Prevalence of cardiovascular disease risk amongst the population eligible for the NHS Health Check Programme

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What is This?
Prevalence of cardiovascular disease risk amongst the population eligible for the NHS Health Check Programme

Andrew RH Dalton¹,², Michael Soljak¹, Edgar Samarasundera¹, Christopher Millett¹ and Azeem Majeed¹

Abstract

Background: The National Health Service (NHS) Health Check Programme aims to identify and manage patients in England aged 40–74 years with a 10-year cardiovascular disease (CVD) risk score over 20%. We aimed to assess the prevalence of high CVD risk in the English population, using the two CVD risk scores and the 20% cut off mandated in national policy, and the prevalence of risk factors within this population.

Design: Modelling study using patients registered in general practice in England.

Methods: Using data from the Health Survey for England, we modelled the prevalence of high CVD risk in general practice populations.

Results: Of those eligible for an NHS Health Check, 10.5% (2,012,000) had a risk score greater than 20% using the QRISK2 risk score; 22.0% (4,267,000) using Joint British Societies’ (JBS2) score. There was a median of 206 (range 0–1693) and 447 (0–3321) patients per practice at high risk respectively, with wide geographic variation. Within the high-risk population, there was a high prevalence of CVD risk factors; in the QRISK2 population, for example 82.6% were physically inactive. To reduce risk in those at high CVD risk, we estimate the total costs of the Programme to be £176 million using QRISK2 or £378 million using JBS2.

Conclusions: A large number of high-risk patients will be identified by the Programme; health service commissioners must ensure the adequate provision and the targeted allocation of risk reduction services for the Programme to be effective. The NHS must consider whether extra costs using JBS2 are warranted. The Programme must be fully monitored to ensure its cost effectiveness and appropriate outcomes such as the numbers at high risk assessed.

Keywords
Cardiovascular diseases, primary health care, primary prevention

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Introduction

The NHS Health Check Programme¹ is a high-profile national policy in England designed to reduce the morbidity, mortality, and health inequalities stemming from cardiovascular disease (CVD), type II diabetes, and chronic kidney disease (CKD). It aims to lower CVD risk in adults aged 40–74 years without pre-existing CVD or diabetes, through risk assessment and treatment (see Box 1). The Health Check Programme is informed by national clinical guidance² which recommends stratification and management of patients based on global risk of developing CVD. High risk is defined as a risk of a CVD event within 10 years of 20% or more.³

Almost all of the English population is registered with a general practice, which will be responsible for offering interventions to their high-CVD-risk patients. These patients will be offered a number of risk reducing interventions, as will those in the low-to-moderate risk group presenting with single raised

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The NHS Health Check Programme

The NHS Health Check Programme is a population-wide primary prevention programme for CVD in England, and was implemented nationally by the Department of Health in April 2009. The Programme involves offering a ‘health check’ to all persons aged 40–74 years without diagnosed CVD, diabetes, chronic kidney disease, or hypertension. The Programme includes the measurement of height, weight, BMI, blood pressure, smoking status, and blood lipids. For patients deemed at high risk of diabetes or impaired renal function, those with raised blood pressure or BMI, fasting glucose, and renal function tests will additionally be offered in order to detect undiagnosed disease. Those found at high risk of developing CVD and those with established CVD risk factors will then be advised on lifestyle interventions and, if necessary, prescribed preventive medication or referred for further management. In addition to accelerating reductions in overall CVD mortality in England, NHS Health Checks aims to reduce socioeconomic and ethnic inequalities in health. These are longstanding, particularly in CVD and diabetes, and contribute to the worse health outcomes and lower life expectancy experienced by people from disadvantaged groups.

The key objectives of the NHS Health Check Programme are:

Objective 1: For all those eligible (i.e. those aged between 40 and 74 who do not have previously diagnosed vascular disease), to be offered a NHS Health Check every 5 years and for this to be carried out in line with the best practice guidance.

Objective 2: That the NHS Health Check Programme is clinically and cost effective, and that it remains so.

Objective 3: Help people live longer, healthier lives by: reducing the risk, and incidence, of heart attacks and strokes, type 2 diabetes, and chronic kidney disease; detecting cardiovascular disease, chronic kidney disease, and type 2 diabetes earlier, allowing people to be managed earlier and in doing so improve their quality of life.

Objective 4: Reduce health inequalities – including socioeconomic, ethnic, and gender inequalities that result from vascular disease (heart disease, stroke, type 2 diabetes, and chronic kidney disease).

Box 1. The NHS Health Check Programme.

risk factors. The Programme currently requires the use of either the QRISK2 or Joint British Societies’ 2 (JBS2) risk-scoring systems. The original Framingham CVD risk scores overestimates CVD risk in European populations. The JBS2 algorithm is an English modification of the original Framingham risk score, whilst QRISK2 was derived from a large sample of the English population derived from an database extracted from general practice electronic health records.

There are no national estimates of the number of persons at high CVD risk in England, the prevalence of risk factors within this population, or their distribution. Rather than a focus on process measures such as the numbers of Health Checks offered, the baseline local prevalence of high CVD risk, and subsequent local changes in this population should be a key indicator of the performance of the Programme. Although the NHS Health Check Programme started in April 2009 and general practices will be capturing data electronically, there are as yet no data on national coverage, although this is planned. We aimed to assess the prevalence of high CVD risk in English general practices and primary care trusts (PCTs; NHS organizations responsible for managing the contracts of general practices in geographic areas), the prevalence of CVD risk factors within the high-risk group, and the effects of using the two different risk scores mandated for the national programme.

Methods

Data sources

The Health Survey for England (HSfE) is an annual survey of people living in private households in England. We appended person-specific data from the HSfE from 2003 to 2006 inclusive. The methodology of HSfE data collection is described elsewhere. Briefly, small geographical areas are randomly selected, and within these a number of households. In the core dataset, all adults within selected households are eligible for survey. Interviewers record personal socio-demographic and lifestyle details, and information on health and health service use. Nurses record anthropometric measurements including blood pressure, body mass index (BMI), take blood specimens, and ask respondents about prescribed medications. Of 71,717 informants interviewed between 2003 and 2006, 25,319 were aged 40–74 years. We excluded patients with doctor-diagnosed CVD, and diabetes and hypertension (n = 5186) i.e. those not eligible for the Health Check. In addition to the standard HSfE data, we obtained 2001 Townsend deprivation scores and
Index of Multiple Deprivation (IMD) 2007 scores for each informant, based on postcode of residence.

We applied the QRISK2 \(^4\) (after the 2010 update) and JBS2 \(^2\) CVD risk algorithms to each informant’s data. Both models use age, sex, ethnicity, smoking status, family history of CVD, systolic blood pressure, and lipid ratios (total cholesterol and high-density lipoprotein). The HSfE contained complete data with the following exceptions. We assumed no family history of CVD in the 5986 (29.7%) with missing data. Data were missing for other required risk factors: 7641 (38.0%) had missing blood pressure, 2322 (11.5%) missing BMI, and 12,187 (60.5%) missing blood cholesterol to high-density lipoprotein (lipid) ratios (Table 1). We used multiple imputation to estimate missing values,\(^11\) building linear regression models using backward stepwise selection to predict the four outcomes within the complete data. Multiple imputation is most applicable when data are missing completely at random (MCAR); however, the method is robust when data are missing at random (MAR), i.e. dependent on other variables in the dataset.\(^12\) Based upon the HSfE methodology we had no reason to assume a strong violation of MAR. We included variables with complete recording as model candidates. For each variable the final imputation model contained age, sex, ethnicity, smoking status, deprivation, and age/sex interaction term. Using the \texttt{mi} command in Stata, we produced 10 imputed copies of the dataset (\(m\)). We calculated the fraction of missing information (\(\gamma\)) for each imputed variable, using this to assess whether \(m\) was sufficiently large.\(^13\) We determined that \(\gamma = 0.61, 0.45, \text{ and } 0.25\) for cholesterol, blood pressure, and BMI, respectively, give an acceptable power of imputation with \(m = 10\).

In addition to JBS2 variables, the QRISK2 algorithm requires data on BMI, Townsend deprivation score, CKD, rheumatoid arthritis, heart failure, and atrial fibrillation. As there are no data in the HSfE for CKD, heart failure, atrial fibrillation, or rheumatoid arthritis, and the prevalence is low, these were assumed negative. Both JBS2 and QRISK2 require ethnicity data. The JBS2 risk score differs from the Framingham combined CVD score by employing a multiplication factor of 1.4 for men with a south Asian background and 1.5 if a first-degree relative has a history of premature CVD.

### High-risk models

We partitioned the population based on age (40–49, 50–54, 55–64, 65–74 years); gender; ethnicity [White, south Asian (Asian or Asian British in the HSfE), black (Black or Black British in the HSfE), Chinese, or Other], and deprivation (national thirds of IMD). We applied the risk algorithms to each imputed dataset and calculated a mean risk score between imputations for each observation. We calculated proportions at high risk (\(\geq 20\%\)) in each cell, combining any cell with fewer than 10 entrants with the adjacent (next highest age group).

We obtained age, sex, ethnicity, and IMD breakdowns of every general practice in England. We subtracted the numbers of patients on the CHD, stroke/transient ischaemic attack, diabetes, and hypertension registers, using estimates from Quality and Outcomes Framework data.\(^14\) We used HSfE data to estimate the proportion of each disease register in the 40–74 age group and adjusted the prevalence for patients with multiple conditions, deriving estimates of comorbidity from the HSfE data; 40% of diabetes patients have CVD and 37% with hypertension have CVD or diabetes. We obtained estimates of the ethnic breakdown of each practice from the Care Quality Commission (CQC), which were derived by assuming the proportions admitted to hospital reflected the ethnic composition of lower super output area (LSOA) resident populations.\(^15\) We applied the ethnicity proportions to our population data assuming a uniform ethnic breakdown over the 40–74 age group and sex. We used IMD scores for each practice, derived by the CQC from the postcode of residence of the registered population, and assigned each practice to a national deprivation third. Each practice was broken

### Table 1. Variables included in QRISK2 and JBS2 score and levels of missing data

<table>
<thead>
<tr>
<th></th>
<th>QRISK2</th>
<th>JBS2</th>
<th>Missing (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong> (^a)</td>
<td>Yes</td>
<td>Yes</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Sex</strong> (^a)</td>
<td>Yes</td>
<td>Yes</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Ethnicity</strong> (^a)</td>
<td>Yes</td>
<td>(-)</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Deprivation</strong> (^a)</td>
<td>Yes</td>
<td>(-)</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Smoking</strong> (^a)</td>
<td>Yes</td>
<td>Yes</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Hypertension</strong></td>
<td>Yes</td>
<td>(-)</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Diabetes</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Blood pressure</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>38.0</td>
</tr>
<tr>
<td><strong>Cholesterol/HDL</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>60.5</td>
</tr>
<tr>
<td><strong>Body mass index</strong></td>
<td>Yes</td>
<td>(-)</td>
<td>11.5</td>
</tr>
<tr>
<td><strong>Family history of CVD</strong></td>
<td>Yes</td>
<td>(-)</td>
<td>29.7</td>
</tr>
<tr>
<td><strong>Heart failure</strong></td>
<td>Yes</td>
<td>(-)</td>
<td>100</td>
</tr>
<tr>
<td><strong>Chronic kidney disease</strong></td>
<td>Yes</td>
<td>(-)</td>
<td>100</td>
</tr>
<tr>
<td><strong>Rheumatoid arthritis</strong></td>
<td>Yes</td>
<td>(-)</td>
<td>100</td>
</tr>
<tr>
<td><strong>Atrial fibrillation</strong></td>
<td>Yes</td>
<td>(-)</td>
<td>100</td>
</tr>
</tbody>
</table>

\(^a\)Variables used in the multiple imputation of missing data; \(^b\)not included within the algorithm but adjustment factors are added; \(^c\)Townsend score for QRISK2/IMD2007 for other analysis.
down into the same 96 cells as the HSfE risk proportions which we then applied to the practice data, giving the number of patients with \( \geq 20\% \) score for JBS2 and QRISK2 in each practice; these were summed to give PCT level estimates. We present both median at a PCT level, due to skewed data. We used the Wilcoxon sign rank test to assess the difference in national ranking of practices and PCTs by risk prevalence when using each risk score.

**Managing CVD risk factors in high-risk group**

We modelled the distribution of individual CVD risk factors in patients with high-risk scores. These were BMI \( \geq 25 \text{ kg/m}^2 \); undiagnosed hypertension (assuming 50% of patients with a raised blood pressure proceed to be diagnosed with hypertension); physical inactivity (fewer than five 30-minute bouts of exercise per week); undetected impaired fasting glycaemia (fasting plasma glucose between 6.1 and 6.9 mmol/l); smoking, and undiagnosed diabetes (fasting plasma glucose \( \geq 7 \text{ mmol/l} \)). Taking the high-risk population, we found the proportion in the HSfE data of patients in each age/sex category with risk factors and transposed the proportions onto the PCT high-risk estimates.

**Costs**

We estimated the costs of the basic NHS Health Check, the initial interventions and referrals (related to the major risk factors above) in the high-risk group. We assume one Health Check encounter per patient. Almost all of model assumptions were those used in the Department of Health impact assessment, including uptake and cost of risk factor interventions. On that basis, we assumed 70% attendance at the initial Health Check. However, one of the key assumptions of the Department of Health impact assessment is that 50% of Health Checks already happen as part of routine clinical practice. Once the Programme is underway, GPs are likely to switch their preventative CVD care to occur within the Health Check policy activity; the NHS will be funding the majority of CVD prevention through the Programme, hence we modelled the entire costs of activity. We estimated the costs of the basic Health Check; including time, diagnostic tests, and resultant referrals, but not additional time for the diagnoses. All data analyses were carried out using Stata 11.1SE.

**Results**

**Prevalence of high CVD risk**

We estimate 2,012,151 people in England aged 40–74 years have a QRISK2 score \( \geq 20\% \), out of 19,388,681 eligible for a Health Check (10.4%) (Table 2). The median number per PCT was 10,838 (range 3799–42,258). As a percentage of the eligible population, the PCT median was 10.7 (range 6.4–13.7). There was a median of 206 patients at high risk per practice (range 0–1693). Using the JBS2 algorithm there was a larger number of people classified as at high risk; 4,267,415 aged 40–74 years (22.0%), with a median of 23,136 (range 8796–96,342) per PCT.

**Prevalence of risk factors in the high-risk population**

The distribution of individual CVD risk factors in patients with high global risk scores is presented in Table 3. Within the high-risk population defined by the QRISK2 score, there were a large proportion of physically inactive (82.6%) and overweight or obese (65.1%) patients. We estimate 23.9% of the eligible population (479,200 patients) will have undiagnosed hypertension and 11.3% (228,800 patients) will have impaired fasting glucose. Screening will detect 114,400 patients with undiagnosed diabetes, 5.7% of the screened population, with a median of 604 (range 222–2463) per PCT. The distribution of risk factors identified using JBS2 differ from that estimated from QRISK2 (Table 3). The JBS2 population had an especially large proportion of patients who smoke (42.7%), higher undiagnosed hypertension (27.2%), and larger numbers of high risk in younger age groups.

Figure 1 shows the geographical distribution of high-CVD-risk status in England using both risk scores. The highest prevalence of high-risk status is centred on the major urban areas in northern England. The absolute prevalence of high-risk status

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**Table 2. Primary care trust and practice level estimates of the numbers and proportion of high-risk patients**

<table>
<thead>
<tr>
<th>Risk score</th>
<th>Total</th>
<th>Median</th>
<th>Min–max</th>
<th>IQR</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCT level</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>QRISK2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>2,012,151</td>
<td>10,838</td>
<td>3,799–42,258</td>
<td>7577–16,438</td>
</tr>
<tr>
<td>%</td>
<td>10.4</td>
<td>10.7</td>
<td>6.4–13.7</td>
<td>9.1–13.7</td>
</tr>
<tr>
<td>JBS2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>4,267,415</td>
<td>23,136</td>
<td>8796–96,342</td>
<td>16,958–34,343</td>
</tr>
<tr>
<td>%</td>
<td>22.0</td>
<td>22.4</td>
<td>17.2–26.4</td>
<td>20.6–24.0</td>
</tr>
<tr>
<td>Practice level</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>QRISK2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>206</td>
<td>0–1693</td>
<td>112–342</td>
<td></td>
</tr>
<tr>
<td>%</td>
<td>10.3</td>
<td>0–26.9</td>
<td>8.6–12.2</td>
<td></td>
</tr>
<tr>
<td>JBS2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>447</td>
<td>0–3321</td>
<td>249–718</td>
<td></td>
</tr>
<tr>
<td>%</td>
<td>22.1</td>
<td>0–53.5</td>
<td>19.9–24.8</td>
<td></td>
</tr>
</tbody>
</table>
changes with the risk score and there is a change in relative distribution of prevalence. The national ranking of both PCT (Wilcoxon signed rank, \(p = 0.017\)) and practice (\(p < 0.001\)) prevalence varies significantly upon changing the risk score.

Cost estimates
In the 2,012,151 patients estimated at high risk using QRISK2, with a total of 1,509,113 (75%) screened, we estimate the total cost of the basic Health Check
Discussion

Summary of main findings

Using the QRISK2 risk score, our model estimates 2.0 million patients aged 40–74 years are at high risk of CVD in England, with wide geographic variation in prevalence. The JBS2 risk score results in larger numbers at high risk (4.3 million) and changes rankings of PCT level prevalence. We predicted a high prevalence of CVD risk factors in this population; for example 65% of the high-risk patients will be overweight or obese (BMI $>25$ kg/m$^2$), 83% physically inactive, and over 220,000 will have undetected impaired fasting glucose using QRISK2. The levels of CVD risk factors captured by the high-risk population were dependent on the risk score used; with relatively higher levels of smoking and raised blood pressure with JBS2.

Strengths and limitations of the study

There has been no standard collection of NHS Health Check data across England as yet, although this is planned for 2011. This makes modelling a vital element in the programme evaluation. We used practice population data, which captured local differences in population composition, and risk factor estimates for the high-risk population, unlike the Department of Health impact assessment which used general population estimates for each risk factor.

Limitations include missing data for some HSfE variables used. This is common when using large population-based datasets. Blood pressure, BMI, and lipid ratio recording had the highest proportions incomplete; we used multiple imputation to estimate missing data. Multiple imputation can give unbiased estimates even with a large proportions of missing data and we generated sufficient imputed datasets. Data were more likely to be missing in deprived respondents and those of black ethnicity (supplementary appendix, Table A2), but our multiple imputation used these as covariates. Estimates of predicted CVD risk, and therefore the prevalence of high risk, are likely to be more accurate in the affluent white population. Differences in risk factors between deprived and affluent, and white and black respondents may be open to dilution. A problem with HSfE sampling based on the household is there is no information concerning unresponsive households (even the number of non-responders). There is an estimated response rate of 61% in the 2006 survey, 88% for individuals within compliant households. There are no data on the ethnic patterns of non-response. We used fasting plasma glucose as the diagnostic criteria for diabetes, since HbA1c analysis can be used for diagnosis; however, this has limited impact on the prevalence of undiagnosed diabetes here.

There is no HSfE data on CKD, heart failure, atrial fibrillation, or rheumatoid arthritis, which are components of the QRISK2 score. These are not core components of the algorithm and the risk score allows them to be assumed absent if data are missing. Family history of CVD was further assumed null when missing; sensitivity analysis using only complete data, however, gives comparable model outputs. Similarly, a sensitivity analysis was carried out in those have complete data overall (barring CKD, heart failure, atrial fibrillation, or rheumatoid arthritis) and again model outputs were similar. One aim was to estimate the cost of Health Checks in the high-CVD-risk population; we did not consider costs in the low-risk population. As we used cross-sectional survey data, we had no data concerning cardiovascular outcomes; therefore, we were unable to compare the predictive accuracy and discrimination of the mandated risk scores.

Some of the estimates used in this assessment, such as programme uptake of 70% in both high- and low-risk groups have been questioned. Lower uptake may reduce programme costs. In practice, however,
with staffing a major element of the cost, the programme effectiveness might be reduced for no great reduction in cost.\textsuperscript{19} However, we constrained our modelling to the invitation and intervention uptake assumptions made in the Department of Health economic assessment. Our evaluation shows only the predicted uptake from the Department of Health, but we explored variation in level of uptake and found the workload and cost both varied in a linear fashion. We did not conduct any other formal sensitivity analysis, as there are many model assumptions that could be varied for example the uptake for each intervention; we concentrated on Department of Health assumptions. We do however present summary of two alternate screening scenarios (supplementary appendix, Table A3). Our modelling has only examined costs, and it should form the basis for a full cost-effectiveness analysis focussed specifically on the high-risk population, which properly compares QRISK2 and JBS2 and considers the health outcomes of the Programme.

Comparison with existing literature

Modelled data presented here are the first estimates of the prevalence of high-CVD-risk status in England. Using Framingham-based risk scores in smaller populations, there have been estimates of 15.8\%\textsuperscript{20} and 19.1\%\textsuperscript{4} for 35–74 years, 15.5\% for 30–74 years and 17.8\% for 40–70 years,\textsuperscript{21} and 13.3\% for 35–74 years for QRISK2.\textsuperscript{4} The evaluation of a pilot CVD risk assessment service in pharmacies found 70\% of the population screened required a referral to general practice because of a raised risk factor.\textsuperscript{21} This population was not just those at high risk, but as here there was a large need for referral. CVD risk scores were derived as clinical tools to assist treatment, although they can be used to compare levels of risk between populations.\textsuperscript{22} There is geographic variation in the distribution of high CVD risk across England, with prevalence highest in the urban centres of the north. Adding social deprivation to CVD risk scores is believed to improve equity in their use.\textsuperscript{23} The QRISK2 algorithm alters the ranking of risk between PCTs and practices nationally, possibly due to the inclusion of deprivation and ethnicity.

We could not directly compare our estimates of the cost of the Health Check Programme with those generated by the Department of Health (£180–243 million annually) because the latter include assessment and interventions in the total population (not solely high risk), and the methods used are different, notably our omission of the assumption that 50\% of costs are not attributable to the Programme. Our analysis suggests that screening and treating the high-risk group alone will cost at least this amount if the QRISK2 algorithm is used, because of the high prevalence of risk factors in the high-risk group, and much more if the JBS2 algorithm is used. The NHS Health Check Programme once fully implemented will be a 5-year rolling programme, with 20\% of the eligible population screened annually. The high-risk cohort identified here are fewer in number than the annual target for screening, although they possess increased levels of risk factors, increasing management costs.

Implications for programme commissioning and clinical practice

The population impact of healthcare interventions in high-CVD-risk groups is strongly dependent on the uptake achieved.\textsuperscript{19} Early evaluation of the Programme has suggested that uptake might not reach the 70\% estimated by the Department of Health.\textsuperscript{17} High-risk approaches need to be complemented by population-based interventions to reduce the burden of CVD,\textsuperscript{24} for example legislation to reduce salt content of food. In the current financial situation, NHS resources must be allocated carefully. Given population strategies are effective and cost saving,\textsuperscript{24,19} there is a strong case for their greater utilization especially in view of the cost implications of a high-risk approach presented here.

Studies have highlighted the considerable workload implications of the Health Check Programme on primary care.\textsuperscript{25} This varies enormously between practices, with some estimated to have over 1693 high-risk patients using QRISK2. Local commissioners must account for these differences when allocating resources to achieve an equitable service. Further due to geographic variations, the national funding of the Programme might be better targeted using prevalence of high risk, instead of being based solely on population size. Lifestyle- and community-based interventions to address risk factors such as obesity and low levels of physical activity remain underdeveloped. Commissioners must ensure that there is sufficient capacity for referral to manage the CVD risk unearthed by the Programme and will need to scale these services up according to our estimates. National guidance includes the offer of a statin to all patients at high risk of CVD.\textsuperscript{2} This will generate large prescribing costs, with over 2 million patients eligible. Although questions remain over the cost effectiveness of statins for primary prevention in the lowest risk groups, there is support for their use in the high-risk groups presented here.\textsuperscript{26,27} Further, additional work to ascertain the most appropriate threshold of risk at which statins become cost effective is required.

The Department of Health have specified the use of either the QRISK2 or JBS2 risk scores in the NHS Health...
Check Programme. The two risk scores have the same aim, to predict a patient’s 10-year risk of a CVD event, and guidelines quote 20% risk as the cut off for high risk using both scores. Validation of the risk scores was outside the scope of this study. However, our modelling suggests the choice of risk score has a large impact, given considerable differences in size, geographic distribution, and risk factor profile of the high-risk populations identified. Although risk scores have been adapted and used in a wide range of settings, they perform better in populations similar to their derivation cohort.6 The QRISK2 score may outperform Framingham or JBS2 scores in England and therefore may be more applicable to the population.28 The data presented here suggest, if using QRISK2 to select a high-risk cohort, the Programme will be much less costly, largely due to the smaller number at high risk. Using more than one scoring system may cause confusion for both patients and healthcare providers and may result in considerable local inequities over who is eligible for CVD risk-lowering interventions. Moreover, the national dataset does not include a variable specifying which risk-scoring system has been used, making it difficult to ascertain if interventions have been appropriate.

A major deficiency in the Health Check Programme has been the lack of definition of the size of the high-risk population. Current performance indicators include process but not outcome measures. The success of the Programme should be judged by the reduction in size of this population over time, not solely on simple metrics such as the number of Health Checks offered. Our study has provided a baseline estimate against which the health impact of the Programme can be monitored locally and nationally.

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Conflict of interest

The authors declare that there is no conflict of interest.

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