Assessment of cardiovascular risk factors prior to NHS Health Checks in an urban setting: cross-sectional study

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DECLARATIONS

Competing interests
None declared

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MA will act as guarantor

Summary

Objectives To assess the completeness of cardiovascular disease (CVD) risk factor recording and levels of risk factors in patients eligible for the NHS Health Check.

Design Cross-sectional study.

Setting Twenty-eight general practices located in Hammersmith and Fulham, London, UK.

Participants 42,306 patients aged 40 to 74 years without existing cardiovascular disease or diabetes.

Main Outcome Measures Measurement and level of CVD risk factors: blood pressure, cholesterol, body mass index (BMI), blood glucose and smoking status.

Results There was a high recording of smoking status (86.1%) and blood pressure (82.5%); whilst BMI, cholesterol and glucose recording was lower. There was large variation in BMI, cholesterol, glucose recording between practices (29.7–91.5% for BMI). Women had significantly better risk factor recording than men (AOR = 1.70 [1.61–1.80] for blood pressure). All risk factors were better recorded in the least deprived patient group (AOR = 0.79 [0.73–0.85] for blood pressure) and patients with diagnosed hypertension (AOR = 7.24 [6.67–7.86] for cholesterol). Risk factor recording varied considerably between practices but was more strongly associated with patient than practice level characteristics. Age-adjusted levels of cholesterol and BMI were not significantly different between men and women. More men had raised blood glucose, blood pressure and BMI than women (29.7% [29.1–30.4] compared to 19.8% [19.3–20.3] for blood pressure).

Conclusions Before the NHS Health Check, CVD risk factor recording varied considerably by practice and patient characteristics. We identified significant elevated levels of raised CVD risk factors in the population

Contributorship
MA conducted and ARHD and CM supervised the statistical analysis. All authors helped interpret the data analysis results. AM, ARHD and CM wrote the first draft of the paper. All authors reviewed the manuscript critically for important intellectual content.

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eligible for a Health Check, which will require considerable work to manage.

Background

Cardiovascular disease (CVD) is the leading cause of death in the UK, although there has been a decline in the mortality since early 1970s, and it is a major contributor to health inequalities.[1] Reducing the burden of CVD requires both primary and secondary prevention strategies.[2] While there have been some primary prevention strategies in the UK over the past decade,[3,4] there has been far greater focus on secondary prevention strategies targeting high risk individuals.

The National Health Service (NHS) Health Check is a national primary prevention programme for combined vascular disease; namely CVD, diabetes, hypertension and chronic kidney disease (CKD). The programme, implemented nationally from April 2009, aims to the reduce CVD risk and narrow health inequalities.[5] Predictive algorithms are used to estimate patient-specific risks for future cardiovascular events. Assessment, communication and reduction of these risks form the basis of management under the programme. National guidance recommends CVD risk to be managed through general lifestyle advice, the management of individual risk factors (e.g. weight management) and lipid lowering medications for patients with a 20 percent or higher risk of developing CVD in the next 10 years.[6,7]

Since the implementation of Quality Outcomes Framework (QOF), there has been an improvement in CVD risk factor recording in patients with established CVD.[8] Risk factor recording in patients without existing CVD is lower, except for risk factors covered by the QOF indicators for primary prevention (smoking status and blood pressure recording).[9] Some PCTs may prioritize screening for patients with higher estimated CVD risk based on the existing medical records. Although CVD risk can be estimated with incomplete risk factor data, the more complete the data, the better the sensitivity and specificity of estimation.[10] More complete risk factor data leads to more accurate prioritization of high risk patients and will determine the workload implications of the programme for general practice.

We aimed to assess the recording and level of risk factors before the implementation of the Health Check in Hammersmith and Fulham, and to examine how recording varies with patient and practice characteristics.

Methods

NHS Health Check in Hammersmith and Fulham, West London

The NHS Health Check is managed locally by Primary Care Trusts (PCTs) and offers 5-yearly screening to patients aged 40 to 74 years.[5] PCTs were provided with national guidance on implementation, but given substantial autonomy to administer the programme differently from the national programme based upon the needs of the local population, as long as minimum standards were met. PCTs were able to extend the age range of the programme (i.e. typically by inviting patients under 40 years) and deliver the programme in settings other than general practice, e.g. pharmacies, places of worship.[11]

The Health Check programme was implemented in Hammersmith and Fulham ahead of the national schedule and has been administered under a local Quality and Outcomes Framework (QOF Plus).[12] The QOF Plus Health Check differs from the national minimum Health Check by including patients with hypertension and CKD. In the first year of the programme, patients determined to have high CVD risk (greater than 20 percent risk using a designated risk score) from existing medical records were prioritized for screening. In the second year of the programme all patients, regardless of baseline risk, were included in the programme.[13]

Data

Baseline data for the Health Check programme was extracted from patient electronic records in 28 of the 31 general practices in the borough. This included Read-Coded data of patients aged 40 to 74 years, registered in practices on 31st

June 2008 and not already on CVD (CHD, stroke/transient ischaemic attack and atrial fibrillation) or diabetes registers. Extracted data included demographic information (e.g. age, sex, ethnicity); clinical information (e.g. BMI, blood pressure, disease status); and prescribing data. Data on the most recent recording of each CVD risk factor were extracted from the dataset, removing any risk factor reading older than 5 years. We assessed the proportion of patients with a CVD risk factor reading (blood pressure, BMI, blood glucose and lipid ratio) recorded within last 5 years.

Predictor variables

We divided age into four groups (40–44, 45–54, 55–64, 65–74 years). We used the 2001 UK Census for ethnicity classification but condensed the 16 ethnicity categories into ten due to small numbers. As well as family history for CHD, we obtained disease status for hypertension and CKD. We also obtained data on asthma, mental health, depression, hypothyroidism, chronic obstructive pulmonary disease (COPD) status and classified patients with one or more of these co-morbidities as having *discordant co-morbidity*. Each patient was assigned a deprivation (Indices of Multiple Deprivation [IMD] 2007) score based on the postcode of their residence. We divided patients into local thirds of deprivation (where 1 is most deprived). As well as patient postcodes, we obtained the postcodes for each practice, splitting into local thirds. We obtained practice list size, the number of full-time equivalent GPs in each practice and QOF performance indicators for each practice; one indicator from each of the clinical, patient experience and additional service domains.[14]

Outcome Measures

Our outcome measures were the recording and level of CVD risk factors; blood pressure, cholesterol, glucose, BMI and smoking status.

Analysis

We assessed the characteristics of the study population and levels of CVD risk factors; blood pressure, cholesterol, glucose and BMI, and smoking status. We calculated age-standardized risk factor levels by direct-standardization to examine risk factor levels between gender groups. We also examined the overall recording of CVD risk factors and the variation in risk factor recording between practices and patients.

We examined the recording of CVD risk factors using multilevel logistic regression analysis. We used random effects models with patient variables at level 1 and practice at level 2. Recent evidence has suggested that model selection methods produce poorly performing models.[15] We therefore used regression models including all variables eligible for selection. For each CVD risk factor, we built three sets of models; one with only patient level variables, one with practice level, and with both patient and practice level variables to examine the relative impact of practice and patient level variables on CVD risk factor recording. We determined an estimate of variance at level 1 (σ_μ), the Median Odds Ratio (MOR)[16] and Intraclass Correlation Coefficient (ICC) to quantify the variance in risk factor recording at the practice or patient level. MOR is suggested as a good measure of level 2 variance compared to σ_μ,[17] it shows the odds ratio of risk factor recording between two randomly selected practices.

We used STATA version 11.1 for all analyses. Ethical approval for the study was granted from National Research Ethics Service Committee.

Results

Characteristics of the Study Population

Characteristics of the patient population are presented in Table 1. In the 28 practices, 42,306 patients (19,561 male and 22,745 female) were aged 40 to 74 years and eligible for a health check. The mean age of the study population was 52.2 years. Of the sample, 77.7% had a valid ethnicity record and 35.9% of these patients were White British, 2.5% South Asian (Indian, Pakistani and Bangladeshi) and 8.6% Black African and Caribbean. The percentage of patients with hypertension was 15.4% and CKD was 3.0%.

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Table 1

Characteristics of the study population and percentage level of recording of blood pressure, cholesterol, glucose, BMI and smoking status within last 5 years

Patient Characteristics	*Characteristics*	*Number of Patients (%)*	*Blood Pressure (% recorded)*	*Cholesterol (% recorded)*	*Glucose (% recorded)*	*BMI (% recorded)*	*Smoking (% recorded)*
Sex	Male	19,561 (46.2)	78.3	44.4	42.0	57.9	84.8
	Female	22,745 (53.8)	85.9	49.5	51.1	60.7	87.5
Age	40–44	11,271 (26.4)	73.1	31.2	34.5	58.9	84.7
	45–54	15,473 (36.2)	82.4	42.8	43.1	57.3	84.3
	55–64	10,313 (24.1)	87.4	59.1	55.7	59.8	87.9
	65–74	5,649 (13.2)	92.3	70.2	66.9	65.6	92.0
Ethnicity	White British	15,181 (35.9)	87.8	49.7	48.0	63.1	91.1
	Other White	7,953 (18.8)	86.2	53.2	53.0	65.4	91.0
	Mixed	1,184 (2.80)	90.3	56.2	60.0	78.6	94.7
	Indian	640 (1.51)	91.6	65.6	66.6	75.0	92.3
	Pakistani	332 (0.78)	84.0	57.8	57.5	74.7	88.3
	Bangladeshi	90 (0.21)	93.3	66.7	67.8	87.8	96.7
	Black Caribbean	1,732 (4.09)	91.4	60.4	63.4	76.6	94.5
	Black African	1,907 (4.51)	90.5	58.7	62.0	79.2	92.9
	Other ethnic group	3,850 (9.10)	84.4	50.8	52.2	67.5	88.0
	Missing	9,437 (22.3)	64.6	28.9	28.1	33.8	69.2
Deprivation*	1	13,468 (31.8)	85.4	50.9	52.0	65.4	88.7
	2	14,217 (33.6)	82.5	46.8	47.8	59.1	86.4
	3	14,621 (34.6)	79.6	44.0	41.3	54.2	83.9
Hypertension	Yes	6,496 (15.4)	97.5	88.0	82.9	77.6	98.3
	No	35,810 (84.7)	79.7	39.8	40.3	56.1	84.1
Chronic Kidney Disease	Yes	1,247 (3.0)	97.1	92.1	90.4	71.8	93.7
	No	41,059 (97.0)	81.9	45.8	45.6	59.1	86.0
Discordant co-morbidities**	Yes	10,058 (23.8)	90.6	58.8	59.6	67.0	93.5
	No	32,248 (76.2)	79.8	43.5	42.9	57.0	83.6
Family history of CHD	Yes	5,231 (12.4)	89.6	60.6	57.8	73.9	94.0
	No	37,075 (87.6)	81.4	45.3	45.4	57.4	83.8
Smoking Status	Never smoked	11,938 (28.2)	83.1	44.1	43.6	65.3	87.0
	Ex-smoker	15,185 (35.9)	87.1	55.2	45.9	69.4	92.9
	Current smoker	9,371 (22.2)	83.2	44.4	53.9	61.0	92.0
	Missing	5,812 (13.7)	33.8	15.5	16.1	10.3	0.0

(Continued)

Table 1
Continued

Patient Characteristics	*Characteristics*	*Number of Patients (%)*	*Blood Pressure (% recorded)*	*Cholesterol (% recorded)*	*Glucose (% recorded)*	*BMI (% recorded)*	*Smoking (% recorded)*
Practice Characteristics							
Practice register size	<3500	2,848 (6.7)	83.5	47.1	46.0	60.4	88.1
	6000 > PS > 3500	12,377 (29.3)	86.3	53.9	52.7	72.3	89.7
	1000 > PS > 6000	15,346 (36.3)	81.1	41.1	38.5	52.0	85.7
	PS > 10000	11,759 (27.8)	79.6	49.2	51.9	55.3	83.0
FTE GP	≤1	3,749 (8.86)	86.3	47.8	45.3	67.0	89.0
	1 < FTEGP ≤ 3	12,043 (28.5)	85.0	53.0	53.2	69.9	89.6
	3 < FTEGP ≤ 7	17,150 (40.5)	82.7	42.5	40.4	54.9	86.2
	FTEGP ≥ 8	9,364 (22.1)	76.9	48.0	51.4	51.1	81.0
Practice Deprivation*	1	18,600 (44.0)	84.7	50.7	49.9	63.9	89.6
	2	15,005 (35.5)	79.5	46.0	49.0	54.3	81.5
	3	8,701 (20.6)	82.5	41.5	36.8	58.6	87.2
Total		42,306	82.5	47.5	47.2	59.5	86.1

*Indices of Multiple Deprivation 2007 - local third (1 most deprived)
**Discordant co-morbidities – Asthma, COPD, Depression, Mental Health Hypothyroidism

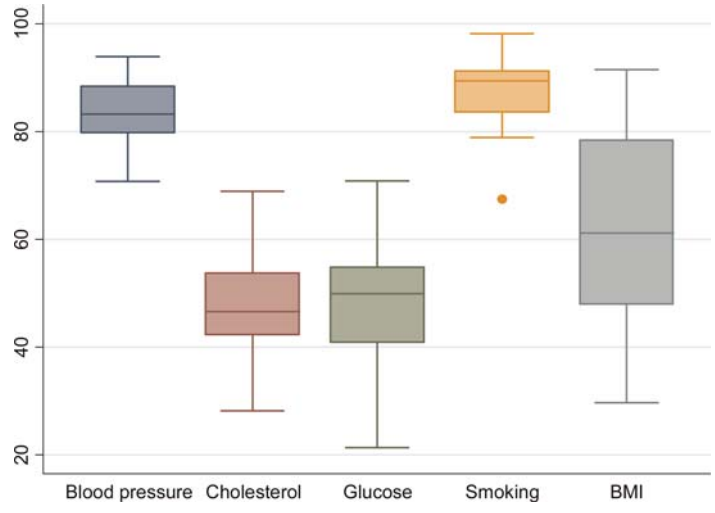
Variation in risk factor recording between practices and patients

There was a considerable variation in risk factor recording by patient and practice characteristics (Table 1 and Figure 1). A high proportion of patients (86.1%) had smoking status recorded within the last 5 years, but there was variation in recording between practices (range = 67.4–98.1%) (Figure 1). Blood pressure recording was also high with 82.5% of all patients having a record and the inter-practice variation in blood pressure recording was more moderate (70.7–93.9%). A lower proportion (59.5%) of patients had BMI recording, with large variation between practices (29.4–91.5%). Cholesterol and glucose were also less well recorded with 47.5% of patients having a cholesterol and 47.2% having a glucose record.

Risk factor recording showed variation across patients with different characteristics (Table 1 & Table 2). A significantly higher proportion of women had blood pressure, cholesterol, BMI, glucose and smoking status recording than men (AOR 1.70 [1.61–1.80] for blood pressure). There was significantly higher risk factor recording, except BMI and smoking status, in older patients than younger (65 to 74 years compared to 40–44 years). BMI recording was significantly lower in older individuals than younger (AOR 0.91 [0.84–0.98]).

Patients from Black Caribbean and Black African ethnic backgrounds had higher risk factor recording than White British patients (blood pressure in Black Caribbean AOR 1.22 [1.02–1.47]). Patients from other white and mixed ethnic backgrounds had all risk factors, except blood pressure, recorded better than White British. Bangladeshi patients had higher cholesterol, glucose and BMI recording higher than White British (cholesterol AOR 2.21 [1.36–3.59]), and Indian and Pakistani patients had higher cholesterol and glucose recording than White British. Patients without a valid ethnicity record had lower recording of all risk factors than White British. All risk factors were less well recorded in the least deprived patient group than the most deprived (blood pressure AOR 0.79 [0.73–0.85]). Hypertension and CKD were strongly and positively associated with risk factor recording (cholesterol recording in

Figure 1
The practice level variation in recording of cardiovascular disease risk factors within last 5 years



hypertensive patients AOR 7.24 [6.67–7.86] and in CKD patients AOR 6.19 [4.95–7.75]). Patients with discordant co-morbidities had higher risk factor recording than patients without (BMI AOR 1.53 [1.45–1.61]).

Practices with a practice size between 3500 and 6000 had higher BMI and smoking status recording than smaller practices (<3500) (BMI AOR 2.40 [1.04-5.52]) (Table 2). There was no significant association between practice level deprivation scores or practice scores on the Quality and Outcomes framework and risk factor recording.

Is the variation in risk factor recording predominantly attributable to practice or patient level factors?

Measures of heterogeneity in risk factor recording due to practice and patient level characteristics are shown in Table 3. MOR, ICC and σ_μ were higher in regression models with only patient level characteristics than those in models with only practice level characteristics, and both practice and patient level characteristics. The variation in risk factor recording is more strongly associated with patient level characteristics than practice level characteristics.

Level of cardiovascular risk factors

Mean levels of CVD risk factors are presented in Table 4. Mean systolic and diastolic blood pressure was significantly higher in men than women. Significantly more men had high blood pressure (≥140/90 mmHg) than women (29.7% [29.1–30.4] v 19.8% [19.3–20.3]). Age-adjusted mean cholesterol and BMI levels were not significantly different between men and women (BMI 26.6 (25.5–26.7) kg/m^2 compared to 26.7 (26.6–26.8) kg/m^2), but a higher proportion of men had high glucose levels (>6.0 mmol/l) and more men were overweight or obese than women. The proportion of women (32.6% [32.0–33.2]) with raised total cholesterol was higher than in men (27.2% [26.6–27.9]). The smoking prevalence was higher in men than women (26.1% [25.5–26.7] v 18.8% [18.3–19.3]).

Discussion

Main findings

Smoking status and blood pressure were well recorded in patients eligible for the NHS Health Check. Although the size of the financial incentives for the QOF indicators covering smoking and blood pressure recording in those without current disease is modest, the recording of these risk factors was better than other risk factors; cholesterol, glucose and BMI. Therefore, the QOF may play a role in the better recording of blood pressure and smoking. The variation in risk factor recording between practices was large. Variation in risk factor recording was more strongly associated with characteristics of the study population than practice level factors.

Recording of risk factors varied in patients with different characteristics. Women had better risk factor recording than men, although men are at a higher risk of CVD than women.[18] This might be due to the higher consultation rates in women than men, especially those at reproductive ages.[19] Older individuals had higher blood pressure, cholesterol and glucose recording than the younger; this may also be attributable to the higher GP consultation rates in older individuals[20] and QOF incentives for risk factor recording in older individuals.[21] More deprived patients were more likely to have a risk factor recording, GPs perceive deprived patients to be at high risk of

Table 2
Multivariate logistic regression analysis results of blood pressure, cholesterol, glucose, BMI and smoking status recording with practice level clustering

Patient Characteristics	*Characteristics*	*Blood Pressure AOR (95% CI)*	*Cholesterol AOR (95% CI)*	*Glucose AOR (95% CI)*	*BMI AOR (95% CI)*	*Smoking Status AOR (95% CI)*
Sex	Male	1.00	1.00	1.00	1.00	1.00
	Female	1.70 (1.61–1.80)	1.20 (1.15–1.25)	1.45 (1.39–1.52)	1.09 (1.05–1.14)	1.16 (1.09–1.23)
Age	40–44	1.00	1.00	1.00	1.00	1.00
	45–54	1.75 (1.65–1.87)	1.53 (1.44–1.61)	1.35 (1.28–1.43)	0.85 (0.81–0.90)	0.87 (0.81–0.94)
	55–64	2.16 (2.00–2.33)	2.55 (2.40–2.71)	1.98 (1.86–2.10)	0.85 (0.80–0.90)	0.95 (0.88–1.04)
	65–74	2.66 (2.37–2.98)	3.11 (2.87–3.36)	2.42 (2.24–2.61)	0.91 (0.84–0.98)	1.06 (0.94–1.19)
Ethnicity	White British	1.00	1.00	1.00	1.00	1.00
	Other White	0.90 (0.83–0.98)	1.08 (1.02–1.15)	1.12 (1.05–1.19)	1.14 (1.07–1.21)	1.11 (1.00–1.22)
	Mixed	1.19 (0.97–1.47)	1.25 (1.09–1.43)	1.45 (1.27–1.66)	1.65 (1.41–1.93)	1.44 (1.10–1.89)
	Indian	1.25 (0.93–1.68)	1.88 (1.56–2.26)	2.14 (1.78–2.57)	1.22 (1.00–1.48)	1.02 (0.75–1.39)
	Pakistani	0.64 (0.47–0.89)	1.59 (1.24–2.03)	1.61 (1.26–2.06)	1.15 (0.87–1.51)	0.72 (0.51–1.04)
	Bangladeshi	1.66 (0.71–3.90)	2.21 (1.36–3.59)	2.27 (1.30–3.66)	2.62 (1.34–5.12)	2.04 (0.63–6.57)
	Black Caribbean	1.22 (1.02–1.47)	1.32 (1.17–1.48)	1.51 (1.35–1.70)	1.40 (1.23–1.59)	1.41 (1.13–1.76)
	Black African	1.39 (1.18–1.65)	1.47 (1.32–1.65)	1.65 (1.48–1.85)	1.82 (1.61–2.06)	1.29 (1.07–1.56)
	Other ethnic group	0.84 (0.76–0.94)	1.20 (1.11–1.30)	1.27 (1.17–1.37)	1.33 (1.23–1.45)	0.89 (0.79–1.00)
	Missing	0.31 (0.29–0.33)	0.56 (0.53–0.60)	0.56 (0.53–0.60)	0.38 (0.35–0.40)	0.25 (0.24–0.28)
Deprivation*	1	1.00	1.00	1.00	1.00	1.00
	2	0.92 (0.85–0.99)	0.98 (0.92–1.03)	1.00 (0.94–1.06)	1.05 (0.99–1.11)	0.97 (0.89–1.05)
	3	0.79 (0.73–0.85)	0.94 (0.89–1.00)	0.86 (0.81–0.91)	0.88 (0.83–0.93)	0.82 (0.76–0.89)
Hypertension	No	1.00	1.00	1.00	1.00	1.00
	Yes	5.50 (4.67–6.46)	7.24 (6.67–7.86)	4.93 (4.58–5.30)	2.22 (2.06–2.38)	7.48 (6.16–9.09)
Chronic Kidney Disease	No	1.00	1.00	1.00	1.00	1.00
	Yes	3.37 (2.38–4.77)	6.19 (4.95–7.75)	5.08 (4.14–6.24)	1.38 (1.19–1.59)	1.49 (1.15–1.92)
Discordant co-morbidities**	Yes	1.00	1.00	1.00	1.00	1.00
	No	2.06 (1.91–2.22)	1.71 (1.63–1.80)	1.82 (1.73–1.92)	1.53 (1.45–1.61)	2.77 (2.52–3.04)
Family history of CHD	No	1.00	1.00	1.00	1.00	1.00
	Yes	1.65 (1.49–1.83)	1.66 (1.55–1.78)	1.34 (1.30–1.49)	1.73 (1.61–1.86)	1.31 (1.17–1.46)
Practice Characteristics						
Practice register size	<3500	1.00	1.00	1.00	1.00	1.00

(Continued)

Table 2
Continued

Patient Characteristics	Characteristics	Blood Pressure AOR (95% CI)	Cholesterol AOR (95% CI)	Glucose AOR (95% CI)	BMI AOR (95% CI)	Smoking Status AOR (95% CI)
	6000 > PS > 3500	1.59 (1.00–2.52)	1.39 (0.95–2.04)	1.78 (1.08–2.29)	2.40 (1.04–5.52)	1.96 (1.07–3.60)
	10000 > PS > 6000	1.10 (0.66–1.84)	0.86 (0.56–1.32)	1.24 (0.71–2.17)	0.91 (0.36–2.30)	1.71 (0.87–3.35)
	PS > 10000	1.10 (0.62–1.95)	1.15 (0.72–1.85)	1.79 (0.96–3.34)	1.19 (0.42–3.36)	1.23 (0.58–2.59)
Practice IMD	1	1.00	1.00	1.00	1.00	1.00
	2	0.78 (0.57–1.07)	0.91 (0.69–1.18)	1.01 (0.71–1.43)	0.67 (0.38–1.20)	0.62 (0.41–0.94)
	3	1.19 (0.79–1.79)	0.82 (0.59–1.15)	0.89 (0.57–1.39)	1.55 (0.74–3.25)	1.46 (0.85–2.50)
QOF Indicators	CHD8†	1.01 (0.99–1.03)	1.00 (0.99–1.02)	1.00 (0.98–1.01)	0.99 (0.96–1.02)	1.00 (0.98–1.02)
	PE07‡	1.00 (0.99–1.02)	1.00 (0.98–1.01)	1.00 (0.99–1.02)	0.99 (0.96–1.02)	1.01 (0.99–1.04)
	CS1§	0.99 (0.98–1.00)	1.00 (0.99–1.02)	0.99 (0.98–1.01)	0.98 (0.96–1.01)	0.98 (0.96–1.00)

*Indices of Multiple Deprivation 2007 - local third (1 most deprived)
**Discordant co-morbidities – Asthma, COPD, Depression, Mental Health Hypothyroidism
†CHD08 – The percentage of patients with coronary heart disease, whose last measured total cholesterol (measured in the previous 15 months) is 5 mmol/l or less
‡PE07 – the percentage of surveyed patients who said they could get an appointment with their practice within 48 hours of requesting one
§CS01 – The percentage of patients aged from 25 to 64 (in Scotland from 21 to 60) whose notes record that a cervical smear has been performed in the last five years.
Note: Odd ratios are adjusted for all variables in the table

CVD therefore may be more likely to record CVD risk factors.[22] Black patients had higher risk factor recording than white patients; likewise South Asian (Indian, Pakistani and Bangladeshi) patients had more complete cholesterol and glucose recording. The higher GP consultation rates of Black and South Asian people[23] and GPs' perception of greater CVD risk in Black and South Asian people[24] may have a role on the higher risk factor recording in these populations. Having co-morbid diseases (e.g. hypertension, asthma) was a strong determinant of risk factor recording; this may be due to the higher GP attendance rates for regular review of co-morbid conditions. In hypertensive patients, GPs' perception of higher CVD risk in these patients and larger size of QOF incentives for recording of risk factors[21] may also play a role in better risk factor recording.

What is already known on this topic?

The high blood pressure recording was consistent with the findings of the previous work, which reported very high blood pressure recording in individuals older than 45 years without chronic disease and an improvement in blood pressure recording after the introduction of the QOF.[25] Poorer BMI and cholesterol recording confirms the previous evidence, which showed less complete BMI and cholesterol recording in individuals aged 32 to 74 years without CVD and diabetes.[9] Dalton *et al.*[9] found better cardiovascular risk factor recording in women and that variation in recording is largely due to the difference in patient characteristics, consistent with our study. Although evidence of better risk factor recording in deprived patients is limited, Lyratzopoulos *et al.*[26] reported that deprived patients had better BMI and smoking recording.

What this study adds?

Unlike previous studies, our study presents variation in cardiovascular risk factor recording in a wide range of ethnic groups. We illustrated that Black Caribbean and African patients have better recording of all risk factors than White British patients, while Dalton *et al.*[9] showed only cholesterol recording was better in Black patients. We observed

Table 3
The heterogeneity in the cardiovascular disease risk factor recording when adjusted for patient level, practice level and both patient and practice level characteristics

	Patient level model	*Practice level model*	*Practice and patient level model*
Blood pressure			
σ_μ	0.41 (0.31–0.54)	0.38 (0.29–0.50)	0.34 (0.26–0.46)
ICC	0.111	0.104	0.094
MOR	1.87	1.82	1.77
Cholesterol			
σ_μ	0.37 (0.28–0.49)	0.28 (0.21–0.37)	0.29 (0.22–1.39)
ICC	0.101	0.078	0.081
MOR	1.81	1.67	1.69
Glucose			
σ_μ	0.46 (0.35–0.60)	0.37 (0.28–0.49)	0.38 (0.29–0.51)
ICC	0.123	0.101	0.104
MOR	1.94	1.81	1.82
BMI			
σ_μ	0.83 (0.64–1.09)	0.63 (0.48–0.82)	0.65 (0.49–0.84)
ICC	0.201	0.161	0.165
MOR	2.43	2.17	2.19
Smoking status			
σ_μ	0.56 (0.42–0.74)	0.45 (0.34–0.60)	0.45 (0.33–0.59)
ICC	0.145	0.120	0.120
MOR	2.07	1.92	1.92

σ_μ – Estimated Variance
ICC – Intraclass Correlation Coefficient
MOR – Median Odd Ratio

that patients with non-CVD co-morbidities are more likely to have CVD risk factors recorded. This may be due to more frequent attendance to general practice in these patients.

Implications for practice

Our findings show incomplete recording of risk factors; particularly glucose, cholesterol and BMI, suggesting that the recording of risk factors for cardiovascular disease risk assessment will generate a large workload for primary care teams.

Attention to the prevention of CVD has grown worldwide. A number of prevention initiatives have recently been introduced; for example the "Million Hearts" initiative in the U.S.[27] and a framework to prevent CVD, diabetes and CKD in Australia,[28] but none have had the scope of the UK's NHS Health Check. The latter involves primary care teams offering health checks to specific patient groups, but not the entire population.[28] Work presented here suggests that considerable efforts will be required and that additional support to primary care teams may be required to facilitate improved risk factor recording.

A high proportion of the study population is overweight and obese, have raised blood pressure and raised cholesterol levels. Efforts must be made by primary care teams to manage CVD risk factors effectively. Early findings suggest the uptake of statins, in eligible patients, after the Health Check was low.[29] The strong uptake and adherence to interventions is vital for the management of the large burden of CVD risk factors found here and, in turn, for the success of the programme. The uptake of both the initial Health Check and subsequent interventions must be further monitored across different settings, and as the programme progresses. We have shown that a higher proportion of men are overweight and obese, and have raised blood pressure and higher glucose levels than women. Although men have higher levels of CVD risk factors compared to women, they have lower attendance at general practice[20] and lower usage of preventative health care.[30] Primary care teams must promote the Health Check attendance in male patients and ensure the appropriate management of their CVD risk. The management of this risk will generate a large workload for the Health Check programme, in addition to the workload of screening.

There are inequalities in CVD morbidity and mortality between ethnic and socioeconomic groups. We found that risk factor recording was highest in ethnic groups at greatest risk of CVD. However, ethnicity recording was incomplete in general practices participating in our study; this must be improved to enable commissioners to monitor the equality in delivery of the programme.

Strengths and Limitations

The size of the study population was large, and the study covered most of the population eligible for the Health Check in one English PCT. We used the most recent data from patient medical

Table 4
Age standardised mean levels of cardiovascular disease risk factors

		Men	*Women*
Blood pressure	Mean systolic blood pressure (mm/Hg)	129.9(129.7–130.1)	125.1 (124.9–125.3)
	Mean diastolic blood pressure (mm/Hg)	80.0 (79.9–80.1)	77.6 (77.4–77.7)
	High blood pressure (≥140/90) (%)	29.7 (29.1–30.4)	19.8 (19.3–20.3)
Cholesterol	Mean total cholesterol (mmol/l)	5.32 (5.29–5.34)	5.36 (5.34–5.38)
	Raised cholesterol (≥5 mmol/l) (%)	27.2 (26.6–27.9)	32.6 (32.0–33.2)
Glucose	Mean blood glucose (mmol/l)	5.26 (5.24–5.28)	5.05 (5.03–5.06)
	High glucose (blood glucose ≥6.0 mmol) (%)	5.52 (5.20–5.84)	4.40 (4.13–4.66)
BMI	Mean BMI (kg/m^2)	26.6 (25.5–26.7)	26.7 (26.6–26.8)
	Overweight and obese (≥25 kg/m^2) (%)	35.1 (34.4–35.8)	32.6 (32.0–33.2)
Smoking	Smoking rate (%)	26.1 (25.5–26.7)	18.8 (18.3–19.3)

records and examined associations between risk factor recording and a number of patient and practice characteristics. We could not include patients from three practices, due to low data returns, but the patients of these practices did not differ in their characteristics to our study population. Since all patients have universal access to primary care services, we did not exclude any patient group from the study. This study was based on a primary care population of a diverse area both in terms of deprivation and ethnicity, where CVD is common. The findings of this study are not generalizable to the UK, but they may be similar to those in other urban areas with similar patterns of deprivation, ethnic diversity and a high burden of vascular disease. A weakness of our study is that we did not have complete ethnicity recording for the study population. An area deprivation score based on postcodes was used as a measure of socioeconomic status for patients and practices. Other individual-level measures of socioeconomic status of patients, such as household income and education, might have better measured socioeconomic status; however these are not present in routine medical data. Other practice-level characteristics, such as age, ethnicity and place of training of GPs, could be included in models to examine their association with risk factor recording, but were again unavailable.

Conclusions

Patients without CVD and diabetes have low CVD risk factor recording in electronic medical records, although risk factor recording in individuals with CVD has been increasing in the UK. Risk factor recording varies between practices and patients with different characteristics, but this variation is mostly associated with patient characteristics. CVD risk factors are elevated in a large proportion of patients without CVD and diabetes. The Health Check will generate a considerable workload for general practices through the management of patients with high CVD risk, as well as in the initial screening of patients.

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