What factors influence differential uptake of NHS Health Checks, diabetes and hypertension reviews among women in ethnically diverse South London? Cross-sectional analysis of 63,000 primary care records

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Summary

Background Uptake of health checks among women has not been examined in relation to patient and General Practitioner (GP) practice level factors. We investigated patient and practice level factors associated with differential uptake of health checks.

Methods Primary care records from 44 practices in Lambeth for women aged 40-74 years old (*N* = 62,967) from 2000-2018 were analysed using multi-level logistic regression models. An odds ratio (OR) >1 indicates increased occurrence of no health check.

Findings The mean age (IQR) of the included female sample (aged 40-74 years) was 52.9 years (45.0-59.0). Adjusted for patient-level factors (age, ethnicity, English as first language, overweight/obesity, smoking, attendance to GP practices, and co-morbidity), the odds of non-uptake of health checks were higher for Other White (OR 1.24, 95% confidence interval 1.17-1.33), and Other ethnicity (1.20, 1.07-1.35) vs. White British. It was also higher for 50-69 year olds (1.55, 1.47-1.62), 70-74 year olds (1.60, 1.49-1.72) vs. 40-49 year olds. These ORs did not change on adjustments for practice level factors (proportion of patients living in deprived areas, proportion of patients with ≥1 chronic condition, ≥3 emergency diabetes admissions annually, GP density/1000 patients, quality outcome framework score of ≥ 95%, and patient satisfaction scores of ≥80%). Non-uptake was lower for Black Caribbeans, Bangladeshis, overweight/obese patients, frequent practice attenders and comorbid patients.

Interpretation Differential uptake in health checks remained after adjustment for patient and practice level factors. Better measures of social determinants of health and of practice context are needed.

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Keywords: Health check; Inequalities; Ethnicity; Social determinants; Contextual factors

Introduction

Improving detection and management of cardiovascular disease (CVD), such as hypertension, and diabetes is the aim of the NHS health checks, and separately hypertension, and diabetes screening checks in the last year. However, women remain 50% less likely than men to be diagnosed with CVD,[1] and are under-treated with pharmacotherapy such as hypotensive or cholesterol lowering medicines.[2] In the UK, there are ~3.7 million women living with CVD, and 81,000 deaths annually (14,129 in women <75 years old).[3] The UK ranks 31/47 highest for CVD rates in women across Europe.[1] Ethnicity is not currently recorded on death registrations in England and Wales and national monitoring relies on country of birth. Our analyses of 35-years of CVD mortality showed striking differences by gender and country of birth. We found excess mortality (relative to gender and age specific rates for all born in England and Wales) was greater among women than among men born in India, Pakistan, Bangladesh, Caribbean, Nigeria, and Ghana (Figure 1); and generally high for those from Scotland, Northern Ireland and Republic of Ireland.[4] There is substantial predominance of deaths from

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Research in context

Evidence before this study

National Health Service (NHS) health checks, and annual hypertension, and diabetes reviews for eligible patients are associated with improved quality of care and cardiovascular disease (CVD) risk management. A Cochrane review highlighted that equitable access to healthcare is influenced by a range of factors that influence service availability (e.g., resources including appropriate number of health care professionals) and accessibility (e.g., culturally appropriateness of services, socio-economic position of patients) although previous studies reported inconsistent associations of deprivation with uptake of NHS check.

What this study adds

Using primary care records, we examined the factors at patient and at general practitioner (GP) practice levels that affect women's uptake of health checks. In an inner-city area with high levels of deprivation and ethnic diversity, patient level rather than GP practice level factors accounted for a greater proportion of the total variance in non-uptake. About 80% of the variance, however, remained unexplained due to unmeasured factors in the primary care records. We found that compared with White British, health check uptake was lower in Other White, Other ethnicity and among those with missing information on ethnicity and smoking, and also among older age groups.

Implications

The value of primary care records for tackling inequalities in uptake of health checks could be strengthened by the inclusion of better measures of social determinants of health at patient level and of accessibility of care at practice level. Inner city areas can be super-diverse with migration status, generation status, religion, language, and socio-economic position being important determinants for accessing available care. Improved data capture is critical for primary care to embrace population-based perspectives and for developing context specific delivery strategies for CVD prevention.

coronary heart disease in South Asians and from strokes for these groups.[5,6] In a recent paper in the Lancet, Watkinson et al. reported on the urgent need to address ethnic inequalities in the prevalence of diabetes and hypertension.[7] The prevalence of hypertension and type 2 diabetes is very high in some ethnic minority groups, such as Black Caribbean and Black African groups, and is diagnosed approximately 10−12 years earlier in these groups than in White British.[8] The onset of type 2 diabetes can trigger the onset of other long-term conditions.[9]

Annual CVD related health care costs to the NHS in England total ∼£9 billion. Annual costs to the UK economy (including premature death, disability and informal costs) are ∼ £19 billion.[3] £68 billion could be saved, 4.9 million quality-adjusted life years gained, and 3.4 million CVD cases prevented over 25 years if those in England with the six CVD high risk conditions were diagnosed and managed at current levels. Short-term benefits come from the detection of individuals with an elevated CVD risk (≥10%) and management of high cholesterol and long-term benefits from the detection and treatment of diabetes.[10]

The WHO Commission on Social Determinants of Health (CSDH) was set up by the World Health Organisation (WHO) which emphasised both the structural and social determinants of health within and across population groups in society.[11] It emphasised access to health care as an important mediator within a dynamic system context and aligns with several calls for transformative changes in health care that engage with the social and structural determinants that drive ethnic inequalities in health and access to health care. In the UK, the NHS Long Term plan advocates for upstream prevention of avoidable Long Term Conditions and reducing health inequalities through ensuring that health is central to social and economic policy.[12] Sizeable inequalities clearly continue to exist, as evidenced from the health impacts of the Covid-19 pandemic.[13]

Service availability is concerned with the provision of healthcare and availability does not necessarily mean they are accessible. A range of factors affect both, for example the availability of healthcare professionals can affect provision and the cultural appropriateness of delivery can affect accessibility. In the UK, 98% of the population have access to primary health care services, but there are local variations in the uptake of preventive services. The uptake of the health check is a good example of this variation in uptake. This is a freely available check-up at GP practices (where Primary Care practitioners are based) for adults in England aged 40 to 74 years without certain pre-existing conditions to diagnose early signs of diseases such as stroke, kidney disease, heart disease, type 2 diabetes, or dementia. About one-third of eligible women in Lambeth, a socially diverse inner city area in London, have not had an NHS health check, diabetes or hypertension review within the last 5 years, or blood pressure/blood glucose measurements in the last year where indicated, signalling missed opportunities for early prevention and control of CVD risk factors.[14] The use of computer prompts had some effectiveness for increasing uptake among males in deprived areas of London,[15] which could exacerbate gender inequalities in CVD. Attempts to develop a validated open-access web-based model that enables local commissioners to quantify the cost-effectiveness and equitable population health gain of the NHS Health Check programme suggested that future work should
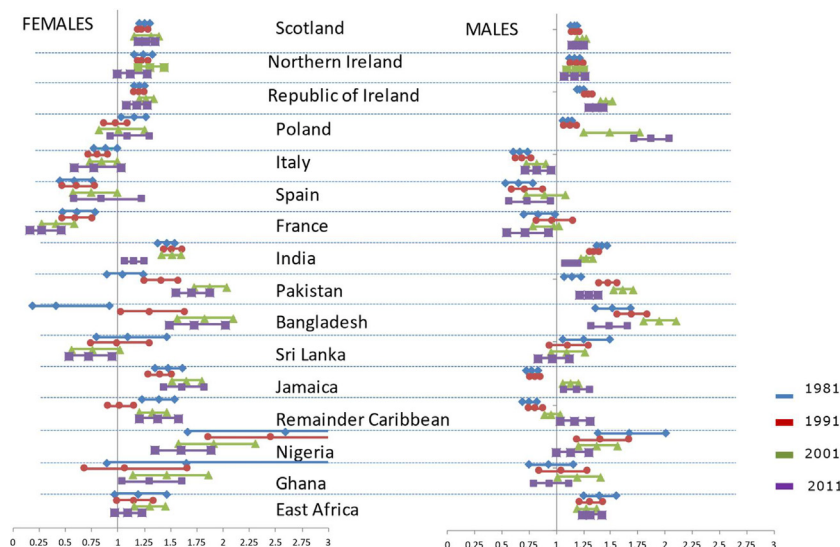
Figure 1. Cardiovascular disease mortality by country of birth, England & Wales 1981-2011: Rate Ratios, 95% CIs).
[1]Earlier work has revealed slow declines in mortality notable for selected groups (5).
[2]Cross-sectional analyses based on 100% national individual level death records for 1979−1983, 1989−1993, 1999−2003, 2009-2013, and tabulated population data from the 1981, 1991, 2001 and 2011 Censuses for England & Wales.
[3]The figure used death rates of those born in England and Wales as the reference rate and are shown with 95%CI.
[4]Death rates were directly age-standardised using the European standard population from the year 2000. Gender-specific Poisson regression models were used to compare the differences in RRs by country of birth within and across time periods.

focus on improving user interactions with the model, modelling standards, and evaluation, design and implementation support.[16] However, challenges remain in understanding, competencies, and training in CVD risk communication for NHS health checks carried out by healthcare professionals.[17]

The current study is based on the unique superdiverse and deprived population in Lambeth, South London, UK home to residents born in 216 countries, and with 172 self-reported ethnicities and 147 languages spoken. There are large numbers of Black Africans, Black Caribbeans, South Asians, Irish, as well as migrants from Portugal, Eastern Europe, Southern Europe, and Latin America. Lambeth is one of the 20% most deprived districts/unitary authorities in England. There are also high levels of CVD, obesity, hypertension and diabetes.[18]

We sought to understand the factors at the patient level and at the practice level in primary care that affect the uptake of health checks in this superdiverse inner city context,[19] as these are not well understood and studies tend to report area level variables of socioeconomic factors.[7,20] At patient level we selected locally specific factors that are evidenced in the literature as determinants of health and that are available in primary care records,[10] e.g. ethnicity, English as a first language,[21] cardiovascular risk factors and comorbidities.[22] At practice level we examined practice factors such as proportion of patients living in deprived neighbourhoods,

proportion with comorbidity, emergency diabetes admissions, full time equivalent GPs, Quality and Outcomes framework (QOF) and patient satisfaction scores. The QOF is an annual reward and incentive programme for GP practices in England, Wales, and Northern Ireland and part of national quality standards. The study reported here is part of a wider project that is exploring the promotion of the uptake of the health check among women living in diverse inner-city settings. Our aim was to determine a) to what extent do patient and practice level factors associate with differential uptake of health checks, and b) the relative contribution of GP practices in influencing the uptake of health checks.

Methods

Study design
Cross-sectional survey of adult women eligible for NHS health check, diabetes, or hypertension review (referred hereafter as health check) on the GP record, with blood pressure or HbA1c recording. We determined demographic characteristics, comorbidity status, risk factors and measures of GP contact in a multi-ethnic population according to the STROBE reporting guidelines.

Setting
General practices within Lambeth, South London, UK.

Data sources

This study used a dataset derived from general practice electronic health records in one inner London borough, Lambeth DataNet (LDN), (18) for 2000-2018. LDN contains patient level clinical data, prescribing data, laboratory data, and demographic information, including ethnicity, risk factors and co-morbidities.

Study population

The study was carried out using anonymised data from 62,967 adult female patients (aged 40 to 74 years) registered with 44 (of a total of 47) GP practices, in Lambeth, South London. The remaining 3 practices in Lambeth had not provided continuous data throughout the study period and were excluded.

Objectives

To assess the factors at the patient level and at the practice level in primary care that affect the uptake of health checks

Primary outcome

A composite measure of NHS health check, diabetes and hypertension review status (in eligible patients) were determined using NHS Health check clinical code for the latest 5-year period from 2013 to 2018, and blood pressure and HbA1c clinical review codes recording,[22] within the last year.

Correlates of health check uptake

Patient-level correlates socio-demographic (age, ethnicity, English as a first language), cardiovascular risk factors (smoking status categorised as non-smoker, ex-smoker, current smoker; obesity categorised as not overweight or obese BMI $<25kg/m^2$; overweight or obese $\geq 25kg/m2$), comorbidities and healthcare access (frequency of GP attendance during the last year categorised as 0-3; 4-5; 6 or more visits in preceding 12 months). Ethnicity was self-reported and aggregated into 15 categories: White British; Other White; Black African; Black Caribbean; Black Other; White and Black Caribbean; Chinese; Bangladeshi; Pakistani; Indian; Asian Other; White and Asian; Arab; Mixed other; and Other ethnicity. English as a first language was chosen as a proxy measure of socio-position (SEP). Other measures such as occupation and employment were not systematically reported and were not included in the analyses. Comorbidities included hypertension, diabetes, diabetes complications, coronary heart disease, hyperlipidaemia, heart failure, atrial fibrillation, stroke, transient ischaemic attack, peripheral arterial disease, chronic kidney disease, serious mental illness, respiratory illness, osteoporosis, osteoarthritis, rheumatoid arthritis, cancer/palliative care, depression, epilepsy,

dementia, HIV, and learning disability, identified using Read codes and QOF disease registers.[22,23]

Practice level correlates captured data in 2017 and 2018. The Income Deprivation Domain of the Index of Multiple Deprivation was used as a measure of relative deprivation and is based on residential addresses at a small local area level with an average of 1800 people (known as Lower Super Output Areas).[24] It measures the proportion of the population experiencing deprivation relating to low income, which includes both those people that are out-of-work, and those that are in work but who have low earnings (according to means tests). This was included as proportion of patients living in areas classified as the 4th and 5th lowest quintiles vs those in 1st and 3rd quintiles of the income domain of the Index of Multiple Deprivation). Other variables included morbidity (proportion of patients with ≥ 1 chronic condition); emergency diabetes admissions (≥ 3 per practice annually); GP density per 1000 patients (<0.5; 0.5-1, >1 FTE); QOF score April 2017-April 2018, (95% and over), and General Practitioner (GP) Patient Satisfaction Survey ($\geq 80\%$),[25] used to assign practice measures of target achievement and patient self-reported patient assessments during their medical care experience.

Analysis

Multivariable mixed effects logistic regression analysis with individual patients (Level 1), nested within practices (Level 2), was used to determine the association of patient and practice level factors with uptake of the health check, using sequential adjustments of patient level factors followed by practice level factors. Two thirds (66.5%) of adult female patients had complete information in all analyses variables. Binary non-response models highlighted those female patients with missing information in one or more analysis's variables were more likely to be between 50-64 years old, they were more likely to be from an minoritized ethnic background, be overweight, current smoker, be registered with a Practice with a QoF score <95% and be registered with practices with fewer than on GP per 1000 patients. Initially, missing data were coded as a separate category for each variable. To avoid the possibility of biased estimates stemming from this decision, 40 multivariable imputation models were generated under the Missing at Random Assumption and using the Multiple Imputation by Chained Equations (MICE) method in Stata.[26] All estimates from the imputed models were combined using Rubin's rules.[27] Adjusted odds ratio (OR) used health check uptake as the reference so an adjusted OR of > 1 indicates greater likelihood of non-uptake, and a 2-sided statistical significance threshold of $p < 0.05$ wase used. Tjur's Coefficients of Discrimination were used as a measure of explanatory power.[28] Intraclass correlation coefficients (ICC) provided an

estimate of the relative contribution of the GP practices to the total variance of the model. All analyses were conducted using Stata 16.[29]

Ethical approval: Access to LDN was granted by the LDN Steering Group and the Information Governance Committee at NHS Lambeth CCG (NHS Lambeth CCG). Patient consent for publication was not required.

Role of the funding source: The funder had no role in writing the manuscript or in the decision to submit the article for publication.

Results

Summary characteristics of study population
Table 1 shows the summary characteristics from 62,967 patient records in South London. The mean age (IQR) of the included female sample (aged 40-74 years) was 52.9 years (45.0-59.0). Twenty eight per cent had not taken up the health check. About 83% of the patients did not self-identify as White British, ~9% did not have an ethnicity recorded, and 21% did not report English as their first language. The other White ethnic group (14,243, 28% of the whole sample) reported 135 countries of birth. The top 10 countries were Portugal, England (second and subsequent generations born in England), Poland, Italy, Ireland, Spain, Brazil, France, Columbia and Germany. There were high levels of overweight (~60%) and patients with ≥2 co-morbidities (~57%). Variations by practice level factors differed. The interquartile range for area income deprivation was wide, with 25% of the practices with patients living in areas that would be classified as very deprived. The median percentage patients with a comorbidity across the 44 practices was 17%, with 25% of practices below the median having 14%, and 25% above the median having 19% patients. In contrast, there was less variation in diabetes emergency admissions in the last year and in the Quality and Outcomes Framework Score.

Ethnic differences in patient level factors of health check uptake
Supplementary Table 1 shows the ethnic differences in patient level factors. There were some notable striking differences. Uptake of the health check ranged from 78-88% among the Bangladeshis, Pakistanis, Arabs, Black Caribbeans, White and Black Caribbeans to 62% among those with Chinese or missing ethnicity. The highest proportions for English not being the first language was among Black Africans (32%) and Black Other (27%). Highest levels of overweight/obesity were among Black African and Black Caribbean origin groups (75-79%), and of smoking among White British and Other White (19%) and the White and Black Caribbeans (27%). These figures underscore the need to target a range of ethnic groups for CVD screening via the health check.

Associations between health check uptake and patient and practice level factors
Table 2 shows the associations between health check uptake and patient and practice level factors, and the relative contribution of the GP practices to non-uptake, derived from the multilevel regression models. There was little change in the analysis's estimates when using multiply imputed data or when item non-response is coded as a separate category. Adjusted for all patient-level correlates (age, ethnicity, English as first language, overweight/obesity, smoking, attendance to GP practices, and co-morbidity), the odds of non-uptake of health checks were higher for Other White (OR 1.24, 95% confidence interval 1.17-1.33) and Other ethnicity (1.20, 1.07-1.35), compared with White British. Non-uptake was also higher for 50-69 year olds (1.55, 1.47-1.62), 70-74 year olds (1.60, 1.49-1.72) compared with 40-49 year olds. The odds of non-uptake were lower for Black Caribbeans (0.87, 0.80-0.94), and Bangladeshis (0.61, 0.41-0.89), overweight/obese patients (0.87, 0.83-0.91), frequent GP practice attenders (4-5 visits annually 0.10, 0.09-0.11; ≥6 visits 0.10, 0.10-0.11) compared <3 visits, and those with ≥2 comorbidities compared with fewer (0.48, 0.46-0.51). Adjustment for overweight/obesity, smoking, frequency of GP visits and comorbidity removed the statistically significant lower non-uptake among for Black African, Black Other, White and Black Caribbean and Pakistani groups, and the higher non-uptake among Chinese. Adjustment for practice level factors did not materially alter these results. Sensitivity analyses (not shown/online) showed that Other White and Other ethnic groups were least likely to have a diabetes or hypertension check (independently from a NHS health check) in the preceding 12 months.

Determinants of variance in health check uptake
The Tjur's coefficients and ICC indicated that ~20% of the variance in non-uptake of health checks was explained by adjusting for the patient-level correlates, with the explanatory power of the models increasing considerably after adjustment for overweight/obesity, smoking, attendance to GP practices and comorbidity. Supplementary Table 2 shows the Tjur's coefficients and ICC after addition of each variable to the model. The Tjur's coefficients show that age, ethnicity, English as first language, smoking and overweight contributed ~2%. This increased to ~7% on addition of comorbidity, and to ~21% on addition of frequency of attendance at GP practices. The ICC indicated that the relative contribution of GP practices to the non-uptake of health checks was small, at about 1% of the total variance.

Discussion
While the health check is recognised as an important preventative measure for CVD, no known study has

No NHS Health Check in last 5 years; no blood pressure or HbA1c recording in last year where clinically indicated %, 95% CI	28.4 (28.1-28.8)
PATIENT LEVEL CHARACTERISTICS	
Self assigned ethnicity, % (N)	
White British	29.4 (29.0-29.8)
Other White	24.9 (24.6-25.3)
Black African	14.6 (14.3-14.9)
Black Caribbean	10.9 (10.7-11.2)
Black Other	4.4 (4.3-4.6)
White and Black Caribbean	1.4 (1.3-1.5)
Chinese	1.5 (1.4-1.6)
Bangladeshi	0.5 (0.5-0.6)
Pakistani	0.9 (0.8-0.1)
Indian	1.9 (1.8-2.0)
Asian Other	3.3 (3.2-3.5)
White and Asian	0.4 (0.4-0.5)
Arab	0.1 (0.1-0.1)
Other	3.8 (3.6-3.9)
Other Mixed	1.9 (1.8-2.0)
Mean or %; 95% CI (N)	
Age (years)	
40-49 (reference category)	42.4 (42.0-42.8)
50-69	43.9 (43.5-44.3)
70-74	13.7 (13.4-14.0)
English not a first language vs. English as a first language	71.9 (71.5-72.3)
English as a first language missing	26.4 (26.1-26.8)
Overweight or obese (BMI $\geq$ 25 kg/m^2;)	59.3 (58.9-59.7)
Current smoker	
Yes	15.1 (14.9-15.4)
Frequency of GP visits in last year	
0-3 visits	53.3 (52.9-53.7)
4 - 5 visits	19.7 (19.3-20.0)
6 + visits	27.0 (26.7-27.4)
Morbidity	
1 or no comorbidity	43.3 (42.9-43.7)
2 or more comorbidities	56.7 (56.3-57.1)
GP PRACTICE LEVEL CHARACTERISTICS (N = 44; Median (Interquartile range)	
Index of Multiple Deprivation (Income Score)[a]	0.182 (0.133-0.256)
Practice Morbidity %)[b]	16.9 (14.0-19.0)
Diabetes emergency admissions in last year[c]	1.8 (1.2-2.6)
Full time equivalent GP/1000 patients[d]	0.77 (0.52-0.86)
Quality and Outcomes Framework score[e]	97.3 (95.1-98.1)
Patient satisfaction %[f]	78.0 (67.0-87.0)

Table 1: **Profile characteristics of 62, 967 patient records across 44 GP surgeries in South London.**

[a]The Income Deprivation Domain of the Index of Multiple Deprivation (IMD) was used as a measure of relative deprivation and is based residential addresses at a small local area level with an average of 1800 people (known as Lower Super Output Areas).

[b]Practice morbidity is the proportion of patients with $\geq$ 1 chronic condition in the practice.

[c]Number of emergency diabetes admissions for the practice in the last year.

[d]Number of full time equivalent General Practitioner doctors per 1000 patients.

[e]The Quality and Outcomes framework, QOF) is an annual reward and incentive programme for GP practices in England, Wales, and Northern Ireland with a maximum of 100 (most practices score over 90%).

[f]The GP Patient Survey assesses patients' experience of healthcare services provided by GP practices, including experience of access, making appointments, the quality of care received from healthcare professionals, patient health and experience of out of hours health services.

Table 2: Multilevel multivariable logistic regression modelling adjusted for patient and practice level correlates of health check uptake: Odds Ratios and 95% confidence levels.

	PATIENT LEVEL FACTORS						PRACTICE LEVEL FACTORS			
	Adjusted for age and ethnicity	P-value	+ English as first language	P-value	+ Overweight, smoking, GP visits, comorbidity	P-value	+ residential area SEC	P-value	+ all other practice factors	P-value
Health check no vs. yes										
PATIENT LEVEL FACTORS										
Self-assigned ethnicity										
White British	ref		ref		ref		ref		ref	
Other White	**1.38 (1.32-1.45)**	<0·0001	**1.36 (1.28-1.44)**	<0·0001	**1.24 (1.17-1.33)**	<0·0001	**1.24 (1.17-1.33)**	<0·0001	**1.24 (1.17-1.33)**	<0·0001
Black African	**0.90 (0.85-0.96)**	0.002	**0.89 (0.84-0.95)**	0.001	1.05 (0.97-1.13)	0.22	1.05 (0.97-1.13)	0.24	1.05 (0.97-1.13)	0.22
Black Other	**0.87 (0.79-0.96)**	0.01	**0.87 (0.79-0.96)**	0.01	1.04 (0.93-1.16)	0.51	1.04 (0.93-1.16)	0.52	1.04 (0.93-1.16)	0.51
Black Caribbean	**0.68 (0.64-0.74)**	<0·0001	**0.69 (0.64-0.74)**	<0·0001	**0.87 (0.80-0.94)**	0.001	**0.87 (0.80-0.94)**	0·001	**0.87 (0.80-0.94)**	0.001
White and Black Caribbean	**0.77 (0.65-0.91)**	0.002	**0.76 (0.64-0.91)**	0.002	1.01 (0.83-1.22)	0.95	1.00 (0.83-1.22)	0.96	1.01 (0.83-1.22)	0.96
Chinese	**1.66 (1.44-1.93)**	<0·0001	**1.63 (1.40-1.89)**	<0·0001	**1.15 (0.97-1.37)**	0.10	1.15 (0.97-1.37)	0.10	1.15 (0.97-1.37)	0.10
Bangladeshi	**0.37 (0.26-0.52)**	<0·0001	**0.36 (0.25-0.51)**	<0·0001	**0.60 (0.41-0.89)**	0.01	**0.60 (0.41-0.89)**	0.01	**0.61 (0.41-0.89)**	0.01
Pakistani	**0.79 (0.64-0.98)**	0.03	**0.78 (0.63-0.96)**	0.02	1.08 (0.85-1.36)	0.55	1.08 (0.85-1.36)	0.55	1.08 (0.85-1.37)	0.54
Indian	1.06 (0.92-1.22)	0.40	1.05 (0.91-1.21)	0.50	1.09 (0.93-1.28)	0.27	1.09 (0.93-1.28)	0.27	1.10 (0.93-1.29)	0.26
Asian Other	0.96 (0.86-1.07)	0.44	0.94 (0.84-1.05)	0.30	1.03 (0.90-1.17)	0.68	1.03 (0.90-1.17)	0.68	1.03 (0.91-1.17)	0.67
White and Asian	0.88 (0.66-1.17)	0.37	0.87 (0.65-1.16)	0.35	0.84 (0.61-1.15)	0.27	0.84 (0.61-1.15)	0.27	0.84 (0.61-1.15)	0.27
Arab	0.73 (0.37-1.46)	0.37	0.71 (0.36-1.41)	0.33	0.88 (0.42-1.87)	0.74	0.88 (0.42-1.87)	0.74	0.88 (0.42-1.87)	0.75
Other ethnicity	**1.31 (1.19-1.44)**	<0·0001	**1.27 (1.15-1.41)**	<0·0001	**1.20 (1.07-1.35)**	0.002	**1.20 (1.07-1.35)**	0.002	**1.20 (1.07-1.35)**	0.002
Other Mixed	**1.14 (0.99-1.31)**	0.06	1.12 (0.97-1.29)	0.12	1.12 (0.95-1.31)	0.17	1.12 (0.95-1.31)	0.17	1.12 (0.95-1.31)	0.17
Age (Years)										
40-49 (reference category)	ref		ref		ref		ref		ref	
50-69	**0.90 (0.87-0.94)**	<0·0001	**0.90 (0.87-0.94)**	<0·0001	**1.55 (1.47-1.62)**	<0·0001	**1.55 (1.47-1.62)**	<0·0001	**1.55 (1.47-1.62)**	<0·0001
70-74	**0.69 (0.65-0.73)**	<0·0001	**0.69 (0.65-0.73)**	<0·0001	**1.60 (1.48-1.71)**	<0·0001	**1.60 (1.48-1.71)**	<0·0001	**1.60 (1.49-1.72)**	<0·0001
English as first language (reference category)			ref		ref		ref		ref	
English not a first language			**0.96 (0.91-1.02)**	0.18	1.01 (0.95-1.07)	0.83	1.01 (0.95-1.07)	0.82	1.01 (0.95-1.07)	0.82
Overweight or obese (BMI ≥ 25 kg/m^2) vs. not overweight (BMI < 25 kg/m^2)					**0.87 (0.83-0.91)**	<0·0001	**0.87 (0.83-0.91)**	<0·0001	**0.87 (0.83-0.91)**	<0·0001
Current smoker										
Yes vs. no					1.01 (0.95-1.07)	0.84	1.01 (0.95-1.07)	0.86	1.01 (0.95-1.07)	0.86
Frequency of GP visits in last year										

Table 2 (*Continued*)

	PATIENT LEVEL FACTORS						PRACTICE LEVEL FACTORS			
	Adjusted for age and ethnicity	P-value	+ English as first language	P-value	+ Overweight, smoking, GP visits, comorbidity	P-value	+ residential area SEC	P-value	+ all other practice factors	P-value
0-3 visits (reference)					ref		ref		ref	
4 - 5 visits					**0.10 (0.09-0.11)**	<0·0001	**0.10 (0.09-0.11)**	<0·0001	**0.10 (0.09-0.11)**	<0·0001
6 + visits					**0.10 (0.10-0.11)**	<0·0001	**0.10 (0.10-0.11)**	<0·0001	**0.10 (0.10-0.11)**	<0·0001
Morbidity										
1 or fewer comorbidities					ref		ref		ref	
2 or more comorbidities					**0.48 (0.46-0.51)**	<0·0001	**0.48 (0.46-0.51)**	<0·0001	**0.48 (0.46-0.51)**	<0·0001
GP PRACTICE LEVEL CHARACTERISTICS[a]										
Index of Multiple Deprivation (Income Score): Most deprived 4th and 5th quintiles vs. Less deprived 1st to 3rd quintiles							0.99 (0.95-1.04)‼	0.75	0.99 (0.95-1.04)	0.75
Practice Morbidity									0.89 (0.78-1.03)	0.12
≥3 Diabetes emergency admissions in last year									1.04 (0.88-1.23)	0.67
Full time equivalent GP/1000 patients									0.99 (0.79-1.24)	0.93
Quality and Outcomes Framework score ≥ 95%									1.13 (0.97-1.31)	0.12
Patient satisfaction score ≥80%									1.04 (0.93-1.18)	0.48
Tjur's Coefficient of Discrimination (D)[b], all $p < 0.0001$	0.024 (0.023-0.025)		0.024 (0.023-0.025)		0.208 (0.204-0.211)		0.208 (0.204-0.211)		0.208 (0.205-0.211)	
Intra Class Coefficient (ICC)[c]	0.012 (0.008-0.019)		0.012 (0.008-0.019)		0.011 (0.007-0.017)		0.010 (0.006-0.017)		0.009 (0.006-0.015)	

Table 2: **Patient and practice level correlates of NHS Health Check uptake, blood pressure or HbA1c recording in last year where clinically indicated: Odds Ratios and 95% confidence levels (imputed).**

[a] Multilevel multivariable logistic regression modelling using Practice characteristics include: Index of Multiple Deprivation (Income Score); Practice Morbidity; Diabetes emergency admissions, Full time equivalent GP/1000 patients, Quality Outcomes Framework (QOF) score, QOF, Patient satisfaction score-see Table 1 for further detail.

[b] Tjur's Coefficient of Discrimination (D), is a measure of explanatory power.

[c] Intra Class Coefficient (ICC), provides an estimate of the relative contribution of the GP practices to the total variance of the model.

examined the contributions of patient related factors and practice context related factors to the uptake of the health check. This study aimed to address that gap by using patient records from GP practices in an inner-city area in London with high levels of need. Patient level factors contributed ~20% of the variance while practice level factors contributed <1%. After adjustments for both patient and practice level factors, non-uptake remained higher for Other White, Other or unknown ethnicity groups, older age groups and those with missing information for smoking status, signalling missed opportunities for early prevention and control of CVD risk factors. Adjustment for overweight accounted for the higher non-uptake among Chinese and Other mixed ethnicity groups. Non-uptake was less likely among Black Caribbeans and Bangladeshis, overweight, frequent attenders to practices and those with a comorbidity. We adjusted for comorbidities as we also included individuals who may have had pre-existing conditions for diabetes and screening checks who would be ineligible for the NHS Health Check alone. We additionally adjusted for non-cardiovascular comorbidities for individuals invited for NHS Health Checks. Adjustment for overweight/obesity, smoking, frequency of GP visits and comorbidity accounted lower non-uptake among Black African, Black Other, White and Black Caribbean and Pakistani groups. We tested six practice level factors and none were significantly associated with non-uptake. The large unexplained variance (~80%), however, signals unmeasured confounders, including employment and social behaviours.

A key strength of our study, which was the first to examine practice and patient level factors, was the use of a 15-category ethnicity variable rather than the broad categories such as 'White' 'Black' or 'South Asian' or "Other", which are not culturally or socio-economically homogenous groupings.[30] Our findings underscore the importance of using meaningful disaggregation. For example, the 'Other White' group showed a higher non-uptake than the 'White British' group. This is an often-overlooked group which is very diverse and includes second and subsequent generations born in the UK and a large number of South Americans with known health inequalities.[9] Furthermore, ethnicity is self-reported and may be subjective. Whilst lower non-uptake of the health check remained lower among Black Caribbean, lower non-uptake among Black Africans was no longer evident after adjustments for overweight and co-morbidity. We found a similar pattern for Bangladeshis and Pakistanis. This suggests that different factors shape access of the heath checks across these groups. More than 98% patients were registered with a GP in Lambeth and combining primary care records across 44 GP practices in a local area of high need enabled reliable reporting of this heterogeneity of uptake amongst diverse ethnic groups. An additional strength of the study is that the sample is representative of female patients aged 40-74 yrs in Lambeth. The population

studied was chosen as it is unique in diversity and enabled a study of factors affecting health check uptake in diverse ethnic groups, however we note results may be less generalisable to less diverse areas in the UK.

There are a number of potential limitations that need to be considered. Social and ethnic inequalities are known to shape health inequalities,[20] however measures of SEC which are diverse and context specific, vary in effect size and direction of effect after adjustment varying across ethnic groups. Furthermore, living in a socially disadvantaged neighbourhood may differ between ethnic groups, due to historical or community concentrations of some groups and other pragmatic factors.[31] The lack of robust measures of socio-economic position in the patient records limited the examination of inequalities in uptake. Understanding ethnic differences in uptake requires an understanding of how ethnicity intersects with SEP as well as other social determinants such as religion and migration status.[32] There was substantial missing data for occupation (90%), employment status (80%) and country of birth (54%). Religion is scantily recorded. The IMD is an area measure of residential area deprivation and is commonly used as a proxy measure of individual SEP in the analyses of primary care records. We used it as a practice level measure to examine whether high proportions of patients in deprived areas may associate with lower uptake due to increased workload from higher needs. As part of a sensitivity analyses, we included it as a patient level measure, but this did not materially alter the results and remained non-significant. Caution is warranted in its use as ethnic minorities may choose to live in deprived areas with high ethnic density for the benefit of cultural support (regardless of SEP).[33] Recently arrived migrants may choose to live in areas with low-cost housing despite having higher education qualifications.[34] Using IMD as a measure of deprivation, previous studies have reported inconsistent associations with uptake of NHS check.[35,36] We note selection bias may influence uptake of NHS health checks and this may vary by patient motivation, ethnicity and social determinants of health.

We included missing data for all variables in multiple imputation analyses, however the effect size change on estimates was minimal (<5%). It is important to understand the context of missing data and how this relates to potentially vulnerable and overlooked groups. For example, those with missing information on ethnicity and smoking status were more likely not to uptake the health check and were also less likely to be a frequent attender at the practice. Additionally, insufficient number of practices with large number of patients within each practice may explain the low contribution of practice level measures. Although the cross-sectional study design is limited as it provides a snapshot in time and that a longitudinal study design is needed to explore changes in the magnitude and the direction of associations over time.

A rapid review of the NHS Health Check Programme published in 2020, suggested that that the uptake ranged

from 41 to 49%. In a sensitivity analysis separating the uptake of the NHS Health Check from that of the annual (hypertensive and diabetic) reviews, we found much lower uptake (∼24.0%). The uptake of the annual reviews with patients with diagnosed hypertension and diabetes was 71.6%. The QOF will capture some of the NHS Health Check Programme Standards. These include identifying the eligible population and offering an NHS Health Check, and use of templates to help ensure a complete NHS Health Check for those who accept the offer is undertaken and recorded. Practices have standardised quality controls for equipment and on site testing as part of their mandatory independent national regulator, Care Quality Commission (CQC) inspections. Other parameters are undertaken by practices as part of routine care (all results are automatically captured in electronic records) and additional testing and clinical follow up, but we did not assess this in our study.

The QOF is known to pay dividends as it is a primary care pay-for-performance scheme that rewards practices for delivering effective interventions in long-term conditions. This incentive may be more effective for management of diagnosed conditions (via the hypertension and diabetes reviews) than for the NHS Health Check which focuses on prevention of these conditions. A systematic review found that QOF was associated with a modest slowing of both the increase in emergency admissions and the increase in consultations in severe mental illness (SMI), and modest improvements in diabetes care.[37] Most of the studies in the rapid review of the NHS Health Check were of low quality but there are some noteworthy points. The review found inconsistency in ethnic differences in uptake, with several reporting lower uptake in White British compared than African/Caribbean, Asian or mixed background, in deprived areas, among smokers, and among those >60 years old. In contrast, our sensitivity analyses with only the NHS Health Checks found that compared to White British, uptake was lower among Black African, Black Other, Black Caribbean, White and Black Caribbean, Bangladeshi, White and Asian, Other Mixed, Other White, Other ethnic groups and among smokers. The determinants for the uptake of the NHS Health Check may vary from that of the annual reviews and is worthy of further attention. Some qualitative studies have reported that ethnic minorities may benefit from community ambassadors, invitation via telephone and opportunistic testing due to morbidities.[38] These models of advocacy and delivery could be important to optimise the uptake of both the NHS Health Check and the annual reviews.

We found patient level rather than GP practice level factors accounted for a greater proportion of the total variance in non-uptake, which may benefit from targeted health interventions. However, differential uptake in health checks remained after adjustment for patient and practice level factors. The value of primary care records for tackling inequalities in uptake of health checks could be strengthened by the inclusion of better measures of social determinants of health at patient level and of accessibility of services at the GP practice context level. This is critical for developing context specific interventions to promote the uptake of health checks. In addition, health behaviours are shaped by the context people live in. Linkage of environmental variables (e.g., transport, cultural assets that can promote uptake, safety) would also strengthen our understanding of how the context of where patients live affects availability and access of services. This calls for a population perspective to primary care. Identifying and building on synergies that exist between population health and primary care would help address the data quality issues that we have encountered.[27] Primary care is already relying on knowledge models derived from population health (e.g., via use of decision support systems) and there is growing awareness of the need to improve data capture standards. Furthermore, a population perspective to primary care can facilitate creating partnerships with a range of organisations involved in delivering preventive CVD interventions in the community,[39] and co-ordinated efforts for health advocacy.[40] The paper highlights inequalities in missed opportunities for increasing uptake of health checks which are the subject of targeted interventions in a future planned feasibility study (NIHR202679).

Declaration of interests
None.

Contributors
Conception and design of the research: MM, SH, SA, AK, and VL; Data curation and verification: MM and SD; Acquisition and interpretation of the data: SH, MM, AK and SA ; Statistical analysis: SA, AK, MM, and SH; Methodology: SA, AK, VL, MA, MM and SH. Writing of the original manuscript draft: SA, AK, MM, and SH; Writing review and editing of the manuscript: All authors. Funding acquisition: MM and SH.

Data sharing statement
Data may be obtained from a third party and are not publicly available. Access to the deidentified data in this study can be applied for through Lambeth DataNet. Access is granted only if approval is given by the Lambeth DataNet Steering Group.

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