factors and conditions and 2) evidence based lipid prescribing behaviour.

METHODS

This is a population based observational study comparing retrospective data from practices in deprived communities, practices in non-deprived communities and national practice-level data from the year before the COVID-19 pandemic started (April 2019 to March 2020) and the first year of the COVID-19 pandemic (April 2020 to March 2021). This data was obtained from publicly accessible datasets only.

Data sources

Practice characteristics

A total of 34 practices that fall into the 15% most deprived practice populations in England have previously been identified as the Deep End practices in the North East and North Cumbria (https://deependnenc.org/), according to the definition used in the Scottish Deep End project[21]. These practices form the Deep End network in the NENC, and the network aims to improve and change the way primary care is delivered to the most deprived populations, to meet patients' needs and to reduce health inequalities. The practices described as 'Non-Deep End' practices are the rest of the GP practices located in the NENC region.

A summary of practice characteristics for Deep End, non-Deep End and practices across England was obtained from the GP Practice Profiles in the Office for Health Improvement and Disparities (OHID)'s Fingertips tool[22]. Profiles that update annually are generated for all practices in Quality and Outcomes Framework (QOF) to support GPs, primary care networks, clinical commissioning groups and local authorities to ensure appropriate healthcare services are provided for their local population. Variables included practice list size, Index of Multiple Deprivation (IMD), age breakdown of registered population, Income Deprivation Affecting Children Index (IDACI), Income Deprivation Affecting Older People Index (IDAOPI), patient satisfaction (from the GP patient survey), total QOF points, sex breakdown of life expectancy and percentage of patient with caring responsibilities.

CVD-related risk factors and CVD conditions: CVD registers and prevalence

Practice level data was downloaded from QOF[23] 2019/20 cardiovascular group data, covering recorded CVD-related risk factors (estimated smoking prevalence, hypertension (HYP)) and CVD conditions (coronary heart disease (CHD), atrial fibrillation (AF), heart failure (HF), left ventricular systolic dysfunction (LVSD), peripheral arterial disease (PAD), and stroke and transient ischaemic attack (STIA)). Each condition was analysed separately. Raw prevalence percentages for the seven conditions were calculated as the number of patients on the practice disease register divided by practice list size.

Statin prescription

Data on statin therapy (low intensity, medium intensity, and total statins) was downloaded from OpenPrescribing[24] which gives free and open access to monthly prescription data at every GP practice in England.

High-intensity statins are recognised as the most appropriate evidence based treatment for those with hypercholesterolaemia who have not responded to lifestyle modification[25] with the proportion of high-intensity statin prescribing of overall statin used as a surrogate marker for evidence based approaches to lipid management. High-intensity statins were calculated by subtracting low and medium intensity statins from the total statins, which was then divided by the total statins.

Population

The study population was patients aged 16 and above who have registered with the 34 Deep End practices in the NENC as recorded on the QOF from 2019 to 2020. The study comparators were the patients registered in non-Deep End practices in the region and all registered patients in England where data was available for the same time period.

Data analysis

Primary outcomes were (a) the comparison of prevalence of CVD-related risk factors and conditions between Deep End practices, non-Deep End and all-England practices (b) comparison of statin prescribing rates and (c) the change in the prevalence of CVD-related risk factors and conditions in these groups of practices pre and during COVID. GP practice code was used to link data across all datasets. Due to the nature of the aggregated data available from the public sources used (Fingertips[22] and QOF), it was not possible to control any of the comparisons for age, gender, deprivation or ethnicity. Descriptive statistics, using means, standard deviations, and range, were used to compare the practice profile of the 34 Deep End practices with non-Deep End in the region and the England average level. The prevalence of risk factors, conditions and statin prescribing were analysed with an appropriate statistical test (i.e., two-sample t-test, single sample t-test, and paired t-test), which yielded p values that indicated the statistical significance of any differences between Deep End, non-Deep End and England level, and over time (pre and during COVID).

Patient and Public Involvement Statement

Due to the nature of this study being a fully data-based analysis based on the existing datasets, there was no specific involvement of patients or the public in the design or conduct of the study. However, results will be widely shared via the Public Involvement and Community Engagement network for the NIHR Applied Research Collaboration NENC that brings together six regional universities, the NHS, health and social care providers, local authorities, the voluntary sector, community groups, members of the public and others.

RESULTS

Characteristics of the Deep End practices compared to non-Deep End and England

As shown in Table 1, on average the 34 Deep End practices had a list size of 7760 which is smaller than the average seen in non-Deep End practices and England average[26]. The Deep

End practices had significantly higher levels of deprivation compared to the non-Deep End (46.4 vs 26.7) and England practices (46.4 vs 21.7), with deprivation scores around twice as high as the England average in the NENC Deep End practices. This highlighted that NENC practices in general were more deprived. The age profile of those registered in the Deep End was different compared to both the non-Deep End NENC practices and England overall, with a significantly lower proportion of those aged over 85 in the Deep End and an apparent shift towards younger age groups. Deprivation was also significantly higher for those younger and older groups in the Deep End Practices in NENC when assessed using the Income deprivation for children and older people. As explained earlier, despite these very clear differences in the demographic make-up of Deep End vs non-Deep End and all-Englandpractices, it was not possible to control any of the comparisons in this paper for these factors.

Also as expected, life expectancy for those living in the Deep End was significantly lower in both males and females, with males living on average 3.2 and 4.5 years and females 2.8 and 3.8 years less in the Deep End compared to the non-Deep End practices and England respectively.

There were comparable proportions of those in the Deep End practices with caring responsibilities compared to the non-Deep End practices (18.0% vs 18.6%) and England (18.0% vs 17.0%). Lower proportions of people registered in the Deep End practices (6.7% and 12% less than the non-Deep End and England practices respectively) were in paid work or full-time education and more were unemployed (6.7% and 7.3% more than the non-Deep End and England practices respectively).

In the GP patient survey data, patients in the NENC region were found to be more satisfied with their GP practices compared to England, specifically with ‘phone access, appointment times and overall experience of appointment. This was the case across the board for both patients from Deep End and non-Deep End practices.

Over 2.5% and 7% more of those registered with a Deep End Practice had a long-term condition compared to the non-Deep End (59.7% vs 57.1%) and England levels (59.7% vs 52.4%) respectively and the total QOF points achieved were lower than non-Deep End practices (95.4 vs 97.4) but comparable with the England average (95.4 vs 95.6).

Table 1 NENC Deep End practice (n=34) characteristics compared to NENC non-Deep End and England level practices

Characteristics	Deep End practices		Non-Deep End practices		95 % CI Mean diff (DE vs non-DE)	England	P value[$] (DE vs England)
	Mean (SD)	Range	Mean (SD)	Range		Mean	
Practice list size (Oct 2020)	7760 (5238)	(1337, 26551)	8509 (4730)	(1668, 39075)	(-2474 to 972)	8757[+]	
IMD scores 2019	46.4 (7.8)	(34.2, 67.4)	26.7(8.7)	(8.5, 42.7)	(16.6 to 22.8)**	21.7	**
% Patients, 0-4 yrs, 2021	5.7 (1.0)	(3.6, 8.2)	4.7 (1.0)	(0.9, 8.8)	(0.7 to 1.4)**	5.1	**
% Patients, 5-14 yrs, 2021	12.7 (2.5)	(8.7, 21.1)	11.0 (1.9)	(1.2, 17.3)	(0.9 to 2.3)**	11.8	*
% Patients, under 18 yrs, 2021	21.7 (3.5)	(14.9, 33.4)	18.9 (3.2)	(2.4, 32.2)	(1.7 to 4.0)**	20.2	*
% Patients, 65 yrs+, 2020	14.8 (5.1)	(0.4, 22.9)	20.4 (5.2)	(1.1, 34.5)	(-7.5 to -3.8)**	17.4	*
% Patients, 85 yrs+, 2020	1.5 (0.6)	(0.0, 2.7)	2.4 (0.7)	(0.1, 4.3)	(-1.1 to -0.5)**	2.1	**
IDACI, under 16 yrs, 2019	0.3 (0.1)	(0.2, 0.5)	0.2 (0.1)	(0.0, 0.3)	(0.1 to 0.2)**	0.2	**
IDAOPI, 60+ yrs, 2019	0.3 (0.1)	(0.2, 0.4)	0.2 (0.1)	(0.1, 0.4)	(0.1 to 0.1)**	0.1	**
Female life expectancy 2013-17	79.3 (1.4)	(76.0, 82.1)	82.1 (1.6)	(78.8, 88.3)	(-3.4 to -2.2)**	83.1	**
Male life expectancy 2013-17	75.0 (1.4)	(71.9, 77.6)	78.2 (1.9)	(74.7, 83.6)	(-3.8 to -2.5)**	79.5	**
% Patients with caring responsibility, 2020	18.0 (5.7)	(3.2, 29.3)	18.6 (4.5)	(2.8, 33.7)	(-2.2 to 1.1)	17.0	
% Paid work or full-time education, 2020	51.7 (8.9)	(15.6, 64.1)	58.4 (7.4)	(33.9, 79.1)	(-9.4 to -3.9)**	63.7	**
% Unemployed, 2020	11.2 (10.4)	(2.2, 57.4)	4.5 (3.7)	(0.0, 17.5)	(4.9 to 8.5)**	3.9	**
% Patients positive experiences, 2020	83.8 (7.0)	(70.7, 95.0)	84.6 (9.3)	(55.1, 100.0)	(-4.0 to 2.5)	81.8	
% Patients satisfied with phone access, 2020	72.1 (19.6)	(33.4, 98.4)	74.3 (19.2)	(21.3, 100.0)	(-9.1 to 4.7)	65.2	*
% Patients satisfied with appointment times, 2020	69.4 (9.6)	(53.6, 88.9)	67.1 (14.0)	(26.2, 96.8)	(-2.5 to 7.2)	63.0	**
% Patients good overall experience of appointment, 2020	71.8 (10.8)	(53.9, 95.1)	70.1 (14.1)	(33.7, 98.5)	(-3.3 to 6.6)	65.5	*
% Patients with a long-standing cond, 2020	59.7 (9.9)	(31.4, 78.1)	57.1 (7.4)	(26.3, 73.7)	(-0.2 to 5.4)	52.4	**
Total QOF points	95.4 (9.3)	(47.8, 100.0)	97.4 (2.7)	(84.9, 100.0)	(-3.5 to -0.6)**	95.6	

IMD Score: the larger the score, the more deprived the area; Total QOF points: defined as a proportion of all achievable QOF points across all domains[2223].
IMD: Index of Multiple Deprivation; IDACI: Income Deprivation Affecting Children Index; IDAOPI: Income Deprivation Affecting Older People Index
*p<0.05; **p<0.001; [$] practice level data for England is not publicly accessible, one sample t test was conducted to compare the sample against the population mean.
[+]Published by NHS Digital for October 2019[26]

Cardiovascular disease (CVD) and CVD-related risk factor prevalence in the Deep End practices compared to non-Deep End and England practices

As shown in Table 2, when considering individual CVD risk factors, recording of smoking prevalence was significantly higher in Deep End practices compared to the rest of the region and England. However, the recorded HYP prevalence was lower in the Deep End practices than that in the non-Deep End but comparable with the England average.

Looking at CVD-related conditions, interestingly, lower recorded CHD prevalence in Deep End practices compared to the non-Deep End but higher prevalence compared to England. The prevalence of AF was also lower in the Deep End practices compared to regional non-Deep End practices but was similar to England. Prevalences for HF were comparable across the Deep End, regional non-Deep End, and England. Despite no difference in rates for LVSD and PAD between the Deep End and regional non-Deep End practices, Deep End practices had higher prevalence compared to England. However, the pattern of prevalence was different when it came to STIA with the Deep End having lower prevalence compared to non-Deep End but similar to England. As noted earlier, none of these comparisons of CVD-related conditions between the different groups of practices have been controlled for age, sex or deprivation.

There was no significant change in any of the identified CVD-related risk factor pre and during COVID-19. However it was noted that the range for each risk factor in regional non-Deep End practices was greater.

Table 2 Cardiovascular diseases and CVD-related risk factor prevalence in NENC Deep End practices compared to NENC non-Deep End and England practices

Risk factors	Deep End practices		Non-Deep End practices		95% CI	England		95% CI
	Mean (SD)	Range	Mean (SD)	Range	Mean diff (DE vs non-DE)	Mean (SD)	Range	Mean diff (DE vs Eng)
Smoking prev.(%)								
Register 19/20	24.5 (4.9)	(17.8, 39.3)	16.3 (4.5)	(4.7, 27.5)	(6.5 to 9.8)**	16.5 (-)		(6.3 to 9.7)**
Register 20/21	23.8 (4.5)	(17.6, 37.5)	15.8 (4.4)	(4.5, 26.4)	(6.4 to 9.6)**	15.9 (-)		(6.3 to 9.5)**
95% CI Mean diff	(-2.9 to 1.6)		(-1.3 to 0.3)					
HYP								
Register (n) 19/20	1131 (856)	(11, 4504)	1373 (717)	(164, 3530)	(-506 to 22)	1279 (868)	(0, 11720)	(-440 to 145)
Register (n) 20/21	1136 (876)	(14, 4500)	1392 (861)	(176, 8858)	(-567 to 54)	1287 (889)	(0, 11888)	(-450 to 149)
95% CI Mean diff	(-414 to 424)		(-120 to 159)			(-22 to 38)		
Prev. (%) 19/20	14.2 (4.3)	(0.9, 21.2)	16.6 (3.2)	(1.0, 29.3)	(-3.6 to -1.2)**	14.4 (4.1)	(0, 87.9)	(-1.5 to 1.2)
Prev. (%) 20/21	13.9 (4.1)	(1.0, 20.7)	16.5 (3.2)	(1.0, 28.8)	(-3.7 to -1.3)**	14.2 (4.0)	(0, 61.3)	(-1.6 to 1.1)
95% CI Mean diff	(-2.3 to 1.7)		(-0.7 to 0.4)			(-0.3 to 0.0)		
AF								
Register (n) 19/20	143 (112)	(0, 539)	202 (112)	(12, 634)	(-99 to -18)*	186 (150)	(0, 1445)	(-94 to 7)
Register (n) 20/21	146 (122)	(0, 517)	206 (113)	(14, 1346)	(-107 to -12)*	189 (155)	(0, 1424)	(-95 to 9)
95% CI Mean diff	(-53 to 60)		(-17 to 26)			(-2 to 8)		
Prev. (%) 19/20	1.7 (0.6)	(0, 2.7)	2.4 (0.6)	(0.1, 4.2)	(-0.9 to -0.5)**	2.0 (1.0)	(0, 28.7)	(-0.6 to 0.1)
Prev. (%) 20/21	1.7 (0.6)	(0, 2.7)	2.4 (0.6)	(0.1, 4.3)	(-0.9 to -0.5)**	2.0 (1.1)	(0, 28.2)	(-0.7 to 0.1)
95% CI Mean diff	(-0.3 to 0.3)		(-0.1 to 0.1)			(0.0 to 0.0)		
CHD								
Register (n) 19/20	302 (221)	(3, 1078)	348 (192)	(25, 977)	(-117 to 24)	281 (204)	(0, 2392)	(-48 to 90)
Register (n) 20/21	301 (230)	(3, 1067)	349 (231)	(24, 2447)	(-131 to 35)	282 (209)	(0, 2447)	(-51 to 90)
95% CI Mean diff	(-110 to 109)		(-36 to 39)			(-6 to 8)		
Prev. (%) 19/20	3.8 (1.3)	(0.3, 6.4)	4.2 (0.9)	(0.2, 6.2)	(-0.7 to 0.0)*	3.2 (1.2)	(0, 31.1)	(0.2 to 1.1)*
Prev. (%) 20/21	3.7 (1.2)	(0.2, 5.9)	4.1 (0.9)	(0.1, 6.2)	(-0.7 to -0.1)*	3.1 (1.2)	(0, 30.0)	(0.2 to 1.0)*
95% CI Mean diff	(-0.7 to 0.5)		(-0.2 to 0.1)			(-0.1 to 0.0)		

HF								
Register (n) 19/20	86 (82)	(1, 405)	104 (73)	(4, 471)	(-45 to 8)	81 (70)	(0, 1124)	(-19 to 29)
Register (n) 20/21	91 (92)	(1, 410)	106 (92)	(5, 1047)	(-48 to 18)	84 (74)	(0, 1047)	(-18 to 32)
95% CI Mean diff	(-37 to 47)		(-13 to 16)			(0 to 5)		
Prev. (%) 19/20	1.0 (0.5)	(0.1, 2.2)	1.2 (0.5)	(0, 3.1)	(-0.4 to 0)	0.9 (0.5)	(0, 13.4)	(0 to 0.3)
Prev. (%) 20/21	1.1 (0.6)	(0.1, 2.8)	1.2 (0.5)	(0, 2.9)	(-0.3 to 0)	0.9 (0.5)	(0, 12.1)	(0 to 0.3)
95% CI Mean diff	(-0.2 to 0.3)		(-0.1 to 0.1)			(0.0 to 0.0)		
LVSD								
Register (n) 19/20	45 ((51)	(0, 259)	59 (50)	(3, 309)	(-31 to 5)	33 (39)	(0, 532)	(0 to 26)
Register (n) 20/21	51 (62)	(0, 265)	60 (60)	(3, 625)	(-31 to 12)	36 (43)	(0, 670)	(0 to 29)*
95% CI Mean diff	(-22 to 33)		(-8 to 11)			(2 to 4)		
Prev. (%) 19/20	0.6 (0.4)	(0, 1.6)	0.7 (0.4)	(0, 2.3)	(-0.3 to 0)	0.4 (0.3)	(0, 3.4)	(0.1 to 0.3)**
Prev. (%) 20/21	0.6 (0.5)	(0, 2.2)	0.7 (0.4)	(0, 2.1)	(-0.2 to 0.1)	0.4 (0.3)	(0, 5.6)	(0.1 to 0.3)**
95% CI Mean diff	(-0.2 to 0.2)		(-0.1 to 0.1)			(0.0 to 0.0)		
PAD								
Register (n) 19/20	76 (55)	(0, 251)	77 (45)	(3, 228)	(-17 to 16)	54 (45)	(0, 747)	(7 to 37)*
Register (n) 20/21	76 (56)	(0, 243)	76 (51)	(4, 487)	(-19 to 19)	54 (46)	(0, 720)	(6 to 37)*
95% CI Mean diff	(-27 to 27)		(-10 to 7)			(-1 to 2)		
Prev. (%) 19/20	0.9 (0.3)	(0.0, 1.8)	0.9 (0.3)	(0.0, 2.4)	(-0.1 to 0.1)	0.6 (0.4)	(0.0, 12.3)	(0.2 to 0.5)**
Prev. (%) 20/21	0.9 (0.3)	(0.0, 1.7)	0.9 (0.3)	(0.0, 2.2)	(-0.1 to 0.1)	0.6 (0.4)	(0.0, 21.4)	(0.2 to 0.5)**
95% CI Mean diff	(-0.2 to 0.1)		(-0.1 to 0.0)			(0.0 to 0.0)		
STIA								
Register (n) 19/20	162 (125)	(0, 617)	197 (107)	(19, 529)	(-75 to 4)	163 (123)	(0, 1385)	(-43 to 40)
Register (n) 20/21	167 (135)	(0, 651)	200 (127)	(20, 1240)	(-79 to 13)	166 (128)	(0, 1427)	(-42 to 44)
95% CI Mean diff	(-57 to 68)		(-18 to 24)			(-1 to 8)		
Prev. (%) 19/20	2.0 (0.6)	(0.0, 2.9)	2.4 (0.5)	(0.1, 3.5)	(-0.6 to -0.2)**	1.8 (0.8)	(0.0, 21.9)	(-0.1 to 0.5)
Prev. (%) 20/21	2.0 (0.6)	(0.0, 2.9)	2.3 (0.5)	(0.1, 3.9)	(-0.5 to -0.1)**	1.8 (0.9)	(0.0, 26.4)	(-0.1 to 0.5)
95% CI Mean diff	(-0.3 to 0.3)		(-0.1 to 0.1)			(0.0 to 0.0)		

*p<0.05; **p<0.001

Prescribing of statin therapy in Deep End practices compared to the non-Deep End and England

Prescribing statins is the next step where lifestyle modification shows no effects in managing hypercholesterolaemia. As shown in Table 3, the percentage of high intensity was comparable between the Deep End and the non-Deep End, but significantly higher than England average.

The percentage of high-intensity statins had increased during COVID compared to the year pre-COVID, with a significant increase for regional non-Deep End practices and England practices but not for Deep End practices.

Table 3 Statin therapy in NENC Deep End practices compared to NENC non-Deep End and England practices

Statin	Deep End practices		Non-Deep End practices		95% CI Mean diff (DE vs non-DE)	England		95% CI Mean diff (DE vs Eng)
	Mean (SD)	Range	Mean (SD)	Range		Mean (SD)	Range	
Total intensity (n)								
19/20	14068 (9124)	(152, 41312)	15763 (8623)	(1133, 46517)	(-4819 to 1431)	-	-	
20/21	14872 (10339)	(172, 44602)	16204 (9101)	(1315, 54288)	(-4662 to 1999)	-	-	
95% CI Mean diff	(-3918 to 5525)		(-1120 to 2002)					
High-intensity (n)								
19/20	8922 (6659)	(100, 28369)	10104 (5984)	(821, 36007)	(-3367 to 1001)	-	-	
20/21	10024 (8047)	(127, 34588)	10812 (6541)	(1011, 42851)	(-3212 to 1636)	-	-	
95% CI Mean diff	(-2474 to 4679)		(-396 to 1812)					
High-intensity (%)								
19/20	61.9 (10.4)	(46.8, 86.7)	63.8 (10.2)	(35.4, 91.0)	(-5.5 to 1.8)	56.4 (5.0)	(44.8, 76.5)	(2.9 to 8.1)**
20/21	65.4 (10.4)	(47.3, 87.4)	66.4 (9.5)	(36.1, 91.2)	(-4.5 to 2.4)	59.7 (4.9)	(48.2, 78.8)	(3.1 to 8.2)**
95% CI Mean diff	(-1.6 to 8.5)		(0.9 to 4.4)*			(2.0, 4.6)**		

*p<0.05; **p<0.001

DISCUSSION

This observational study examined practice profiles and recorded CVD-related risk factors and conditions for Deep-End practices in the NENC and compared these with the regional non-Deep End practices and England before and during the COVID-19 period, using publicly accessible datasets. Due to the limitations of the publicly available datasets, it was not possible to control comparisons for age, gender, deprivation or ethnicity.

This study has found that Deep End practices had on average a smaller and younger population than other practices in the region and nationally[26]. As expected, the overall deprivation score is high in Deep End populations with those below age 16 and over age 60 also being scored higher on income deprivation. The Deep End populations also had lower levels of paid employment or full-time education and higher levels of unemployment. There was clear evidence of higher health needs in the Deep End practices, with higher levels of long-term conditions and poorer life expectancy than both non-Deep End practices and

England. Despite that, patients in the region reported higher satisfaction with their practices compared to England across the board for both Deep End and non-Deep End practices. In addition, Deep End practitioners practices rather then the individuals ? have achieved slightly lower results measured by total QOF points.

This study also found that, consistently across the region, for both the Deep End and non-Deep End practices, patients reported a better overall experience of making appointments than in England. This contradicts previous findings from the GP patient survey that the deprived populations were non-likely to report a positive experience of accessing general practice or a good overall experience[27 28]. It is worth noting that we did not have data on respondents to the survey nor response rate to these questions, therefore comparisons across practices were not possible. Also, patient satisfaction levels were not adjusted for age or gender in this study. Given poorer experience reported in the most deprived populations elsewhere, this finding requires further exploration, which may consider whether primary care staff working in some of the most disadvantaged communities in the region are achieving above-average service delivery despite these circumstances and the impact on staff health.

Despite disruptions to essential health services caused by the pandemic, this study did not observe any significant changes in CVD-related risk factors or conditions regionally and nationally. There may be some reasons for this. First, this study provided a descriptive analysis of practice level data without controlling for demographic variables (particularly age, as Deep End practices have an average younger population). Second, evidence of the wider lifestyle, health and care consequences of the pandemic are still emerging especially for the most disadvantaged communities, hence it may still be too early to observe any significant impact. Third, given that it is known that CVD risk factors are usually more common in deprived areas[7] and if the lower recorded prevalences (and lack of change in prevalences) found in this study were not due only to the inability to control for age, one alternative explanation could include under or missed-recording (e.g. due to potential underdiagnosis); however, the finding needs further exploration including using individual-level data which can be adjusted for demographic variables.

The Deep End practices had a higher smoking prevalence. A multi-level, multi-component, cross-party, evidence based programme targeting the whole systems and local environments is needed to reduce inequalities in smoking prevalence[29]. Interventions focusing solely on individual behaviour change and providing information or education[30] without taking into consideration of issues of differential access, use and outcome of preventive healthcare services across disadvantaged groups[29] are likely to exacerbate these inequalities.

The Deep End patients had lower recorded hypertension and CVD-related conditions overall compared to the non-Deep End patients. However, when compared to the national level the Deep End showed a similar recorded HYP and STIA prevalence and a higher level of many CVD-related conditions (CHD, LVSD, and PAD). This has confirmed existing evidence that the North East of England is an area of high CVD risk[31]. However, the inability to control for age makes this impossible to interpret and the finding may be attributed to differences between the Deep End and England average in the characteristics of the population, particularly age. Further research is needed to compare risk factors and CVD-related conditions in Deep End practices adjusted for the characteristics of the population. Given the positive association between deprivation and HYP, CHD and STIA prevalences [32 33 34 35], the lack of a difference in recorded prevalence between Deep End and non-Deep End needs to be explored further. As

previously noted, none of the comparisons was adjusted by age and therefore the finding of lower recorded CVD-related conditions in Deep End compared to non-Deep End practices could be largely attributed to the larger proportion of young people in the Deep End practices.

There appeared to be a lower recorded level of AF in those living in the Deep End. Although recent studies seemed to observe a rising trend of AF with a deprivation score after controlling for age and gender[36], it is worth noting that there is a lack of association of AF with deprivation shown in an observational study examining the prevalence and treatment of AF in general practice in the UK between 2000 to 2016. It found that a lower proportion of patients with AF were in the most materially deprived areas than the least deprived areas with a steady increase in the age-gender standardised AF prevalence[37]. In addition, when adjusting for age, patient-level socioeconomic status, and comorbidities such as CHD, hypertension, obesity, HF, and diabetes, previous research has concluded that socioeconomic disparities and deprivation are not independently associated with AF[38].

The rate of high-intensity statin prescribing was recorded as lower than the non-Deep End but higher in the Deep End pre and during COVID-19 than in England. This indicates the high risk of CVD in the region and the likelihood of underdiagnosed CVD related risk factors or CVD conditions in the Deep End practices. Higher high-intensity statin prescribing in the region may also reflect that practitioners are actively treating CVDs with greater compliance with the clinical guideline for the use of high-intensity statins[39], which could be the consequence of the Accelerated Access Collaborative (AAC) Lipid Management Rapid Uptake Product (RUP) programme initiated and supported Statin Intolerance Pathway endorsed by NICE[40].

This study has several limitations. It was conducted using multiple observational publicly accessible datasets which recorded data aggregated at the GP practice level. Therefore, limitations and factors influencing the quality of those datasets apply to this study. The analysis was undertaken without controlling for age, gender, deprivation, or ethnicity. The younger than average age of the Deep End practice populations may have been a key confounder in many of the comparisons made. In addition, QOF data is based on recorded data within practices to meet QOF requirements and the QOF is a voluntary reward and incentive programme, which has been reported not to be effective in narrowing health inequality[41]. Although this study focused on only one region in the UK, it did enable a high-level view of CVD-related characteristics of practices in the region with the poorest health outcomes.

CONCLUSION

This descriptive study finds that CVD-related risk factors and conditions remain comparable pre and during COVID-19 across Deep End, non-Deep End and all-England practices. Deep End practices present higher CVD-related conditions compared to England but similar or lower compared to the regional non-Deep End practices, with a higher smoking prevalence and evidence based lipid prescribing rate. However, these findings may be largely confounded by the inability to control for demographic variables in the comparisons. An alternative explanation could include potential underdiagnosed and underrecorded CVD - related conditions, potentially leading to unmet needs. However, these findings require further exploration. Future work is needed using individual-level data controlled for key demographic variables to estimate the health and care consequences of the pandemic on disadvantaged communities and to further compare whether findings are replicated in other areas of deprivation. In addition, research with qualitative methods would be helpful to

explore how health professionals manage CVD-related risk factors and conditions in routine practice for deprived populations and in general how they manage to deliver higher satisfaction.

CONTRIBUTIONS

YF, JN, CP & PW developed the hypothesis and created the concept. YF performed the analysis and created the initial report. YF & JN wrote the initial draft of the manuscript. All authors reviewed and approved the subsequent drafts of the manuscript. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

DATA SHARING

Data is publicly available via Public Health England.

ETHICS APPROVAL

Research ethical approval was not required for this study as all data is publicly available.

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COMPETING INTEREST

None.

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*5-6*
Bias	9	Describe any efforts to address potential sources of bias	n/a
Study size	10	Explain how the study size was arrived at	n/a
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	n/a
		(*d*) If applicable, explain how loss to follow-up was addressed	n/a
		(*e*) Describe any sensitivity analyses	n/a
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6-7
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6-7
		(b) Indicate number of participants with missing data for each variable of interest	n/a
		(c) Summarise follow-up time (eg, average and total amount)	6-7
Outcome data	15*	Report numbers of outcome events or summary measures over time	6-7
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	6-7, Tables 1-3
		(*b*) Report category boundaries when continuous variables were categorized	n/a
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	n/a
Discussion			
Key results	18	Summarise key results with reference to study objectives	8-10
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10
Generalisability	21	Discuss the generalisability (external validity) of the study results	10
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	11

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Cardiovascular related conditions and risk factors in primary care for deprived communities before and during the COVID-19 pandemic: an observational study in Northern England

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Cardiovascular related conditions and risk factors in primary care for deprived communities before and during the COVID-19 pandemic: an observational study in Northern England

Yu Fu[1,2*], Chris Price[1,2], Shona Haining[3], Bob Gaffney[3], David Julien[4], Paula Whitty[1,5], Julia L Newton[2,6]

[1]NIHR Applied Research Collaborative North East and North Cumbria, Cumbria, Northumberland and Tyne and Wear NHS Foundation Trust, The Clocktower Building, St Nicholas Hospital, Gosforth, Newcastle NE3 3XT, UK

[2]Population Health Sciences Institute, Faculty of Medical Sciences, Newcastle University, Newcastle upon Tyne NE1 4LP, UK

[3]North of England Commissioning Support Riverside House, Goldcrest Way, Newburn Riverside, Newcastle, NE15 8NY UK

[4]NHS South Tyneside Clinical Commissioning Group, Monkton Hall, Monkton Lane, Jarrow, NE32 5NN, UK

[5]NEQOS, North East Quality Observatory Service, Cumbria, Northumberland, Tyne and Wear NHS Foundation Trust, 1st Floor, Ridley House, Henry Street, Gosforth, Newcastle upon Tyne NE3 1DQ, UK

[6]AHSN NENC, Academic Health Science Network for North East North Cumbria, Room 2.13, Biomedical Research Building, Campus for Ageing and Vitality, Nuns' Moor Road, Newcastle upon Tyne NE4 5PL, UK

*Correspondence

Population Health Sciences Institute, Faculty of Medical Sciences, Newcastle University, Newcastle upon Tyne NE1 4LP, UK

E-mail: yu.fu@newcastle.ac.uk

ABSTRACT

Objectives

The North East of England, ranked as having the highest poverty levels and the lowest health outcomes, has the highest cardiovascular disease (CVD) premature mortality. This study aimed to compare CVD-related conditions and risk factors for deprived with other general practice (GP) populations in Northern England to England overall, before, and during COVID-19 to identify changes in recorded CVD-related risk factors and conditions and evidence-based lipid prescribing behaviour.

Design

A population-based observational study of aggregated practice-level data obtained from publicly accessible datasets.

Setting

34 practices that fall into the 15% most deprived practice populations in England were identified as the most deprived communities in North East and North Cumbria (Deep End).

Participants

Patients ≥16 registered with GP and diagnosed with any form of CVD.

Primary and secondary outcome measures

CVD-related conditions and risk factors, statin prescribing.

Results

Deep End (n= 263,830) had a smaller, younger, and more deprived population with lower levels of employment and full-time education and higher smoking prevalence. They had some higher recorded CVD-related conditions than England but lower than the non-Deep End. Atrial fibrillation (-0.9, -0.5), hypertension (-3.7, -1.3), stroke and transient ischaemic attack rates (-0.5, -0.1) appeared to be lower in the Deep End than the non-Deep End but the optimal statin prescribing rate was high (3.1, 8.2) than England.

Conclusion

Recorded CVD-related risk factors and conditions remained comparable pre and during COVID-19. These are higher in the Deep End than in England and similar or lower than the non-Deep End, with a higher optimal statin prescribing rate. However, it was not possible to control for age and sex. More work is needed to estimate the consequences of the pandemic on disadvantaged communities and to compare whether the findings are replicated in other areas of deprivation.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- This study focused on the practices that serve the most deprived populations in Northern England.
- This study analysed multiple observational publicly accessible datasets which recorded data aggregated at the GP practice level.
- It compared practice profile and CVD risk management between the deprived population practices and the rest of the GPs in the region and England overall.
- Data analysis undertaken was based on limited data available at the practice level only, without controlling for age, gender, deprivation or ethnicity.

INTRODUCTION

More than seven million people are living with cardiovascular disease (CVD)[1] in the UK. CVD accounts for a quarter of premature mortality and leads to the largest gap in healthy life expectancy[2 3]. CVD morbidity is also a major challenge for health and social care. More than 100,000 admissions per year are caused by heart attacks and more than 100,000 strokes occur in the UK each year. This places a substantial financial burden on the National Health Service (NHS) and wider society, with healthcare costs being estimated at £9 billion and costs to the UK economy at £19 billion per year[1].

Identification and assessment of CVD risk in primary care remain central to clinical guidelines in many countries[4-6]. The overall aim of treatment is to prevent CVD occurrence by reducing risk factors through optimising lifestyle and drug management. Common modifiable risk facros and comorbidities that can increase the risk of developing CVD include smoking, high cholesterol, coronary heart disease, strokes and transient ischaemic attacks (TIAs), and peripheral arterial disease[7]. However, CVD has shown significant health inequalities for people with low socioeconomic status. People in the most deprived areas in England were four times more likely to die prematurely due to CVD than those in the least deprived areas from 2017 to 2019[8]. As a result, CVD has been identified as a clinical priority by Core20PLUS5 (a national NHS England and NHS Improvement approach to support the reduction of health inequalities)[9] and the latest NHS Long Term Plan, which included a major ambition to prevent 150,000 heart attacks, strokes, and dementia cases over the next decade[10]. The plan has also defined new actions to address health inequalities in which all national programmes and local areas are required to set out specific measurable goals and mechanisms contributing to reducing health inequalities. The NHS has also set up the national CVD Prevention programme[2] which aims to develop targeted interventions to minimise risk factors by maximising diagnosis and treatment, accompanied by the GP contract to commission a new national CVD prevention audit for primary care[11], in collaboration with the British Heart Foundation, the Stroke Association, Academic Health Science Networks (AHSNs) and (the former) Public Health England (PHE).

CVD and its risk factors are common comorbidities in patients with COVID-19[12-15] and associated with poorer COVID-19 outcomes and higher mortality[16]. There are early indications that COVID-19 restrictions may have led to a significant, unintended reduction in detection and treatment reviews of CVD risk factors. A study in the UK suggested a 43% reduction in new diagnoses of CVD and a 30-52% decrease in prescribing cardiovascular medications between March and May 2020[17]. Evidence is accumulating that the COVID-19 pandemic has also led to worsening of health inequalities[18]. Research pre COVID-19 had already suggested that attendance at CVD screening assessments was lower in individuals with high deprivation scores who are also more likely to have a higher CVD risk[19], indicating potential unmet needs and under-diagnosis of CVD in disadvantaged communities. CVD has also shown a disproportionate impact on people living in different geographic locations. The North East of England, consistently ranked as having the highest poverty levels and the lowest health outcomes[20], has the highest CVD premature mortality, a close second to the North West compounded by the pandemic[21]. With this background, it is important to explore whether existing inequalities have been exacerbated during COVID-19 in the region,

and therefore whether individuals in areas of higher deprivation face widening disadvantages and worse CVD outcomes going forward.

Using publicly available data, this study aimed to compare CVD-related risk factors and conditions, evidence based lipid prescribing behaviour and other practice characteristics, in the most deprived general practice populations in the North East and North Cumbria (NENC) region with other practices in the region and England, before and during the COVID-19 pandemic.

METHODS

This is a population based observational study comparing retrospective data from practices in deprived communities, practices in non-deprived communities and national practice-level data from the year before the COVID-19 pandemic started (April 2019 to March 2020) and the first year of the COVID-19 pandemic (April 2020 to March 2021). This data was obtained from publicly accessible datasets only.

Setting

There are 283 practices with approximately 2.4 million registered patients in the region. A total of 34 practices (with 263,830 registered patients) that fall into the 15% most deprived practice populations ranked in the lowest indices of multiple deprivation (IMD) decile in England have previously been identified as the Deep End practices in the North East and North Cumbria (https://deependnenc.org/), according to the definition used in the Scottish Deep End project[22]. These practices form the Deep End network in the NENC, and the network aims to improve and change the way primary care is delivered to the most deprived populations, to meet patients' needs and to reduce health inequalities. The practices described as 'Non-Deep End' practices (with 2,118,633 registered patients) are the rest of the GP practices located in the NENC region.

Data sources

Practice characteristics

A summary of practice characteristics for Deep End, non-Deep End and practices across England was obtained from the GP Practice Profiles in the Office for Health Improvement and Disparities (OHID)'s Fingertips tool - a large publicly available public health data collection where data is organised into themed profiles (https://fingertips.phe.org.uk)[23]. Profiles that update annually are generated for all practices in Quality and Outcomes Framework (QOF) that contains indicators calculated for GP practices in key areas of clinical care and public health (accessed via NHS Digital) to support GPs, primary care networks, clinical commissioning groups and local authorities to ensure appropriate healthcare services are provided for their local population. Variables included practice list size, Index of Multiple Deprivation (IMD), age breakdown of registered population, Income Deprivation Affecting Children Index (IDACI), Income Deprivation Affecting Older People Index (IDAOPI), patient satisfaction (from the GP patient survey), total QOF points, sex breakdown of life expectancy and percentage of patient with caring responsibilities.

CVD-related risk factors and CVD conditions: CVD registers and prevalence

Practice level data was downloaded from publicly available QOF[24] 2019/20 cardiovascular group data, covering recorded CVD-related risk factors (estimated smoking prevalence, hypertension (HYP)) and CVD conditions (coronary heart disease (CHD), atrial fibrillation (AF), heart failure (HF), left ventricular systolic dysfunction (LVSD), peripheral arterial disease (PAD), and stroke and transient ischaemic attack (STIA)). Each condition was analysed separately. Raw prevalence percentages for the seven conditions were calculated as the number of patients on the practice disease register divided by practice list size.

Statin prescription

Data on statin therapy (low intensity, medium intensity, and total statins) was downloaded from publicly available OpenPrescribing[25] which gives free and open access to monthly prescription data at every GP practice in England.

High-intensity statins are recognised as the most appropriate evidence based treatment for those with hypercholesterolaemia who have not responded to lifestyle modification[26] with the proportion of high-intensity statin prescribing of overall statin used as a surrogate marker for evidence based approaches to lipid management. High-intensity statins were calculated by subtracting low and medium intensity statins from the total statins, which was then divided by the total statins.

Population

The study population was patients aged 16 and above who have registered with the 34 Deep End practices in the NENC as recorded on the QOF from 2019 to 2020. The study comparators were the patients registered in non-Deep End practices in the region and all registered patients in England where data was available for the same time period.

Data analysis

Primary outcomes were (a) the comparison of prevalence of CVD-related risk factors and conditions between Deep End practices, non-Deep End and all-England practices (b) comparison of statin prescribing rates and (c) the change in the prevalence of CVD-related risk factors and conditions in these groups of practices pre and during COVID. GP practice code was used to link data across all datasets. Due to the nature of the aggregated data available from the public sources used (Fingertips[23] and QOF), it was not possible to control any of the comparisons for age, gender, deprivation or ethnicity. Descriptive statistics, using means, standard deviations, and range, were used to compare the practice profile of the 34 Deep End practices with non-Deep End in the region and the England average level. The prevalence of risk factors, conditions and statin prescribing were analysed with an appropriate statistical test (i.e., two-sample t-test, single sample t-test, and paired t-test), which yielded p values that indicated the statistical significance of any differences between Deep End, non-Deep End and England level, and over time (pre and during COVID). There were no missing values in the practice level data obtained from the publicly available datasets for analyses in this study.

Patient and Public Involvement Statement

Due to the nature of this study being a fully data-based analysis based on the existing datasets, there was no specific involvement of patients or the public in the design or

conduct of the study. However, results will be widely shared via the Public Involvement and Community Engagement network for the NIHR Applied Research Collaboration NENC that brings together six regional universities, the NHS, health and social care providers, local authorities, the voluntary sector, community groups, members of the public and others.

RESULTS

Characteristics of the Deep End practices compared to non-Deep End and England

As shown in Table 1, on average the 34 Deep End practices had a list size of 7760 which is smaller than the average seen in non-Deep End practices and England average[27]. The Deep End practices had significantly higher levels of deprivation compared to the non-Deep End (46.4 vs 26.7) and England practices (46.4 vs 21.7), with deprivation scores around twice as high as the England average in the NENC Deep End practices. This highlighted that NENC practices in general were more deprived. The age profile of those registered in the Deep End was different compared to both the non-Deep End NENC practices and England overall, with a significantly lower proportion of those aged over 85 in the Deep End and an apparent shift towards younger age groups. Deprivation was also significantly higher for those younger and older groups in the Deep End Practices in NENC when assessed using the Income deprivation for children and older people. As explained earlier, despite these very clear differences in the demographic make-up of Deep End vs non-Deep End and all-Englandpractices, it was not possible to control any of the comparisons in this paper for these factors.

Also as expected, life expectancy for those living in the Deep End was significantly lower in both males and females, with males living on average 3.2 and 4.5 years and females 2.8 and 3.8 years less in the Deep End compared to the non-Deep End practices and England respectively.

There were comparable proportions of those in the Deep End practices with caring responsibilities compared to the non-Deep End practices (18.0% vs 18.6%) and England (18.0% vs 17.0%). Lower proportions of people registered in the Deep End practices (6.7% and 12% less than the non-Deep End and England practices respectively) were in paid work or full-time education and more were unemployed (6.7% and 7.3% more than the non-Deep End and England practices respectively).

In the GP patient survey data, patients in the NENC region were found to be more satisfied with their GP practices compared to England, specifically with ‘phone access, appointment times and overall experience of appointment. This was the case across the board for both patients from Deep End and non-Deep End practices.

Over 2.5% and 7% more of those registered with a Deep End Practice had a long-term condition compared to the non-Deep End (59.7% vs 57.1%) and England levels (59.7% vs 52.4%) respectively and the total QOF points achieved were lower than non-Deep End practices (95.4 vs 97.4) but comparable with the England average (95.4 vs 95.6).

Table 1 NENC Deep End practice (n=34) characteristics compared to NENC non-Deep End and England level practices

Characteristics	Deep End practices		Non-Deep End practices		95 % CI Mean diff (DE vs non-DE)	England	P value[$] (DE vs England)
	Mean (SD)	Range	Mean (SD)	Range		Mean	
Practice list size (Oct 2020)	7760 (5238)	(1337, 26551)	8509 (4730)	(1668, 39075)	(-2474 to 972)	8757[+]	
IMD scores 2019	46.4 (7.8)	(34.2, 67.4)	26.7(8.7)	(8.5, 42.7)	(16.6 to 22.8)**	21.7	**
% Patients, 0-4 yrs, 2021	5.7 (1.0)	(3.6, 8.2)	4.7 (1.0)	(0.9, 8.8)	(0.7 to 1.4)**	5.1	**
% Patients, 5-14 yrs, 2021	12.7 (2.5)	(8.7, 21.1)	11.0 (1.9)	(1.2, 17.3)	(0.9 to 2.3)**	11.8	*
% Patients, under 18 yrs, 2021	21.7 (3.5)	(14.9, 33.4)	18.9 (3.2)	(2.4, 32.2)	(1.7 to 4.0)**	20.2	*
% Patients, 65 yrs+, 2020	14.8 (5.1)	(0.4, 22.9)	20.4 (5.2)	(1.1, 34.5)	(-7.5 to -3.8)**	17.4	*
% Patients, 85 yrs+, 2020	1.5 (0.6)	(0.0, 2.7)	2.4 (0.7)	(0.1, 4.3)	(-1.1 to -0.5)**	2.1	**
IDACI, under 16 yrs, 2019	0.3 (0.1)	(0.2, 0.5)	0.2 (0.1)	(0.0, 0.3)	(0.1 to 0.2)**	0.2	**
IDAOPI, 60+ yrs, 2019	0.3 (0.1)	(0.2, 0.4)	0.2 (0.1)	(0.1, 0.4)	(0.1 to 0.1)**	0.1	**
Female life expectancy 2013-17	79.3 (1.4)	(76.0, 82.1)	82.1 (1.6)	(78.8, 88.3)	(-3.4 to -2.2)**	83.1	**
Male life expectancy 2013-17	75.0 (1.4)	(71.9, 77.6)	78.2 (1.9)	(74.7, 83.6)	(-3.8 to -2.5)**	79.5	**
% Patients with caring responsibility, 2020	18.0 (5.7)	(3.2, 29.3)	18.6 (4.5)	(2.8, 33.7)	(-2.2 to 1.1)	17.0	
% Paid work or full-time education, 2020	51.7 (8.9)	(15.6, 64.1)	58.4 (7.4)	(33.9, 79.1)	(-9.4 to -3.9)**	63.7	**
% Unemployed, 2020	11.2 (10.4)	(2.2, 57.4)	4.5 (3.7)	(0.0, 17.5)	(4.9 to 8.5)**	3.9	**
% Patients positive experiences, 2020	83.8 (7.0)	(70.7, 95.0)	84.6 (9.3)	(55.1, 100.0)	(-4.0 to 2.5)	81.8	
% Patients satisfied with phone access, 2020	72.1 (19.6)	(33.4, 98.4)	74.3 (19.2)	(21.3, 100.0)	(-9.1 to 4.7)	65.2	*
% Patients satisfied with appointment times, 2020	69.4 (9.6)	(53.6, 88.9)	67.1 (14.0)	(26.2, 96.8)	(-2.5 to 7.2)	63.0	**
% Patients good overall experience of appointment, 2020	71.8 (10.8)	(53.9, 95.1)	70.1 (14.1)	(33.7, 98.5)	(-3.3 to 6.6)	65.5	*
% Patients with a long-standing cond, 2020	59.7 (9.9)	(31.4, 78.1)	57.1 (7.4)	(26.3, 73.7)	(-0.2 to 5.4)	52.4	**
Total QOF points	95.4 (9.3)	(47.8, 100.0)	97.4 (2.7)	(84.9, 100.0)	(-3.5 to -0.6)**	95.6	

IMD Score: the larger the score, the more deprived the area; Total QOF points: defined as a proportion of all achievable QOF points across all domains[23 24].
IMD: Index of Multiple Deprivation; IDACI: Income Deprivation Affecting Children Index; IDAOPI: Income Deprivation Affecting Older People Index
*p<0.05; **p<0.001; [$] practice level data for England is not publicly accessible, one sample t test was conducted to compare the sample against the population mean.
[+]Published by NHS Digital for October 2019[27]

Cardiovascular disease (CVD) and CVD-related risk factor prevalence in the Deep End practices compared to non-Deep End and England practices

As shown in Table 2, when considering individual CVD risk factors, recording of smoking prevalence was significantly higher in Deep End practices compared to the rest of the region and England. However, the recorded HYP prevalence was lower in the Deep End practices than that in the non-Deep End but comparable with the England average.

Looking at CVD-related conditions, interestingly, lower recorded CHD prevalence in Deep End practices compared to the non-Deep End but higher prevalence compared to England. The prevalence of AF was also lower in the Deep End practices compared to regional non-Deep End practices but was similar to England. Prevalences for HF were comparable across the Deep End, regional non-Deep End, and England. Despite no difference in rates for LVSD and PAD between the Deep End and regional non-Deep End practices, Deep End practices had higher prevalence compared to England. However, the pattern of prevalence was different when it came to STIA with the Deep End having lower prevalence compared to non-Deep End but similar to England. As noted earlier, none of these comparisons of CVD-related conditions between the different groups of practices have been controlled for age, sex or deprivation.

There was no significant change in any of the identified CVD-related risk factors pre and during COVID-19. However it was noted that the range for each risk factor in regional non-Deep End practices was greater.

Table 2 Cardiovascular diseases and CVD-related risk factor prevalence in NENC Deep End practices compared to NENC non-Deep End and England practices

Risk factors	Deep End practices		Non-Deep End practices		95% CI	England		95% CI
	Mean (SD)	Range	Mean (SD)	Range	Mean diff (DE vs non-DE)	Mean (SD)	Range	Mean diff (DE vs Eng)
Smoking prev.(%)								
Register 19/20	24.5 (4.9)	(17.8, 39.3)	16.3 (4.5)	(4.7, 27.5)	(6.5 to 9.8)**	16.5 (-)		(6.3 to 9.7)**
Register 20/21	23.8 (4.5)	(17.6, 37.5)	15.8 (4.4)	(4.5, 26.4)	(6.4 to 9.6)**	15.9 (-)		(6.3 to 9.5)**
95% CI Mean diff	(-2.9 to 1.6)		(-1.3 to 0.3)					
HYP								
Register (n) 19/20	1131 (856)	(11, 4504)	1373 (717)	(164, 3530)	(-506 to 22)	1279 (868)	(0, 11720)	(-440 to 145)
Register (n) 20/21	1136 (876)	(14, 4500)	1392 (861)	(176, 8858)	(-567 to 54)	1287 (889)	(0, 11888)	(-450 to 149)
95% CI Mean diff	(-414 to 424)		(-120 to 159)			(-22 to 38)		
Prev. (%) 19/20	14.2 (4.3)	(0.9, 21.2)	16.6 (3.2)	(1.0, 29.3)	(-3.6 to -1.2)**	14.4 (4.1)	(0, 87.9)	(-1.5 to 1.2)
Prev. (%) 20/21	13.9 (4.1)	(1.0, 20.7)	16.5 (3.2)	(1.0, 28.8)	(-3.7 to -1.3)**	14.2 (4.0)	(0, 61.3)	(-1.6 to 1.1)
95% CI Mean diff	(-2.3 to 1.7)		(-0.7 to 0.4)			(-0.3 to 0.0)		
AF								
Register (n) 19/20	143 (112)	(0, 539)	202 (112)	(12, 634)	(-99 to -18)*	186 (150)	(0, 1445)	(-94 to 7)
Register (n) 20/21	146 (122)	(0, 517)	206 (113)	(14, 1346)	(-107 to -12)*	189 (155)	(0, 1424)	(-95 to 9)
95% CI Mean diff	(-53 to 60)		(-17 to 26)			(-2 to 8)		
Prev. (%) 19/20	1.7 (0.6)	(0, 2.7)	2.4 (0.6)	(0.1, 4.2)	(-0.9 to -0.5)**	2.0 (1.0)	(0, 28.7)	(-0.6 to 0.1)
Prev. (%) 20/21	1.7 (0.6)	(0, 2.7)	2.4 (0.6)	(0.1, 4.3)	(-0.9 to -0.5)**	2.0 (1.1)	(0, 28.2)	(-0.7 to 0.1)
95% CI Mean diff	(-0.3 to 0.3)		(-0.1 to 0.1)			(0.0 to 0.0)		
CHD								
Register (n) 19/20	302 (221)	(3, 1078)	348 (192)	(25, 977)	(-117 to 24)	281 (204)	(0, 2392)	(-48 to 90)
Register (n) 20/21	301 (230)	(3, 1067)	349 (231)	(24, 2447)	(-131 to 35)	282 (209)	(0, 2447)	(-51 to 90)
95% CI Mean diff	(-110 to 109)		(-36 to 39)			(-6 to 8)		
Prev. (%) 19/20	3.8 (1.3)	(0.3, 6.4)	4.2 (0.9)	(0.2, 6.2)	(-0.7 to 0.0)*	3.2 (1.2)	(0, 31.1)	(0.2 to 1.1)*
Prev. (%) 20/21	3.7 (1.2)	(0.2, 5.9)	4.1 (0.9)	(0.1, 6.2)	(-0.7 to -0.1)*	3.1 (1.2)	(0, 30.0)	(0.2 to 1.0)*
95% CI Mean diff	(-0.7 to 0.5)		(-0.2 to 0.1)			(-0.1 to 0.0)		

HF								
Register (n) 19/20	86 (82)	(1, 405)	104 (73)	(4, 471)	(-45 to 8)	81 (70)	(0, 1124)	(-19 to 29)
Register (n) 20/21	91 (92)	(1, 410)	106 (92)	(5, 1047)	(-48 to 18)	84 (74)	(0, 1047)	(-18 to 32)
95% CI Mean diff	(-37 to 47)		(-13 to 16)			(0 to 5)		
Prev. (%) 19/20	1.0 (0.5)	(0.1, 2.2)	1.2 (0.5)	(0, 3.1)	(-0.4 to 0)	0.9 (0.5)	(0, 13.4)	(0 to 0.3)
Prev. (%) 20/21	1.1 (0.6)	(0.1, 2.8)	1.2 (0.5)	(0, 2.9)	(-0.3 to 0)	0.9 (0.5)	(0, 12.1)	(0 to 0.3)
95% CI Mean diff	(-0.2 to 0.3)		(-0.1 to 0.1)			(0.0 to 0.0)		
LVSD								
Register (n) 19/20	45 ((51)	(0, 259)	59 (50)	(3, 309)	(-31 to 5)	33 (39)	(0, 532)	(0 to 26)
Register (n) 20/21	51 (62)	(0, 265)	60 (60)	(3, 625)	(-31 to 12)	36 (43)	(0, 670)	(0 to 29)*
95% CI Mean diff	(-22 to 33)		(-8 to 11)			(2 to 4)		
Prev. (%) 19/20	0.6 (0.4)	(0, 1.6)	0.7 (0.4)	(0, 2.3)	(-0.3 to 0)	0.4 (0.3)	(0, 3.4)	(0.1 to 0.3)**
Prev. (%) 20/21	0.6 (0.5)	(0, 2.2)	0.7 (0.4)	(0, 2.1)	(-0.2 to 0.1)	0.4 (0.3)	(0, 5.6)	(0.1 to 0.3)**
95% CI Mean diff	(-0.2 to 0.2)		(-0.1 to 0.1)			(0.0 to 0.0)		
PAD								
Register (n) 19/20	76 (55)	(0, 251)	77 (45)	(3, 228)	(-17 to 16)	54 (45)	(0, 747)	(7 to 37)*
Register (n) 20/21	76 (56)	(0, 243)	76 (51)	(4, 487)	(-19 to 19)	54 (46)	(0, 720)	(6 to 37)*
95% CI Mean diff	(-27 to 27)		(-10 to 7)			(-1 to 2)		
Prev. (%) 19/20	0.9 (0.3)	(0.0, 1.8)	0.9 (0.3)	(0.0, 2.4)	(-0.1 to 0.1)	0.6 (0.4)	(0.0, 12.3)	(0.2 to 0.5)**
Prev. (%) 20/21	0.9 (0.3)	(0.0, 1.7)	0.9 (0.3)	(0.0, 2.2)	(-0.1 to 0.1)	0.6 (0.4)	(0.0, 21.4)	(0.2 to 0.5)**
95% CI Mean diff	(-0.2 to 0.1)		(-0.1 to 0.0)			(0.0 to 0.0)		
STIA								
Register (n) 19/20	162 (125)	(0, 617)	197 (107)	(19, 529)	(-75 to 4)	163 (123)	(0, 1385)	(-43 to 40)
Register (n) 20/21	167 (135)	(0, 651)	200 (127)	(20, 1240)	(-79 to 13)	166 (128)	(0, 1427)	(-42 to 44)
95% CI Mean diff	(-57 to 68)		(-18 to 24)			(-1 to 8)		
Prev. (%) 19/20	2.0 (0.6)	(0.0, 2.9)	2.4 (0.5)	(0.1, 3.5)	(-0.6 to -0.2)**	1.8 (0.8)	(0.0, 21.9)	(-0.1 to 0.5)
Prev. (%) 20/21	2.0 (0.6)	(0.0, 2.9)	2.3 (0.5)	(0.1, 3.9)	(-0.5 to -0.1)**	1.8 (0.9)	(0.0, 26.4)	(-0.1 to 0.5)
95% CI Mean diff	(-0.3 to 0.3)		(-0.1 to 0.1)			(0.0 to 0.0)		

*p<0.05; **p<0.001

Prescribing of statin therapy in Deep End practices compared to the non-Deep End and England

As shown in Table 3, the percentage of high intensity was comparable between the Deep End and the non-Deep End, but significantly higher than England average.

The percentage of high-intensity statins had increased during COVID compared to the year pre-COVID, with a significant increase for regional non-Deep End practices and England practices but not for Deep End practices.

Table 3 Statin therapy in NENC Deep End practices compared to NENC non-Deep End and England practices

Statin	Deep End practices		Non-Deep End practices		95% CI Mean diff (DE vs non-DE)	England		95% CI Mean diff (DE vs Eng)
	Mean (SD)	Range	Mean (SD)	Range		Mean (SD)	Range	
Total intensity (n)								
19/20	14068 (9124)	(152, 41312)	15763 (8623)	(1133, 46517)	(-4819 to 1431)	-	-	
20/21	14872 (10339)	(172, 44602)	16204 (9101)	(1315, 54288)	(-4662 to 1999)	-	-	
95% CI Mean diff	(-3918 to 5525)		(-1120 to 2002)					
High-intensity (n)								
19/20	8922 (6659)	(100, 28369)	10104 (5984)	(821, 36007)	(-3367 to 1001)	-	-	
20/21	10024 (8047)	(127, 34588)	10812 (6541)	(1011, 42851)	(-3212 to 1636)	-	-	
95% CI Mean diff	(-2474 to 4679)		(-396 to 1812)					
High-intensity (%)								
19/20	61.9 (10.4)	(46.8, 86.7)	63.8 (10.2)	(35.4, 91.0)	(-5.5 to 1.8)	56.4 (5.0)	(44.8, 76.5)	(2.9 to 8.1)**
20/21	65.4 (10.4)	(47.3, 87.4)	66.4 (9.5)	(36.1, 91.2)	(-4.5 to 2.4)	59.7 (4.9)	(48.2, 78.8)	(3.1 to 8.2)**
95% CI Mean diff	(-1.6 to 8.5)		(0.9 to 4.4)*			(2.0, 4.6)**		

*p<0.05; **p<0.001

DISCUSSION

This observational study examined practice profiles and recorded CVD-related risk factors and conditions for Deep-End practices in the NENC and compared these with the regional non-Deep End practices and England before and during the COVID-19 period, using publicly accessible datasets.

This study has found that Deep End practices had on average a smaller and younger population than other practices in the region and nationally[27]. As expected, the overall deprivation score is high in Deep End populations with those below age 16 and over age 60 also being scored higher on income deprivation. The Deep End populations also had lower levels of paid employment or full-time education and higher levels of unemployment. There was clear evidence of higher health needs in the Deep End practices, with higher levels of long-term conditions and poorer life expectancy than both non-Deep End practices and England. Despite that, patients in the region reported higher satisfaction with their practices compared to England across the board for both Deep End and non-Deep End practices. In

addition, Deep End practitioners have achieved slightly lower results measured by total QOF points.

This study also found that, consistently across the region, for both the Deep End and non-Deep End practices, patients reported a better overall experience of making appointments than in England. This contradicts previous findings from the GP patient survey that the deprived populations were non-likely to report a positive experience of accessing general practice or a good overall experience[28 29]. It is worth noting that we did not have data on respondents to the survey nor response rate to these questions, therefore comparisons across practices were not possible. Also, patient satisfaction levels were not adjusted for age or gender in this study. Given poorer experience reported in the most deprived populations elsewhere, this finding requires further exploration, which may consider whether primary care staff working in some of the most disadvantaged communities in the region are achieving above-average service delivery despite these circumstances and the impact on staff health.

Despite disruptions to essential health services caused by the pandemic, this study did not observe any significant changes in CVD-related risk factors or conditions regionally and nationally. There may be some reasons for this. First, this study provided a descriptive analysis of practice level data without controlling for demographic variables (particularly age, as Deep End practices have an average younger population). Second, evidence of the wider lifestyle, health and care consequences of the pandemic are still emerging especially for the most disadvantaged communities, hence it may still be too early to observe any significant impact. Third, given that it is known that CVD risk factors are usually more common in deprived areas[8] and if the lower recorded prevalences (and lack of change in prevalences) found in this study were not due only to the inability to control for age, one alternative explanation could include under or missed-recording (e.g. due to potential underdiagnosis); however, the finding needs further exploration including using individual-level data which can be adjusted for demographic variables.

The Deep End practices had a higher smoking prevalence. A multi-level, multi-component, cross-party, evidence based programme targeting the whole systems and local environments is needed to reduce inequalities in smoking prevalence[30]. Interventions focusing solely on individual behaviour change and providing information or education[31] without taking into consideration of issues of differential access, use and outcome of preventive healthcare services across disadvantaged groups[30] are likely to exacerbate these inequalities.

The Deep End patients had lower recorded hypertension and CVD-related conditions overall compared to the non-Deep End patients. However, when compared to the national level the Deep End showed a similar recorded HYP and STIA prevalence and a higher level of many CVD-related conditions (CHD, LVSD, and PAD). This has confirmed existing evidence that the North East of England is an area of high CVD risk[32]. However, the inability to control for age makes this impossible to interpret and the finding may be attributed to differences between the Deep End and England average in the characteristics of the population, particularly age. Further research is needed to compare risk factors and CVD-related conditions in Deep End practices adjusted for the characteristics of the population. Given the positive association between deprivation and HYP, CHD and STIA prevalences [33 34 35 36], the lack of a difference in recorded prevalence between Deep End and non-Deep End needs to be explored further. As

previously noted, none of the comparisons was adjusted by age and therefore the finding of lower recorded CVD-related conditions in Deep End compared to non-Deep End practices could be largely attributed to the larger proportion of young people in the Deep End practices.

There appeared to be a lower recorded level of AF in those living in the Deep End. Although recent studies seemed to observe a rising trend of AF with a deprivation score after controlling for age and gender[37], it is worth noting that there is a lack of association of AF with deprivation shown in an observational study examining the prevalence and treatment of AF in general practice in the UK between 2000 to 2016. It found that a lower proportion of patients with AF were in the most materially deprived areas than the least deprived areas with a steady increase in the age-gender standardised AF prevalence[38]. In addition, when adjusting for age, patient-level socioeconomic status, and comorbidities such as CHD, hypertension, obesity, HF, and diabetes, previous research has concluded that socioeconomic disparities and deprivation are not independently associated with AF[39].

The rate of high-intensity statin prescribing was recorded as lower than the non-Deep End but higher in the Deep End pre and during COVID-19 than in England. This indicates the high risk of CVD in the region and the likelihood of underdiagnosed CVD related risk factors or CVD conditions in the Deep End practices. Higher high-intensity statin prescribing in the region may also reflect that practitioners are actively treating CVDs with greater compliance with the clinical guideline for the use of high-intensity statins[40], which could be the consequence of the Accelerated Access Collaborative (AAC) Lipid Management Rapid Uptake Product (RUP) programme initiated and supported Statin Intolerance Pathway endorsed by NICE[41].

This study has several limitations that impact the applicability of the findings. It was a retrospective study conducted using multiple observational publicly accessible datasets which recorded data aggregated at the GP practice level. Limitations and factors influencing the quality of those datasets apply to this study, which could include sampling bias, recall bias, confounding by indication and changes in practice and/or disease biology. Despite that, the findings are considered hypothesis generating as this study provided valuable information on practice characteristics and CVD-related risk factors and conditions in a real-world setting which is essential to the evidence base required for CVD optimisation in deprived communities. Due to the inability to access patient-level data, it was not possible to control comparisons for age, gender, deprivation or ethnicity. Also, the analyses based on average values calculated at pre-defined time points can produce biased estimates due to potential missing data in patient-level data. In addition, QOF data is based on recorded data within practices to meet QOF requirements and the QOF is a voluntary reward and incentive programme, which has been reported not to be effective in narrowing health inequality[42]. Although this study focused on only one region in the UK, it did enable a high-level view of CVD-related characteristics of practices in the region with the poorest health outcomes.

CONCLUSION

This descriptive study finds that CVD-related risk factors and conditions remain comparable pre and during COVID-19 across Deep End, non-Deep End and all-England practices. Deep End practices present higher CVD-related conditions compared to England but similar or lower compared to the regional non-Deep End practices, with a higher smoking prevalence and evidence based lipid prescribing rate. However, these findings should be interpreted with caution due to the quality of data and limited analyses possible that may be largely confounded by the inability to control for demographic variables in the comparisons. An

alternative explanation could include potential underdiagnosed and underrecorded CVD - related conditions, potentially leading to unmet needs. However, these findings require further exploration for wider implementation or evidence generation. Future work is needed using individual-level data controlled for key demographic variables to estimate the health and care consequences of the pandemic on disadvantaged communities and to further compare whether findings are replicated in other areas of deprivation. In addition, research with qualitative methods would be helpful to explore how health professionals manage CVD-related risk factors and conditions in routine practice for deprived populations and in general how they manage to deliver higher satisfaction.

CONTRIBUTIONS

YF, JN, CP & PW developed the hypothesis and created the concept. YF performed the analysis and created the initial report. YF & JN wrote the initial draft of the manuscript. SH, BG and DJ commented and edited the data analysis and discussion sections. All reviewed and approved the subsequent drafts of the manuscript. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

DATA SHARING

Data is publicly available via Public Health England, NHS Digital and OpenPrescribing.net.

ETHICS APPROVAL

Research ethical approval was not required for this study as all data is publicly available.

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COMPETING INTEREST

None.

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*5-6*
Bias	9	Describe any efforts to address potential sources of bias	n/a
Study size	10	Explain how the study size was arrived at	n/a
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	n/a
		(*d*) If applicable, explain how loss to follow-up was addressed	n/a
		(*e*) Describe any sensitivity analyses	n/a
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6-7
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6-7
		(b) Indicate number of participants with missing data for each variable of interest	n/a
		(c) Summarise follow-up time (eg, average and total amount)	6-7
Outcome data	15*	Report numbers of outcome events or summary measures over time	6-7
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	6-7, Tables 1-3
		(*b*) Report category boundaries when continuous variables were categorized	n/a
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	n/a
Discussion			
Key results	18	Summarise key results with reference to study objectives	8-10
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10
Generalisability	21	Discuss the generalisability (external validity) of the study results	10
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	11

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.