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Estimating the yield of NHS Health Checks in England: a population-based cohort study

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ABSTRACT

Background This study aimed to evaluate the yield of the NHS Health Checks programme.

Methods A cohort study, conducted in the Clinical Practice Research Datalink in England. Electronic health records were analysed for patients aged 40–74 receiving an NHS Health Check between 2010 and 2013.

Results There were 65 324 men and 75 032 women receiving a health check. For every 1000 men assessed, there were 205 smokers (95% confidence interval 195–215), 355 (340–369) with hypertension (≥140/90mmHg) and 633 (607–658) with elevated cholesterol (≥5 mmol/l). Among 1000 women, there were 161 (151–171) smokers, 247 (238–257) with hypertension and 668 (646–689) with elevated cholesterol. In the 12 months following the check, statins were prescribed to 18% of men and 21% of women with ≥20% cardiovascular risk and antihypertensive drugs to 11% of men and 16% of women with ≥20% cardiovascular risk. Slight reductions in risk factor values were observed in the minority of participants with follow-up values recorded in the 15 months following the check.

Conclusions A universal primary prevention programme identifies substantial risk factor burden in a population without known cardiovascular disease. Research is needed to monitor interventions, and intermediate- and long-term outcomes, in those identified at high risk.

Keywords circulatory disease, electronic health records, primary care, screening

Introduction

Cardiovascular disease (CVD), including coronary heart disease (CHD) and stroke, causes the greatest proportion of deaths in the UK.[1] In 2010 in the UK, >45 000 individuals who were younger than 75 died as a result of CVD. The prevalence of type 2 diabetes, a risk factor for CVD, has increased,[1] with >2.5 million living with a diagnosis in England.[2] In 2008/2009, almost 2 million adults in England were registered as having chronic kidney disease (stages 3–5); this equates to around 4% of the adult population.[3] CVD cost the UK healthcare system an estimated £9 billion ($15 billion/€11 billion) in 2009.[4] CVD risk can be reduced through healthy lifestyle including not smoking, being physically active, maintaining a healthy diet and body weight, and drinking alcohol in moderation.

A primary prevention programme to reduce CVD, NHS Health Checks, was fully implemented in England in 2011.[5] All individuals without known CVD aged 40–74 are invited every 5 years to assess their risk of having a cardiovascular event in the next 10 years. Graded intervention is recommended based on the individual's risk score. The NHS Health Check programme is estimated to potentially prevent

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2000 deaths and 9500 non-fatal myocardial infarctions and strokes each year if implemented according to recommended guidelines.[6] Preliminary evidence suggests that uptake is lower than the figure required for the programme to be cost-effective (75%).[7] Regional studies have found uptake to be lower among individuals without existing non-CVD co-morbidities, smokers, younger men and higher among individuals from a South Asian or mixed background and those registered with smaller general practices.[8–10]

The programme is new, so its impact is unknown. One study suggests that 22% of attendees will have a ≥20% risk of a cardiovascular event in the next 10 years.[11] In London, attendees who were estimated to be a high-risk pre-Check[12] had a reduction in mean CVD risk score, diastolic blood pressure (BP), total cholesterol levels and lipid ratios at 1 year. One randomized controlled trial ($N = 601$) compared NHS Health Checks alone with NHS Health Checks plus lifestyle support.[13] Prevalence of high BP, high total cholesterol and smoking were reduced in both arms at follow-up.

While the implementation of the NHS Check programme may vary across England,[14] a national evaluation provides a better understanding of the programme's progress towards achieving its main objectives. The aims of this study were to estimate the yield of NHS Health Checks in terms of untreated risk factors and to evaluate the impact of interventions.

Methods

We conducted a population-based cohort study using a sample of patients registered with general practices contributing to the Clinical Practice Research Datalink (CPRD). The CPRD comprises electronic medical records for >5.5 million active patients registered with over 650 general practices in the UK. Practices in the CPRD are given an up-to-standard date, which is the date when the data are considered to reach predefined quality standards. The CPRD is socio-demographically representative of the UK population, although it is under-represented in London.[15,16]

The initial cohort comprised all patients in CPRD in England aged 40–74, without a previous diagnosis of diabetes, CHD or stroke, not currently treated with statins or antihypertensive drugs, and with a record of an NHS Health Check or CVD risk assessment between 1 April 2010 and 31 March 2013 ($N = 193\,363$). In 2012, there were 643 896 men and 649 807 women aged 40–74 in CPRD in England.

READ medical codes defined by the NHS Health Check programme[17] and additional codes that indicated that a CVD risk assessment had been completed were used to identify Health Checks. We refer to this assessment as a 'health check'. Although we cannot be certain that patients had a formal NHS Health Check if they had a code that is not used by the programme, all patients included in the study were eligible for a Health Check, and their CVD risk assessment was likely to compose of similar components to a Health Check. The date of the first completed health check was taken as the index date.

Records of systolic and diastolic BP (mmHg), weight (kg), height (m), body mass index (BMI, kg/m^2), total cholesterol (mmol), high-density lipoprotein cholesterol (HDL; mmol) and smoking status were analysed. Hypertension was defined as systolic BP >140 mmHg or diastolic BP >90 mmHg; elevated cholesterol was defined as total cholesterol >5 mmol and obesity was defined as BMI >30 kg/m^2. Prescriptions for statins, antihypertensive drugs and nicotine replacement therapy and whether the patient received diet, exercise and weight or smoking cessation advice or referrals were also evaluated. New diagnoses of diabetes mellitus were identified. We also included the patient's age, gender and the general practice level index of multiple deprivation (IMD) quintile as a measure of social and material deprivation.[18] An IMD score is a composite measure based on small areas of ~1000 households, linked through postcode. The deprivation score can be divided into quintiles based on the distribution for England in 2010 for reference.

A CVD risk score was recorded for a minority (22%) of patients. For this reason, we calculated a 10-year Framingham CVD risk score for all patients with complete measurements (age, gender, whether diagnosed with diabetes, systolic BP, total cholesterol, HDL and smoking status[19]). The Framingham algorithm was employed, because it is widely used in observational studies and has been published openly and in full, allowing replication in large data sets. The score was used to group participants into different categories of CVD risk. The mean difference between the recorded and calculated CVD risk scores was 0.5% (95% confidence interval: −10.1 to 11.2%; see Supplementary data, Appendix S1). The calculated CVD risk score was used in the analyses, including only patients who had complete values to compute the score ($n = 131\,275$; 94% of included patients).

Statistical analysis

We tabulated the demographic characteristics of patients and their clinical characteristics by gender. We estimated the yield of the check as the number of patients per 1000 patients attending for a health check who were identified with elevated risk factor levels or diagnosed with diabetes within 60 days of the check. The delivery of lifestyle advice or referrals and medications prescribed within 12 months of the date of the health check were tabulated by risk score category. By the

nature of the inclusion criteria, all patients prescribed statins and antihypertensives were newly treated. This was not necessarily the case for nicotine replacement/addiction therapy or lifestyle advice/referrals. Among patients with follow-up data on BP, total cholesterol, BMI or smoking status 15 months after the health check, we tabulated the mean values and proportion of smokers at the health check and 15 months later, along with mean or percentage point differences, divided by gender. The latest values recorded before—and within 15 months after—the check were included. The use of a 15-month time window was consistent with UK Quality and Outcomes Framework assessments[20] and was employed to maximize data for analysis. Confidence intervals were corrected for clustering by general practice by means of the 'svy' command in STATA version 12.1.[21]

The study protocol was granted ethical approval by the Independent Scientific Advisory Committee (ISAC) of the Medicines and UKMHRA (Protocol No. 13_071).

Results

Description of the sample

Out of a total of 193 363 patients extracted from the CPRD, 140 356 patients were included in analyses after excluding 11 284 patients not registered at practices in England, 1378 aged <40 or >74 at the index date, 18 171 prescribed statins and 21 191 prescribed antihypertensive drugs in the year preceding the check, and 595 previously diagnosed with diabetes, 169 with CHD and 219 with stroke. Of the patients included in the analyses, 53% were female, 49% were aged 40–54 and 21% were aged 65–74, and the greatest proportion of patients lived in areas in the second least deprived quintile of the English population (Table 1). BP values were available for 97% of the sample, total cholesterol values for 93% of the sample and BMI values for 93% of the sample.

Table 1 Demographic characteristics and measurements recorded for patients who had a NHS Health Check by gender

	Men *65 324*	*Women* *75 032*
Age group (years)		
40–54	32 451 (50)	36 960 (49)
55–64	19 763 (30)	22 349 (30)
65–74	13 110 (20)	15 723 (21)
Deprivation		
Least deprived	9823 (16)	11 056 (15)
2	14 316 (23)	16 992 (24)
3	13 831 (22)	15 374 (21)
4	12 625 (20)	14 458 (20)
Most deprived	11 565 (19)	13 653 (19)
Body mass index, kg/m^2, mean (SD)	27.5 (4.3)	26.9 (5.4)
Systolic BP, mm Hg, mean (SD)	132.9 (15.9)	127.1 (16.8)
Diastolic BP, mm Hg, mean (SD)	81.1 (10.0)	77.7 (9.9)
Total cholesterol, mmol/l, mean (SD)	5.5 (1.0)	5.6 (1.1)
Obese, ≥30 kg/m^2	14 426 (22)	16 933 (23)
Hypertensive, BP ≥140/90 mmHg	23 175 (35)	18 570 (25)
Elevated total cholesterol, ≥5 mmol/l	41 331 (63)	50 088 (67)
Current smoker	13 397 (21)	12 067 (16)

Figures are frequencies (column percent) except where indicated.
BP, blood pressure; SD, standard deviation

Clinical characteristics of the sample

As expected, men had a less favourable CVD risk profile than women (Table 1). A greater proportion of men compared with women smoked (21 versus 16%) and had hypertension (BP ≥140/90 mmHg, 35 versus 25%). A similar proportion of men and women were obese (BMI ≥30 kg/m^2; 22% of men and 23% of women), and a greater proportion of women than men had elevated total cholesterol (≥5 mmol; 67 versus 73%).

For every 1000 men being assessed, there were 205 smokers (95% confidence interval 195–215), 355 (340–369) with hypertension, 633 (607–658) with elevated total cholesterol and 221 (212–230) were obese. Among 1000 women, there were 161 (151–171) smokers, 247 (238–257) with hypertension, 668 (646–689) with elevated cholesterol and 226 (217–234) were obese. There were 296 (276–315) per 1000 men and 60 (55–65) per 1000 women with a Framingham cardiovascular risk score of ≥20% over 10 years.

Prevalence of recorded hypertension and newly diagnosed diabetes among both sexes increased with age, as did elevated cholesterol in women (Table 2). Obesity and smoking declined in both sexes with age. For example, for every 1000 men aged 40–54 with a health check, 300 (95% confidence interval 285–316) had hypertension compared with 439 (422 to 456) in 1000 men aged 65–74, and for every 1000 women aged 40–54, 244 (234–254) were obese (BMI ≥30 kg/m^2) compared with 189 (180–199) women aged 65–74.

Interventions in the 12 months following the health check

Table 3 shows that men were more likely to be at high risk of CVD (10-year risk ≥20%) than women (30 versus 6%). Statin and antihypertensive drug prescription in the 12 months following the health check was low, but increased with CVD risk. For example, 1% of men who were at <10% CVD risk were prescribed statins compared with 18% of men

Table 2 Number (95% confidence interval) identified with cardiovascular risk factors or new diabetes diagnoses per 1000 patients attending for an NHS Check by gender and age group

	Male			*Female*		
	40–54 years	*55–64 years*	*65–74 years*	*40–54 years*	*55–64 years*	*65–74 years*
Hypertensive (BP ≥140/90 mmHg)	300 (285–316)	388 (373–403)	439 (422–456)	167 (159–176)	280 (269–292)	389 (374–404)
Current smoker	237 (225–250)	194 (182–206)	142 (131–153)	188 (176–199)	150 (139–161)	113 (104–122)
Elevated total cholesterol (≥5 mmol/l)	611 (581–641)	658 (632–684)	649 (631–666)	537 (514–559)	780 (758–801)	816 (799–832)
Obese (BMI ≥30 kg/m^2)	244 (232–256)	218 (208–228)	168 (158–177)	244 (234–254)	221 (212–230)	189 (180–199)
Diabetes mellitus	6 (5–7)	8 (7–10)	8 (6–10)	3 (2–4)	4 (3–5)	5 (4–7)

BP, blood pressure; BMI, body mass index.

Table 3 Interventions prescribed by 10-year Framingham CVD risk score

	Framingham 10-year CVD risk score				
	<10% risk	*10–19% risk*	*≥20% risk*	*Not known*	*Total*
Gender *n* (%)					
Male	16 381 (25)	20 553 (31)	19 309 (30)	9081 (14)	65 324 (100)
Female	43 416 (58)	17 838 (24)	4502 (6)	9276 (12)	75 032 (100)
n (%) receiving advice or referrals in 12 months after NHS Check					
Diet, exercise or weight					
Male	9723 (59)	13 226 (64)	13 593 (70)	3728 (41)	40 269 (100)
Female	26 100 (60)	11 875 (67)	3246 (72)	4048 (44)	45 269 (100)
Smoking cessation among smokers					
Male	861/1248 (69)	2710/3854 (70)	4707/6337 (74)	1242/1958 (63)	9520 (100)
Female	2922/4102 (71)	2776/3904 (71)	1743/2315 (75)	1122/1746 (64)	8563 (100)
n (%) prescribed in 12 months after NHS Check					
Statins					
Male	200 (1)	854 (4)	3407 (18)	130 (1)	4591 (100)
Female	542 (1)	1105 (6)	962 (21)	87 (1)	2696 (100)
Antihypertensive drugs					
Male	321 (2)	929 (5)	2145 (11)	220 (2)	3615 (100)
Female	1073 (3)	1028 (6)	732 (16)	225 (2)	3058 (100)
Nicotine replacement/addiction therapy among smokers					
Male	83/1248 (7)	397/3854 (10)	706/6337 (11)	154/1958 (8)	1340 (100)
Female	422/4102 (10)	387/3904 (10)	268/2315 (12)	168/1746 (10)	1245 (100)

who were at ≥20% CVD risk. Around 3% of women who were at <10% CVD risk were prescribed antihypertensive drugs compared with 16% of women who were at ≥20% CVD risk. Approximately 10% of smokers were prescribed nicotine replacement/addiction therapies.

A high proportion of patients received advice about their diet, exercise or weight advice, or were referred to lifestyle services (between 59 and 70% of men and between 60 and 72% of women; Table 3). Also, a large proportion of smokers were offered stop smoking advice or were referred to smoking cessation services (between 69 and 74% of men and between 71 and 76% of women).

Changes in risk factors at 15 months follow-up

Fewer than 52% of patients had follow-up values for CVD risk factors 15 months post-health check (Table 4). The men with follow-up values showed a greater absolute reduction in

Table 4 Changes in risk factor values up to 15 months following a health check

	N *with values at follow-up (% of patients with values at the check)*	*At date of check, mean (SD)*	*15 months after check, mean (SD)*	*Difference (95% confidence interval)*
Systolic BP (mean, SD, mmHg)				
Male	23 259 (37.1)	139.3 (17.7)	133.8 (14.2)	−5.53 (−5.04 to −6.02)
Female	29 126 (39.9)	131.6 (19.1)	129.3 (15.4)	−2.33 (−1.89 to −2.78)
Diastolic BP (mean, SD, mmHg)				
Male	23 259 (37.1)	84.6 (11.0)	80.8 (9.2)	−3.84 (−3.56 to −4.13)
Female	29 126 (39.9)	80.0 (10.9)	78.2 (9.3)	−1.94 (−1.68 to −2.21)
Total cholesterol (mean, SD, mmol/l)				
Male	13 925 (23.2)	5.8 (1.1)	5.4 (1.0)	−0.39 (−0.35 to −0.43)
Female	14 417 (20.6)	6.0 (1.1)	5.8 (1.0)	−0.28 (−0.25 to −0.32)
BMI (mean, SD, kg/m^2)				
Male	11 817 (19.7)	28.5 (5.0)	28.2 (5.0)	−0.28 (−0.23 to −0.32)
Female	16 103 (22.9)	28.3 (6.3)	28.1 (6.2)	−0.19 (−0.15 to −0.24)
Current smokers (%)				
Male	6642 (49.6)	6642 (100)[a]	5562 (83.7)[a]	−16 (−15 to −17)
Female	6255 (51.8)	6255 (100)[a]	5290 (84.6)[a]	−15 (−15 to −16)
CVD risk score (mean, SD)				
Male	2570 (17.6)	19.6 (8.8)	18.2 (9.0)	−1.42 (−3.18 to 0.33)
Female	1984 (12.7)	12.0 (7.9)	11.4 (7.3)	−0.57 (−1.79 to 0.65)

SD, standard deviation; BMI, Body mass index.

[a]Figures are frequencies (row percent).

BP between the health check and 15 months follow-up relative to women (e.g. mean difference in systolic BP: men, −5.53, 95% confidence interval −5.04 to −6.02; women, −2.33, −1.89 to −2.78). There was also evidence of small improvements in diastolic BP, total cholesterol and BMI for men and women 15 months post-health check. There was no evidence of an overall reduction in CVD risk score for men or women, although few patients had follow-up CVD risk scores recorded (15% of those with scores at baseline). There was a 16 percentage point reduction in the proportion of male smokers at 15 months and a 15 percentage point reduction in the proportion of female smokers at 15 months. This would equate to a reduction in Framingham 10-year CVD risk score from 38% at the health check to 22% 15 months later for a 65-year-old male smoker changing to a non-smoker, with HDL of 1.3 mmol/l at both time points (age- and sex-specific mean HDL from Health Survey for England[22]).

Patients with follow-up values had a less favourable CVD risk profile at the check than patients without follow-up values. For example, among patients with values at follow-up, mean systolic BP at the check was 135.0 mmHg (standard deviation: 18.9) compared with patients without values at follow-up (value recorded at the check: systolic BP: 126.5 mmHg (14.1)).

Discussion

Main finding of this study

We used a cohort study design, using a large sample with patient-level data, to estimate the yield of NHS Health Checks in terms of untreated risk factors and to evaluate the impact of interventions. The findings suggest that the NHS Health Check programme is identifying CVD risk factors in a large proportion of the previously presumed healthy and untreated 40- to 74-year-old population. Statins and antihypertensive drugs were prescribed to a small proportion of patients at higher CVD risk subsequent to the check, and around 10% of smokers were prescribed nicotine replacement/addiction therapy. At least 60% of patients with a known CVD risk score received weight, diet or exercise advice/referrals, and among smokers, over 60% received smoking cessation advice/referrals. There was evidence of a small reduction in CVD risk factors 15 months after the health check.

What is already known on this topic?

Recently, one study estimated that 22% of patients eligible for a NHS Health Check would have a CVD risk of ≥20% using the Joint British Societies score.[11] This is compared with our

findings that ~30% of men and 6% of women were at ≥20% risk using the Framingham risk score, although our findings may not be directly comparable as the two risk calculators use different clinical information.

Another study previously found reductions in CVD risk factors 12 months post-check in one deprived and culturally diverse area of London.[12] Participants showed a significant reduction in mean CVD risk score, diastolic BP, total cholesterol and lipid ratios at 1-year follow-up. Our national study found only small reductions in BP, total cholesterol and BMI. However, almost one-fifth of smokers stopped smoking in the 15-month follow-up period and a high proportion of smokers received stop smoking advice/referrals at the check, or were prescribed nicotine replacement/addiction therapy, suggesting that smoking cessation interventions used by the programme may be effective.

Modest reductions in CVD risk factors 15 months after the health check were observed, but these mean differences may not apply to the whole population. Patients with follow-up values had a less favourable CVD risk profiles, and higher risk factor values, at the check than patients without follow-up values; interpretation may be complicated by regression to the mean. We caution, therefore, that these results may not be suitable for evaluating the overall effectiveness of the health check programme.

What this study adds

New NICE guidelines in England recommend that statins be prescribed to individuals with no existing CVD if their 10-year CVD risk score is ≥10% (reduced from ≥20%[23]). In our study, only a small proportion of patients who were at ≥20% risk of CVD were prescribed statins. Van Staa and colleagues[24] found that only one half of patients had a high CVD risk score when they were first prescribed statins. However, in our study, the majority of patients with a calculated CVD risk score received weight, diet or exercise advice/referrals, suggesting that General Practitioners may be using lifestyle modification as a frontline treatment. Based on the data from the present study, the new guidance could result in around a 3 percentage point increase (40% relative increase) in the proportion of men prescribed statins and a 4 percentage point increase (97% relative increase) for women.

Cochrane and colleagues[25] have previously commented that the Framingham risk estimator includes unmodifiable risk factors such as gender and age, which may explain the higher risk scores for men in the present sample. For this reason, clinicians should be mindful of the values that comprise CVD risk scores in addition to the actual risk scores, as younger and female patients with potentially modifiable risk factors may be missed if their risk score is lower than the current threshold. However, the absolute risk of CVD increases steeply with age.

Limitations of this study

A limitation of research using electronic patient records is the level of missing data. In the present study, the proportion of patients with recorded CVD risk scores was low, so scores were calculated for cases with complete data. This increases the potential for bias. The risk score is a key component of the Health Check, and this study highlights the need for better recording of health checks. The recorded and calculated mean CVD risk scores were similar; however, confidence intervals were wide, suggesting that there is wide variation at an individual level. For this reason, the follow-up care values that we grouped by calculated CVD risk score must be interpreted with caution. There was also a high proportion of missing data at 15 months follow-up. These data can generally be expected to be missing, not at random, because patients have to attend their general practice for data to be recorded.

The proportion of patients with detected diabetes or CVD events in this sample was low. It would have been interesting to have included information on pre-diabetes; however, this condition cannot be routinely detected through the NHS Health Check. A future study with longer follow-up would be able to examine CVD events.

Conclusion

A national programme for primary prevention of CVD is detecting individuals at risk of CVD among those who were previously presumed healthy and untreated. A small proportion of individuals at high risk of CVD are being prescribed pharmacological risk-reducing interventions. There is evidence of a small reduction in CVD risk factors among the minority of individuals with follow-up measurements 15 months post-check. Research is needed to monitor interventions, and longer-term outcomes, in those identified at high risk.

Supplementary data

Supplementary data are available at *PUBMED* online.

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