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Does recruiting patients to diabetes prevention programmes via primary care reinforce existing inequalities in care provision between general practices? A retrospective observational study

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ABSTRACT

Background Primary care plays a crucial role in identifying patients' needs and referring at-risk individuals to preventive services. However, well-established variations in care delivery may be replicated in this prevention activity.

Objective To examine whether recruiting patients to the English NHS Diabetes Prevention Programme via primary care reinforces existing inequalities in care provision between practices, in terms of clinical quality, accessibility and resources.

Methods We generated annual practice-level counts of referrals across the first 4 years of the programme (June 2016 to March 2020). These were linked to 15 indicators of practice clinical quality, access and resources measured during 2018/19. We used random effects Poisson regressions to examine associations between referrals and these indicators, controlling for practice and population characteristics, for 6871 practices in England.

Results On average, practices made 3.72 referrals per 1000 population annually and rates varied substantially between practices. Referral rates were positively associated with the quality of clinical care provided. A 1 SD higher level of achievement on Quality and Outcomes Framework diabetes indicators was associated with an 11% (95% CI: 8% to 14%) higher referral rate. This positive association was consistent across all five clinical quality indicators. There was no association between referral rates and accessibility, overall payments or staffing. Associations between referrals and receiving different supplementary payments over the core contract were mixed, with 8%–11% lower referral rates for some payments but not for others.

Conclusion Recruiting patients to diabetes prevention programmes via primary care reinforces existing inequalities between general practices in the clinical quality of care they provide. This leaves patients registered with practices providing lower quality clinical care even more disadvantaged. Providing additional support to lower quality practices or using alternative recruitment methods may be necessary to avoid differential engagement in prevention programmes from widening these variations and potential health inequalities further.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Primary care plays an important role in identifying at-risk individuals and referring them to prevention programmes, such as the NHS Diabetes Prevention Programme.

⇒ The adequacy of this activity may be affected by inequalities between practices in the quality of primary care services provided.

WHAT THIS STUDY ADDS

⇒ Practice-level variation in referral rates to the NHS Diabetes Prevention Programme was consistently related to various indicators of the clinical quality of primary care services, but not to accessibility or the level of resources.

⇒ In particular, the clinical quality of diabetes care provided by practices was positively associated with their level of engagement with diabetes prevention.

⇒ Therefore, recruiting patients to diabetes prevention programmes via primary care reinforces existing inequalities in care provision, leaving patients registered with practices providing lower quality care even more disadvantaged.

INTRODUCTION

It has been widely documented for several decades that there are large unwarranted variations in healthcare provision and use across regions and providers.[1 2] Variations in primary care provision have been found to exist both geographically and

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Commissioners may need to provide additional support to lower quality practices or pursue alternative methods of recruitment if they are to avoid further widening existing inequalities in care provision.

between primary care providers, across a variety of factors including clinical quality, staffing and capacity, and patient experience.[3] Unwarranted variations in the provision of healthcare call into question the equity and efficiency of resource allocation and use.[2] Such inequalities in primary care provision and quality have the potential to contribute to health inequalities,[4 5] as the inverse care law is known to exist in most healthcare systems whereby people with greater need, often those who are socially disadvantaged, receive less or lower quality healthcare.[6 7]

The rising burden of long-term conditions has highlighted the importance of disease prevention and health promotion globally. This had led to the implementation of strategies to reduce the preventable burden of non-communicable diseases internationally,[8] with many high-income countries trialling lifestyle interventions to prevent diabetes.[9–11] More recently, such interventions have been adapted for low-income and middle-income country settings in Africa.[12] Yet, there is a lack of evidence on potential variations in the provision of preventative care.[13] There are clear socioeconomic disparities in preventable mortality.[14] Acting to prevent ill health could therefore improve population health and support health equity.[15]

Implementation of prevention programmes requires the identification and targeting of at-risk groups. As the first point of contact in most healthcare systems, primary care is well placed to undertake this activity.[16] However, there is a risk that using primary care to identify and recruit patients to prevention programmes may reinforce existing inequalities in care provision between general practices. For example, practices already providing high quality primary care may engage more in the identification and referral process, leaving patients registered with lower quality practices at an even greater disadvantage.

We aim to examine whether recruiting to prevention programmes via primary care reinforces existing inequalities in care provision between practices. We investigate the case of the NHS Diabetes Prevention Programme (DPP) in England. While similar lifestyle interventions have been trialled in many countries, this is the first diabetes prevention programme to be implemented on a national scale. The NHS DPP is a behavioural intervention for individuals identified as being at high risk of developing type 2 diabetes. To avoid placing additional burden on primary healthcare services, NHS England commissioned the DPP to be run and delivered by external providers.[17] However, general practices were tasked with the identification and referral of eligible individuals into the programme.

We examine the extent to which between-practice variation in referrals to the DPP is associated with three dimensions of the quality of care provided at general practices: clinical quality, accessibility and resources available to general practices. Our primary measure of clinical quality is for the management of diabetes, but we also consider three measures of clinical quality in broader aspects.

METHODS

Study design and sample

We used a longitudinal study design to examine the association between general practice quality and annual referrals to the DPP in the first 4 financial years of the programme, 2016/17 to 2019/20. The DPP is commissioned across 41 geographically defined sites and was rolled out across sites in a series of waves.[18] Wave 1 began in June 2016 with 27 sites which covered 51% of the country or 3462 general practices.[19] The second wave began in April 2017 with an additional 13 sites, including 1752 general practices, and by April 2018 the DPP was rolled out to the whole of England.[19]

We linked and analysed data at the general practice level. We started with a master dataset of all general practices in England, containing the number of people registered with each practice on the 1 October of each year from 2016 to 2019. A total of 7603 general practices were active in at least one of the 4 years of patient list size data. We dropped practice-years in which the practice's list size was missing, where there were fewer than 1000 registered patients or where they did not appear in the diabetes audit data (599 practices). We then merged in the outcomes and explanatory variables using practice identifiers. Practices with missing values of covariates were dropped (133 practices). Our final analysis sample consists of 22 124 observations, from 6871 practices.

Outcome variables

We obtained individual-level data on referrals from the DPP minimum dataset, which contains information on all referrals received by the DPP providers. DPP providers are contractually obliged to collect these data in order to receive financial reimbursement from NHS England. We examine data covering the period 1 June 2016 to 31 March 2020, during which 526 402 referrals were received. The minimum dataset includes the date and source of referral. While individuals can self-refer to the programme, 99% of referrals come from primary care.[20] We generated annual counts of referrals received from each general practice in England in each of the four financial years. Practices in the second and third waves of the DPP were

not included in the years in which they could not refer patients to the programme.

Explanatory variables

We examined three aspects of care provision and quality at general practices: (i) clinical quality, (ii) access and (iii) resources. There are many ways to measure each of these factors. We therefore undertook several robustness checks to examine whether the results were determined by the choice of indicator. Data were not consistently available for all explanatory variables across the 4 financial years. Therefore, in each year, explanatory variables were fixed to values from the 2018/19 financial year, and we imputed any missing 2018/19 values using data from the 2017/18 financial year.

Clinical quality

The Quality and Outcomes Framework (QOF) is a pay-for-performance scheme designed to incentivise general practices to improve the quality of care provided to patients.[21] This scheme rewards practices according to their achievement against a wide set of indicators across three domains: clinical, public health and public health additional services. Data on levels of achievement on QOF measures are published annually. Within the clinical domain, there are indicators for the management of several long-term conditions, including diabetes. Diabetes indicators measure whether the practice maintains a register of patients with diabetes, as well as the percentage of patients meeting certain treatment target parameters such as the percentage of newly diagnosed patients referred to an education programme.[22] In 2018/19, the QOF diabetes indicators were worth 86 points, around 20% of the total 435 points available for the clinical QOF domain.[22]

We included the proportion of total diabetes points achieved as the primary measure of the quality of diabetes management at general practices.[23] We then examined four alternative indicators of clinical quality. The first is the proportion of patients on a practice's diabetes register for which the practice has completed the eight National Institute for Health and Care Excellence recommended diabetes care processes[24] in the previous 12 months, as recorded in the National Diabetes Audit.[25] These indicators consider the management of patients diagnosed with diabetes, rather than preventative activities of general practices. Therefore, as two further alternative clinical quality indicators, we also examined the proportion of total available points achieved on the clinical and the public health domains of the QOF. The clinical domain indicators measure overall clinical quality across a wide range of conditions. The public health domain indicators measure health promotion and prevention activities by practices such as smoking cessation.

The final measure of clinical quality we examined is the practice's Care Quality Commission (CQC) rating. The CQC is the independent regulator for health and social care services in England. They inspect general practices to monitor their performance across five core standards: safe, effective, caring, responsive and well-led, and generate an overall rating for the practice. The CQC started its programme of practice inspections in October 2014 and had inspected all practices by January 2017.[26] The CQC inspects a practice at least every 5 years. We used the practice's first CQC rating as another alternative indicator for practice clinical quality.

Access

Indicators of the accessibility of practices were obtained from the general practice patient survey (GPPS).[27] The GPPS is an annual postal survey conducted on behalf of NHS England. Participants are sampled from practice registration lists to collect patients' views and experiences of the services provided. We used the published data which were weighted by characteristics of the practice list, to ensure the representativeness of practices' registered populations.[28] As the primary measure of practice access, we used the proportion of patients that reported 'very good' or 'fairly good' experience of making an appointment (as opposed to 'neither good nor poor', 'fairly poor' or 'poor'). As alternative indicators of access, we also examined the proportions of patients who: were offered a choice of appointment; were offered a same or next day appointment; and found it 'very easy' or 'fairly easy' to get through to their practice on the phone (as opposed to 'not very easy' or 'not at all easy').

Resources

Our primary measure of practice resources is the payments made by the National Health Service (NHS) to general practices per patient weighted using the national capitation formula.[29 30] We use this as an overall measure of the resources available to general practices. To account for skewness, we used the natural logarithm of payments per weighted patient registered with the practice.

We then used two alternative indicators of practice resources. The first is a set of indicators that signal whether a practice receives additional funding from the NHS over and above that related to the standard general medical services contract. These are: whether the practice was on a personal medical services or alternative provider medical services contract rather than a general medical services contract[31]; whether the practice was able to dispense as well as prescribe to at least some of their patients; and whether the practice received additional payments over those recommended under the national allocation formula to protect the levels of income they earned prior to the introduction of that formula.[29] The second alternative indicators

measure staffing resources in terms of the number of full-time equivalent (FTE) general practitioners (GPs) and FTE nurses per 1000 patients at each practice.[32]

Control variables

We obtained data on the size and age-gender composition of the registered practice population.[33] Practice-level ethnicity composition[34] and deprivation, measured by the index of multiple deprivation,[35] were estimated based on the lower-layer super output areas where the registered patients lived.[36] We included an indicator of the rurality of the location of the practice's main surgery.[29] We also controlled for the practice prevalence of type 2 diabetes as reported in the QOF.[23] Finally, since the DPP was implemented in waves with full national coverage not available until 2018, we included indicators for whether the practice belonged to the first, second or final wave of the programme. We also included indicators for year and year-wave interactions to control for changes in capacity over time, time since the programme was introduced anywhere and time since each specific wave of implementation. All control variables were measured in the 2018/19 financial year, we imputed any missing 2018/19 values using data from the 2017/18 financial year.

Statistical methods

We first summarised the variation in referrals across practices. We examined referral rates across deciles of the key indicators of clinical quality, access and resources. We examined this across eight quantiles of achievement on the QOF diabetes indicators due to the high number of practices achieving 100%.

We used random effects Poisson regressions to model the annual counts of referrals to the DPP from each general practice, as a function of practice clinical quality, access and resources, controlling for the population and practice characteristics outlined above. Random effects were included for practices to control for unmeasured practice-specific factors. As the exposure term in these regressions, we used an estimate of the practice population potentially eligible for the DPP in each financial year. Data on the number of patients eligible for the DPP are not reliable, since the recording of non-diabetic hyperglycaemia diagnoses at general practices is inconsistent and incomplete. We therefore defined the potentially eligible population as the registered patient population at the mid-point of the financial year aged 15 and over minus the number of people with a diabetes diagnosis. We assessed the sensitivity of the results to different definitions of the at-risk population, first defining this population as the total number of patients aged 15 and over or 18 and over, and then as the number of patients aged 15 and over or 18 and over minus the number of patients diagnosed with diabetes. As we only observe referrals starting from 1 June 2016, the person time at risk is shorter in the first financial year compared with the remaining 3 years. Therefore, we adjusted the exposure term for the first financial year to be 10/12ths of the potentially eligible population in that year. Regression coefficients can be interpreted as the effect on annual rates of referral per potentially eligible patient. Coefficients are reported as incidence rate ratios. Continuous explanatory variables were standardised to z-scores, such that regression coefficients represent the change in the referral rates per patient-year associated with a 1 SD change in the explanatory variable.

Robustness checks

To ensure that the estimates are not driven by the choice of measure used for each practice provision and quality domain, we ran a series of supplementary analyses in which the three main measures were sequentially replaced with alternative indicators. For example, in the first set of these analyses, we kept the access and resource indicators as in the main model, but alternated through the five indicators of clinical quality.

RESULTS

Descriptive statistics

On average, the DPP received 3.72 referrals per 1000 potentially eligible patients per year (table 1). Referral rates varied substantially between practices, with the 25th and 75th percentiles ranging from 0.12 to 5.13 referrals per 1000 patients per year. Referral rates were relatively similar across practices in the different waves of the programme. However, there is substantial variation in referral rates between practices within each of the waves. Furthermore, even though DPP was available nationwide from 2018, we found that 487 practices did not refer any patients to the DPP in the first 4 years. Of these, 47% were third wave practices.

Clinical quality was high on average, with practices achieving a mean of 92.1% of the available QOF points for the diabetes indicators (table 1). Practice access was somewhat restricted, with an average of 69.3% of patients reporting good experience making an appointment. Practices received an average annual payment of £156 per weighted patient. Online supplemental table A1 presents descriptive statistics for the population and practice characteristics. Online supplemental figure A1 shows an upward trend in referral rates at the lower end of the quality distribution (quantiles one to four of achievement on the diabetes QOF indicators). There is no obvious trend in referral rates across deciles of access as measured by the proportion of patients reporting good experience making appointments (online supplemental figure A2). Online supplemental figure A3 shows a slight upward trend in referral rates by decile of average practice payments.

Regression results

Referral volumes were found to be significantly positively associated with clinical quality as measured by

Table 1 Descriptive statistics of referral rates, practice clinical quality, access and resources

	Mean	SD	p10	p25	p50	p75	p90
Annual rate of referrals to the DPP per 1000 patients							
All practices (n=6871)	3.72	5.73	0.00	0.12	1.63	5.13	9.81
First wave (n=3462, 50.4%)	3.87	5.78	0.00	0.18	1.80	5.29	10.16
Second wave (n=1752, 25.5%)	3.29	5.48	0.00	0.12	1.33	4.56	8.48
Third wave (n=1657, 24.1%)	3.80	5.88	0.00	0.00	1.44	5.35	10.39
Clinical quality indicators							
QOF diabetes points achieved (%)	92.12	10.25	79.38	87.91	95.79	99.88	100.00
Patients meeting all eight NICE diabetes care processes (%)	54.43	20.08	26.09	41.51	56.00	70.30	79.10
Clinical QOF points achieved (%)	96.50	5.73	91.56	95.79	98.38	99.75	100.00
Public health domain QOF points achieved (%)	97.27	6.52	89.69	98.13	100.00	100.00	100.00
Practices first CQC rating	N	%					
Outstanding or good	5720	83.20					
Requires improvement or inadequate	1113	16.20					
Not rated	38	0.60					
Accessibility indicators							
Patients reporting good experience making an appointment (%)	69.28	14.50	49.48	59.56	70.21	80.13	87.72
Patients offered a choice of appointment (%)	63.17	13.54	45.29	53.78	63.46	72.71	80.89
Patients reporting easy telephone access (%)	71.70	19.16	43.61	58.62	74.57	87.46	94.64
Patients able to get an appointment the same or next working day (%)	43.39	14.35	26.00	32.61	42.22	53.29	63.54
Resources indicators							
Average practice payment per weighted patient (£)	156.45	43.49	124.98	134.00	145.36	164.05	199.55
Log average payment per weighted patient	5.02	0.23	4.83	4.90	4.98	5.10	5.30
FTE GPs per 1000 practice population	0.56	0.37	0.28	0.40	0.53	0.69	0.86
FTE nurses per 1000 practice population	0.26	0.15	0.11	0.16	0.24	0.33	0.44
Practice contract type	N	%					
Alternative provider medical services	144	2.10					
General medical services	4893	71.20					
Personal medical services	1834	26.70					
Dispensing practice	1061	15.40					
Received minimum practice income guarantee payment	2504	36.40					

CQC, Care Quality Commission; DPP, Diabetes Prevention Programme; FTE, full-time equivalent; GP, general practitioner; NICE, National Institute for Health and Care Excellence; QOF, Quality and Outcomes Framework.

Table 2 Association between practice DPP referrals and practice clinical quality, accessibility and resources

	Practice referrals to the NHS DPP
Proportion of QOF diabetes points achieved†	1.11*** (1.08 to 1.14)
Proportion of patients reporting good experience making an appointment†	1.01 (0.98 to 1.04)
Log payment per patient†	0.99 (0.97 to 1.02)
Observations	22 124
General practices	6871
Log-likelihood	−190905.3

Poisson regression with practice random effects. Coefficients are incidence rate ratios.
*P<0.05; **p<0.01; ***p<0.001.
†Coefficients on these variables represent a 1 SD change in the explanatory variables. Model also includes additional practice covariates: practice gender, age, deprivation and ethnicity compositions, practice rurality, type 2 diabetes prevalence, DPP wave, year and wave year interactions. Regression coefficients for these covariates are presented in online supplemental table A3; 95% CIs in brackets.
DPP, Diabetes Prevention Programme; NHS, National Health Service; QOF, Quality and Outcomes Framework.

achievement on the QOF diabetes indicator (table 2). A 1 SD increase in QOF diabetes achievement was associated with an 11% (95% CI: 8% to 14%) increase in a practice's annual rate of referrals per registered potentially eligible patient. However, referral volumes were not found to be significantly associated with practice access, as measured by the proportion of patients that reported good experience making appointments, or practice resources, as measured by average practice payments. These findings were unaffected by changes to the definition of the at-risk population (online supplemental table A2). Practices with a higher prevalence of type 2 diabetes had a higher rate of referrals, with a one percentage point increase in diabetes prevalence associated with an 8% higher rate of referrals (95% CI: 6% to 11%) (online supplemental table A3). Practices with higher proportions of Asian patients had significantly higher rates of referrals (1%, 95% CI: 1% to 1%).

Robustness checks

Clinical quality is consistently found to be positively and significantly associated with DPP referral volumes across all quality indicators (table 3). For example, a 1 SD increase in achievement on the QOF public health domain was associated with a 7% increase in the rate of referrals (95% CI: 4% to 10%). A CQC rating of 'good' or 'outstanding' was associated with a 10% higher rate of referrals compared with practices rated 'inadequate' or 'requires improvement' (95% CI: 3% to 17%). Regardless of how access is measured, DPP referral rates were not found to be significantly associated with practice accessibility (table 4).

While in our main analysis referral rates were not found to be associated with the average level of payments practices received per weighted patient (table 5, column 1), referral rates were found to be associated with some indicators of whether practices received additional funding from the NHS over and above that related to the standard general medical services contract (table 5, column 2). Practices in receipt of minimum practice income guarantee payments had 8% lower referral rates compared with practices that did not receive this additional source

Table 3 Sensitivity analysis I: alternate indicators of practice clinical quality

	Annual general practice referrals to the NHS DPP				
	1	2	3	4	5
Proportion of patients reporting good experience making an appointment†	1.01 (0.98 to 1.04)	1.01 (0.98 to 1.03)	1.02 (0.99 to 1.05)	1.01 (0.99 to 1.04)	1.02 (0.99 to 1.04)
Log payment per patient†	0.99 (0.97 to 1.02)	1.00 (0.98 to 1.03)	1.01 (0.98 to 1.03)	1.01 (0.98 to 1.04)	1.01 (0.98 to 1.04)
Proportion of QOF diabetes points achieved†	1.11*** (1.08 to 1.14)				
Proportion of patients completed eight NICE diabetes care processes†		1.10*** (1.07 to 1.14)			
Proportion of QOF clinical domain points achieved†			1.08*** (1.06 to 1.11)		
Proportion of QOF public health domain points achieved†				1.07*** (1.04 to 1.10)	
CQC rating: outstanding or good					1.10** (1.03 to 1.17)
Observations	22 124	22 124	22 124	22 124	22 124
Practices	6871	6871	6871	6871	6871
Log-likelihood	−190905.3	−190923.1	−190907.1	−190917.1	−190931.0

Poisson regressions with general practice random effects. Coefficients are incidence rate ratios.
*P<0.05; **p<0.01; ***p<0.001.
†Coefficients on these variables represent a 1 SD change in the explanatory variables. Column 1 represents the main model as presented in table 2. Columns 2–5 represent models including the same indicators of practice resources and accessibility, but alternate indicators for practice clinical quality. Models also include additional practice covariates: practice gender, age, deprivation and ethnicity compositions, practice rurality, type 2 diabetes prevalence, DPP wave, year and wave year interactions; 95% CIs in brackets.
CQC, Care Quality Commission; DPP, Diabetes Prevention Programme; NHS, National Health Service; NICE, National institute for health and care excellence; QOF, Quality and Outcomes Framework.

Table 4 Sensitivity analysis II: alternate indicators of practice accessibility

	Annual general practice referrals to the NHS DPP			
	1	2	3	4
Proportion of QOF diabetes achievement†	1.11*** (1.08 to 1.14)	1.11*** (1.08 to 1.14)	1.11*** (1.08 to 1.14)	1.11*** (1.08 to 1.14)
Log payment per patient†	0.99 (0.97 to 1.02)	0.99 (0.97 to 1.02)	0.99 (0.97 to 1.02)	0.99 (0.97 to 1.02)
Proportion of patients reporting good experience making an appointment†	1.01 (0.98 to 1.04)			
Proportion of patients offered a choice of appointment†		1.01 (0.98 to 1.03)		
Proportion of patients reporting easy phone access†			1.01 (0.99 to 1.04)	
Proportion of patients offered a same or next day appointment†				0.99 (0.97 to 1.02)
Observations	22 124	22 124	22 124	22 124
Practices	6871	6871	6871	6871
Log-likelihood	−190905.3	−190905.3	−190905.2	−190905.4

Poisson regressions with general practice random effects. Coefficients are incidence rate ratios.
*P<0.05; **p<0.01; ***p<0.001.
†Coefficients on these variables represent a 1 SD change in the explanatory variables. Column 1 represents the main model as presented in table 2. Columns 2–4 represent models including the same indicators of practice resources and clinical quality, but alternate indicators for practice accessibility. Models also include additional practice covariates: practice gender, age, deprivation and ethnicity compositions, practice rurality, type 2 diabetes prevalence, DPP wave, year and wave year interactions; 95% CIs in brackets.
DPP, Diabetes Prevention Programme; NHS, National Health Service; QOF, Quality and Outcomes Framework.

of funding (95% CI: −14% to −3%). Practices on personal medical services contracts had significantly lower rates of DPP referrals compared with those on the standard general medical services contract (−11%, 95% CI: −17% to −5%). There were no associations between referrals and indicators for whether practices were dispensing practices or on the Alternative Provider Medical Services contract. When we examine resources in terms of staffing, referral volumes were positively associated with the number of FTE GPs and nurses, however these associations were not significant (table 5, column 3).

DISCUSSION

Prevention programmes are a key element of global action to tackle the increasing prevalence and burden

Table 5 Sensitivity analysis III: alternate indicators of practice resources

	Annual general practice referrals to the NHS DPP		
	1	2	3
Proportion of QOF diabetes points achieved†	1.11*** (1.08 to 1.14)	1.11*** (1.08 to 1.14)	1.11*** (1.07 to 1.14)
Proportion of patients reporting good experience making an appointment†	1.01 (0.98 to 1.04)	1.01 (0.99 to 1.04)	1.00 (0.98 to 1.03)
Log payment per patient†	0.99 (0.97 to 1.02)		
Received minimum practice income guarantee payment		0.92** (0.86 to 0.97)	
Dispensing practice		1.09 (1.00 to 1.18)	
Practice has alternative provider medical services contract		1.06 (0.88 to 1.27)	
Practice has personal medical services contract		0.89*** (0.83 to 0.95)	
No. of FTE GPs per 1000 patients†			1.04 (0.98 to 1.10)
No. of FTE nurses per 1000 patients†			1.01 (0.98 to 1.04)
Observations	22 124	22 124	22 124
Practices	6871	6871	6871
Log-likelihood	−190905.3	−190897.3	−190902.2

Poisson regressions with general practice random effects. Coefficients are incidence rate ratios.
*P<0.05; **p<0.01; ***p<0.001.
†Coefficients on these variables represent a 1 SD change in the explanatory variables. Column 1 represents the main model as presented in table 2. Columns 2 and 3 represent models including the same indicators of practice clinical quality and accessibility, but alternate indicators for practice resources. Models also include additional practice covariates: practice gender, age, deprivation and ethnicity compositions, practice rurality, type 2 diabetes prevalence, DPP wave, year and wave year interactions; 95% CIs in brackets.
DPP, Diabetes Prevention Programme; FTE, full-time equivalent; GP, general practitioner; NHS, National Health Service; QOF, Quality and Outcomes Framework.

of long-term conditions.[8] Identification of individuals at risk of developing these conditions is the first necessary step towards prevention. While the repeated interaction with patients and detailed knowledge of their clinical histories may mean that primary care professionals are well placed to facilitate this identification and referral, there is a danger that such recruitment methods may further compound existing inequalities between practices in care provision. We find evidence that recruiting patients to a national diabetes prevention programme via primary care may have reinforced existing inequalities between practices in terms of the clinical quality of care provided, thus leaving patients registered at lower quality practices even more disadvantaged.

We found that the rate of referrals to the DPP was positively associated with the quality of clinical care provided by general practices. A 1 SD increase in the proportion of points a general practice achieveed on the QOF diabetes indicators was associated with an 11% higher rate of referrals to the NHS DPP. This finding was consistent across a range of different indicators of clinical quality, namely: the quality of diabetes management, overall clinical quality across a range of different health conditions and the quality of public health prevention activities. We also found that practices rated worse by the national care regulator, the CQC, had lower rates of referrals to the DPP. CQC ratings reflect wider aspects of quality including practice management, in addition to clinical quality.

Our findings suggest that practices that provide lower quality clinical care were also less active in referring to the prevention programme. Inequalities in secondary prevention in terms of the management of long-term conditions between practices were therefore replicated in inequalities in their primary prevention efforts. This is likely to result in a cycle of lower quality care and disease management. For example, patients at lower quality practices are less likely to be referred to prevention programmes, have a higher incidence of such preventable diseases and then subsequently receive lower quality care for those diseases when they do develop.

In contrast, regardless of how access was measured, we did not detect an association between referral rates and practice accessibility. We found no relationship between the overall level of financial resources that practices received, adjusted for patient need, and their rate of referrals to the NHS DPP. The way that practices were paid and the activities that they received funding for over and above the standard contract displayed variable relationships with referral rates. However, the resources available at practices in terms of GP and nursing staffing numbers were not significantly associated with referral rates. We therefore find mixed relationships between practice resources and prevention referral, with the impact of resourcing being more complex than simple allocations of monetary amounts. While the overall level of financial resources available to practices did not affect the volume of referrals, some forms of additional payments supplementary to the amount received in the core general medical services contract were associated with lower volumes of referrals.

The NHS DPP is one of the largest behavioural interventions of its kind to be implemented on a national scale. The long-term aims of the DPP are to reduce the incidence of type 2 diabetes, its associated complications and the health inequalities associated with the incidence of diabetes.[17] Our results suggest that by using general practice to identify and recruit patients to the DPP, inequalities in the incidence of diabetes may potentially widen as a result.

Relation to previous research

We examined general practice referrals to a nationwide prevention programme. Previous research has found up to 10-fold variation in the rate of referrals to secondary care across GPs.[37] Practice and GP characteristics were only found to explain a small amount of this variation.[38] A later study further confirmed findings of inequalities in practice referrals to secondary care for defined symptoms by patient age, sex and social deprivation.[39] In addition to these variations between general practices in referrals to secondary prevention activities, our results suggest that variations also exist in referrals to primary prevention services.

Large variations have also been detected in practice-level referrals to weight management services,[40] and the attendance and completion of such programmes.[41] We are not aware of any studies that examine the association between practice factors and referrals to prevention programmes. A recent scoping review highlighted the lack of attention paid to organisational context when researching the effectiveness of health promotion and prevention activities undertaken in primary care.[42] Our results suggest that practice quality is significantly associated with the identification and referral of patients to prevention services, supporting recommendations to examine the importance of such organisational factors in future effectiveness evaluations.

There are known sociodemographic inequalities in both the prevalence of non-diabetic hyperglycaemia and the transition to type 2 diabetes,[43 44] with socioeconomically disadvantaged people more likely to progress to type 2 diabetes. Furthermore, findings from diabetes prevention programmes in other countries have shown sociodemographic disparities in the effectiveness of diabetes prevention interventions.[45 46] In addition to these previously documented inequalities in the incidence of non-diabetic hyperglycaemia and the effectiveness of DPPs, our results suggest that there are also potential inequalities in the identification and referral phases of these programmes. However, early analysis of referrals to the NHS DPP found that

the programme was reaching some subgroups that are at greater risk of developing type 2 diabetes and those who typically access healthcare less effectively, namely individuals of increasing age and Asian, Afro-Caribbean, mixed and other ethnic groups.[47]

Strengths and limitations

This analysis used rich data on referrals to a nationwide prevention programme, combined with national databases used to generate indicators of practice quality and resources. There was no direct financial cost to patients or practices for a referral, so differences in insurance coverage, co-payments or entitlement could not skew the results. We obtained many different indicators of clinical quality, accessibility and resources and systematically tested the robustness of the results to the choice of available indicators. We also controlled for a large number of potentially confounding factors including the practice's patient age profile, ethnicity, deprivation and geographic area characteristics.

There may, however, be important dimensions of primary care services that are not reflected in the indicators used and also potential limitations of those that were included. We assess the two primary concepts of care quality; clinical quality and access.[48] We have not considered any measures of continuity of care which is considered a subcomponent of access. The results on the four measures of access we did examine were, however, very clear and consistent, with no relationship detected between referral rates and practice accessibility. Some doctors have expressed concerns over how well the QOF indicators measure clinical effectiveness, as they focus on meeting clinical guidelines for single diseases rather than person-centred care for patients with multiple or complex conditions.[49 50] Our conclusions were, however, unchanged when using CQC ratings as the measure of clinical quality. The CQC assesses practices against standards covering safe, effective, caring, responsive and well-led domains, therefore representing a broader assessment of clinical quality than QOF indicators. The measures of access are patient-reported measures derived from a sample of a practice's patients. Information on the availability or utilisation of appointments is not available at the general practice level.[51]

We are only able to assess referrals received from general practices as recorded by the programme providers. We are not able to observe the other activity involved such as identifying at-risk patients, discussing the programme with patients, and offering them a place on the programme. Due to the referral process, practice level counts of referrals may be influenced by factors outside the control of practices. Once a patient has been offered a place on the DPP by their GP, they then decide whether or not to take up the offer and attend the programme. Patient factors may therefore also influence the likelihood of the offer of participation made by a practice translating into an actual referral. Our analysis accounts for characteristics of each practice's patient population in terms of age, sex, deprivation, ethnicity and diabetes prevalence in an attempt to control for the influence of such patient factors. We are, however, unable to account for all factors which may influence a patient's decision to take up the offer of a referral, such as individuals' attitudes towards health and risk.

We were unable to use data on patients with non-diabetic hyperglycaemia in this analysis. The specific diagnostic Read codes for non-diabetic hyperglycaemia and the corresponding data set were only introduced in 2016 and such records are incomplete and inconsistent.[52] This had two implications for our study. The first was for the calculation of the population at risk for use as the denominator. We used the practice list size as the denominator, minus the number of patients on the practice list with a diagnosis of type 2 diabetes, as we know that these patients could never be eligible for the programme. Therefore, the defined population at risk is much broader than the true population of patients eligible for the programme. The second was that we were unable to control for differences in need across practices in terms of differences in the prevalence of non-diabetic hyperglycaemia among their patients. Instead, we include the prevalence of type 2 diabetes in the practice patient population, as well as the age, gender and ethnicity composition of the patient population, as proxies. Furthermore, while we adjust for changes in capacity over time as the programme was implemented, we do not adjust for capacity constraints at the local level which may impact the availability of places on the programme in different areas. It was initially proposed that there would be 20 000 places available in the first wave,[53] and 100 000 in each subsequent year, however referrals have exceeded this nationally.[47]

Implications and future research

From July 2020, a self-referral route was introduced to the DPP via an online 'know your score' questionnaire and algorithm, which generates a risk score for patients and invites them to fill out a registration form if they are found to be high risk.[54] Such tools have the potential to improve the reach of prevention programmes, but may exacerbate inequalities if they are underused in some population groups, particularly those for whom there are barriers to the use of digital services.[55] Financial incentives were introduced for programme providers to encourage the recruitment of patients with certain characteristics after the study period we examined (from 1 April 2020 onwards). Research is needed to assess the impact of these developments on inequalities in recruitment and retention to the DPP. Future research is also needed to assess the inequalities in the effectiveness of national prevention programmes such as the DPP.

Commissioners of disease prevention programmes should be aware that recruitment through primary care practices may reinforce existing inequalities in care provision. In order to mitigate this, commissioners could provide additional support to lower quality practices to aid identification and recruitment. While financial incentives may seem like a potential solution to this problem, we measured clinical quality using indicators from the QOF which is itself a financial incentive scheme targeting quality improvement in general practices. Our finding that referral rates were positively associated with clinical quality as measured by the QOF suggests that in this instance lower quality practices may already be unresponsive to financial incentives. Other levers or support mechanisms may therefore be required, or alternative methods of recruitment pursued.

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Contributors BP conducted the analysis and wrote the initial draft of the manuscript. All authors were involved in the conception of the paper, designing the methodology and editing the final manuscript. BP accepts full responsibility for the work as guarantor.

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Figure A1. Rate of DPP referrals by quantile of practice clinical quality

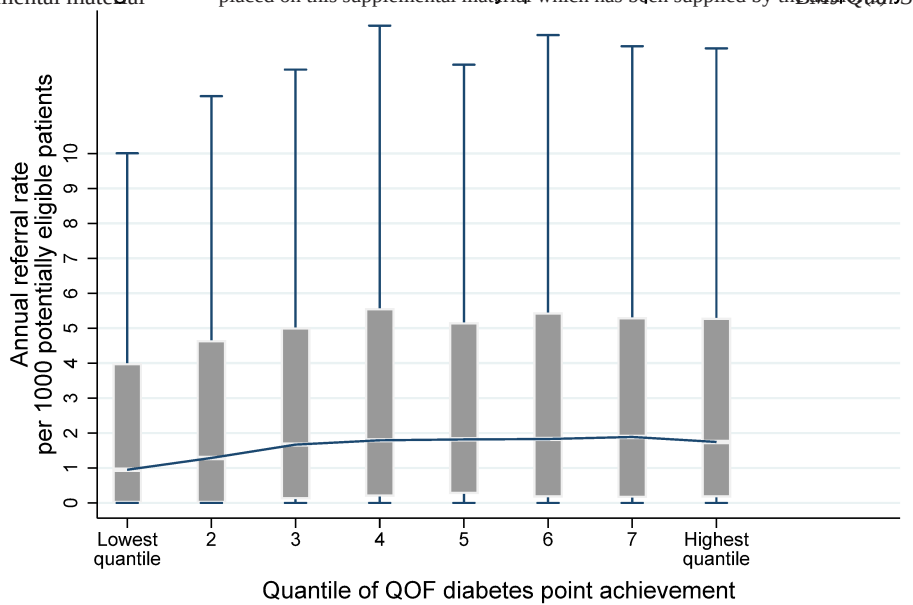

Figure A2 Relationship between referral rate and patient experience

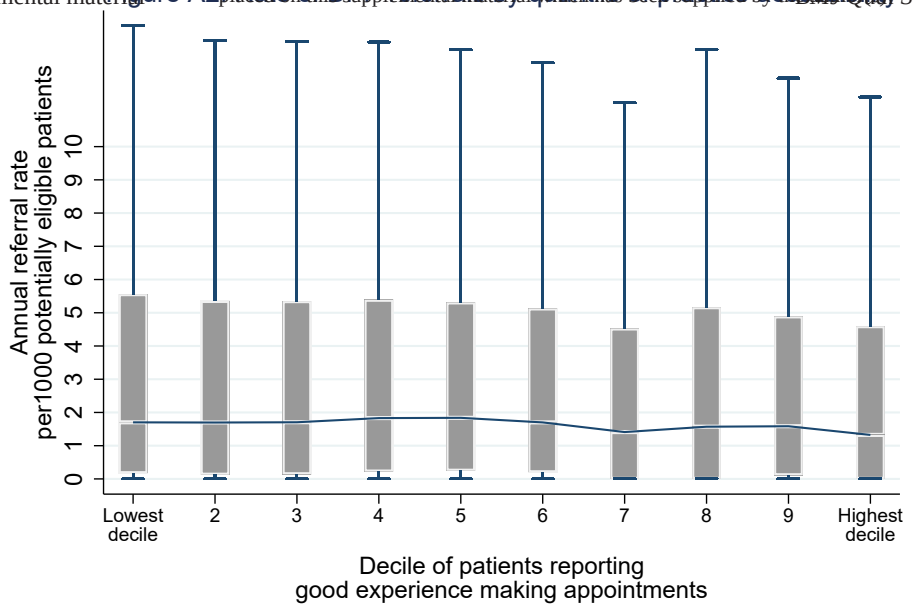

Figure A3 Rate of DPP referrals by quintile of practice prescribing from a

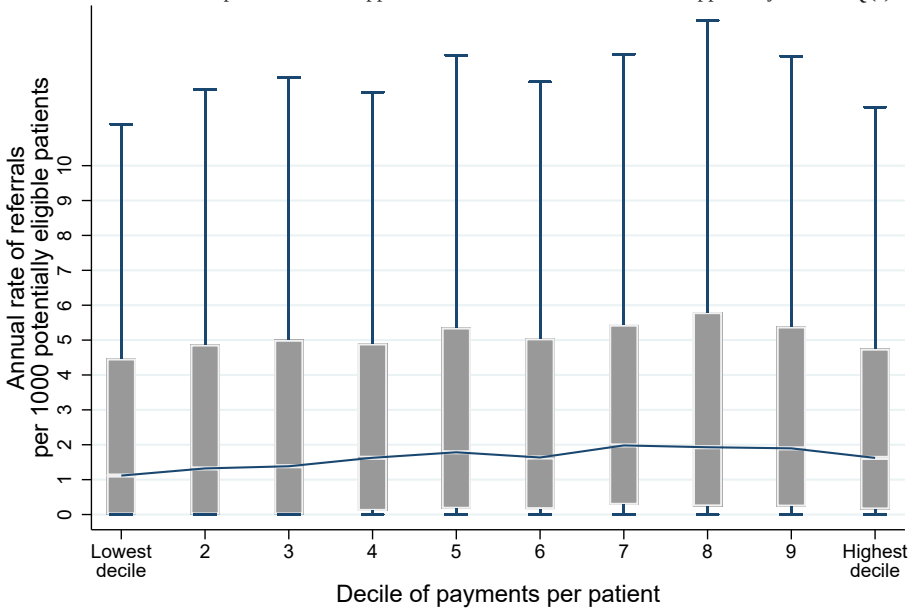

Table A1. Practice population characteristics included in regression models

	mean	sd	p10	p25	p50	p75	p90
Practice list sized aged 15+ with no T2D diagnosis	6505.95	4245.30	2371.00	3574.08	5717.75	8411.00	11210.00
Practice population male (%)	50.16	2.21	48.21	48.93	49.72	50.86	52.68
Practice population age 0-14 (%)	17.46	3.86	13.45	15.26	17.14	19.41	22.16
Practice population age 40-44 (%)	6.43	1.30	5.02	5.57	6.27	7.17	8.17
Practice population age 45-49 (%)	6.94	0.95	6.00	6.48	6.97	7.46	7.95
Practice population age 50-54 (%)	7.06	1.23	5.58	6.52	7.23	7.84	8.35
Practice population age 55-59 (%)	6.40	1.40	4.60	5.67	6.61	7.32	7.92
Practice population age 60-64 (%)	5.34	1.43	3.42	4.46	5.45	6.29	7.04
Practice population age 65-69 (%)	4.80	1.68	2.55	3.63	4.86	5.92	6.93
Practice population age 70-74 (%)	4.60	2.11	1.91	3.11	4.59	5.97	7.22
Practice population age 75+ (%)	6.32	2.72	2.76	4.31	6.35	8.09	9.78
% of Practice population living in most deprived quintile	23.22	26.52	0.01	0.70	12.17	39.42	67.32
% of practice population living in 2nd quintile	21.42	17.96	0.92	7.25	17.97	31.23	47.05
% of practice population living in 3rd quintile	19.80	15.55	3.23	8.06	16.59	27.62	40.68
% of practice population living in 4th quintile	18.32	15.94	0.99	4.64	15.27	27.70	40.12
Diabetes prevalence (%)	7.21	2.16	4.85	6.00	7.11	8.27	9.55
Practice population Mixed ethnicity (%)	2.50	1.87	0.70	1.01	1.84	3.64	5.42
Practice population Asian ethnicity (%)	9.45	13.44	0.72	1.25	3.89	11.43	25.94
Practice population Black ethnicity (%)	4.33	6.92	0.16	0.34	1.15	5.23	13.38
Practice population other ethnicity (%)	1.26	1.84	0.10	0.17	0.45	1.62	3.62
	n	%					
Rural practice	1136	16.5					

Table A2. Sensitivity analysis IV: Different definitions of the practice population at risk

	Annual general practice referrals to the NHS DPP					
	(1)	(2)	(3)	(4)	(5)	(6)
QOF Diabetes achievement†	1.13***	1.13***	1.11***	1.13***	1.13***	1.11***
	[1.10,1.16]	[1.10,1.16]	[1.08,1.14]	[1.10,1.16]	[1.10,1.16]	[1.08,1.14]
Proportion of patients reporting good experience making an appointment†	1.00	1.00	1.01	1.00	1.00	1.01
	[0.98,1.03]	[0.97,1.03]	[0.98,1.04]	[0.98,1.03]	[0.97,1.03]	[0.98,1.04]
Log payment per patient†	0.99	0.99	0.99	0.99	0.99	0.99
	[0.96,1.02]	[0.96,1.02]	[0.97,1.02]	[0.96,1.02]	[0.96,1.02]	[0.97,1.02]
Population at risk	Aged 15+	Aged 15+ minus patients diagnosed with T2D	Aged 15+ minus patients diagnosed with T2D	Aged 18+	Aged 18+ minus patients diagnosed with T2D	Aged 18+ minus patients diagnosed with T2D
Including practice T2D prevalence as control variable	No	No	Yes	No	No	Yes
N	22124	22124	22124	22124	22124	22124
N_g	6871	6871	6871	6871	6871	6871
Log-likelihood	-190803.8	-190928.4	-190905.3	-190816.3	-190948.3	-190924.7

Poisson regression with practice random effects. † Coefficients on these variables represent a one standard deviation change in the explanatory variables. Models also include additional practice covariates. 95% confidence intervals in brackets. QOF: Quality and Outcomes Framework. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A3. Regression results of the main model with coefficients for all practice covariates

	Annual DPP referrals
Proportion practice population male	0.99 [0.98,1.01]
Proportion practice population age 0-14	1.03*** [1.02,1.04]
Proportion practice population age 40-44	1.03 [1.00,1.07]
Proportion practice population age 45-49	1.01 [0.97,1.06]
Proportion practice population age 50-54	1.02 [0.97,1.08]
Proportion practice population age 55-59	1.02 [0.97,1.08]
Proportion practice population age 60-64	1.06* [1.00,1.12]
Proportion practice population age 65-69	1.01 [0.96,1.07]
Proportion practice population age 70-74	1.01 [1.00,1.02]
Proportion practice population age 75+	1.00 [0.98,1.02]
% of practice population living in most deprived quintile	1.00* [1.00,1.00]
% of practice population living in 2nd quintile	1.00 [1.00,1.00]
% of practice population living in 3rd quintile	1.00 [1.00,1.00]
% of practice population living in 4th quintile	1.00 [1.00,1.00]
Type 2 diabetes prevalence	1.08*** [1.06,1.11]
Proportion of practice population of Mixed ethnicity	1.00 [0.96,1.03]
Proportion of practice population of Asian ethnicity	1.01*** [1.01,1.01]
Proportion of practice population of Black ethnicity	1.01 [1.00,1.01]
Proportion of practice population other ethnicity	1.05*** [1.03,1.07]
Rural practice	0.95

	[0.88,1.04]
Wave 2 practice	0.43*** [0.39,0.47]
Wave 3 practice	1.60*** [1.47,1.74]
Year: 2017/18	1.91*** [1.78,2.05]
Year: 2018/19	2.26*** [2.11,2.43]
Year: 2019/20	1.37*** [1.28,1.47]
Year: 2017/18 * Wave 2 practice	2.06*** [1.85,2.30]
Year: 2018/19 * Wave 2 practice	2.05*** [1.88,2.24]
Year: 2018/19 * Wave 3 practice	0.33*** [0.29,0.36]
Proportion of QOF Diabetes achievement†	1.11*** [1.08,1.14]
Proportion of patients reporting good experience making appointments†	1.01 [0.98,1.04]
Log average payment per patient†	0.99 [0.97,1.02]
Observations	22124
General practices	6871
Log-likelihood	-190905.3

Poisson regression with general practice random effects. Coefficients are incidence rate ratios. † Coefficients on these variables represent a one standard deviation change in the explanatory variables. 95% confidence intervals in brackets. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$