Delivery and impact of the NHS Health Check in the first eight years: a systematic review

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Key words: NHS Health Check, uptake, coverage, impact, systematic review

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ABSTRACT

Background: Since 2009, all eligible persons in England have been entitled to an NHS Health Check. Uncertainty remains about who attends and the health-related impact.

Aim: To review quantitative evidence on coverage (the proportion of eligible individuals who attend), uptake (proportion of invitees who attend) and impact of NHS Health Checks.

Design: A systematic review and quantitative data synthesis.

Data sources: Eleven databases and additional internet sources were searched to November 2016.

Inclusion criteria: Studies or data reporting coverage or uptake and studies reporting any health-related impact which used an appropriate comparison group or before-and-after study design.

Results: Twenty-six observational studies and one additional dataset were included. Since 2013, 45.6% of eligible individuals have received an NHS Health Check. Coverage is higher among older people, those with a family history of coronary heart disease, those living in the most deprived areas, and some ethnic-minority groups. Just under half (48.2%) of those invited have taken up the invitation. Uptake is higher in older people and women but lower in those living in the most deprived areas. Attendance is associated with small increases in disease detection, decreases in modelled CVD risk and increased statin and anti-hypertensive prescribing. Few studies examined how attendance affected health-related behaviours. No economic evaluation was identified.

Conclusion: Attendance is lower than originally anticipated but concern that attendees are typically the ‘worried well’ seems misplaced. NHS Health Checks may slightly reduce modelled CVD risk via earlier detection of risk factors and increased prescribing, although data on impact are limited.

Word count: 250

Key words: NHS Health Check, uptake, coverage, impact, systematic review

How this fits in: Simultaneous nationwide rollout in 2009 of the NHS Health Check programme was based on some strong assumptions about the likely impact of the programme. Almost a decade on, there remains much uncertainty about who attends and the overall health benefits. This article presents the first systematic review of quantitative data from the programme. Although we found attendance is much lower than originally anticipated, attendees cannot be readily characterised as the “worried well” or “easiest to reach.”
INTRODUCTION
The NHS Health Check programme was launched in England in 2009 as part of a healthcare strategy aimed at “empowering patients and preventing illness”.[1] It offers everyone aged 40-74 years without pre-existing cardiovascular disease (CVD), chronic kidney disease (CKD), type 2 diabetes (T2DM) or dementia an assessment of their risk of having or developing such conditions and advice about relevant medications and lifestyle changes. Since 2013, the programme has been a statutory responsibility of local authorities. Funded by Public Health England (PHE), the programme is delivered by various providers, predominantly general practices.

Although the programme was introduced simultaneously nationwide without robust economic evaluation evidence from a randomised controlled trial (RCT)[2], the Department of Health modelled the potential long-term cost-effectiveness of the programme[3]. In that modelling it was envisaged that all those eligible would be invited during the first five years. Based on evidence from a national breast screening programme it was expected that 75% would attend.[3] Of those attendees with high cholesterol or CVD risk (10-year ≥20%), it was hoped that 85% would be prescribed statins (in 50% of cases, this was attributed directly to the health check). Using a time horizon of a lifetime, the cost-effectiveness of the programme was predicted in this modelling to be £2,480 per QALY (quality adjusted life year), well within the limit of what would normally be deemed cost-effective by NICE[4].

The objectives of this study were to systematically identify and synthesize available evidence on: (1) coverage (the proportion of the eligible population who have attended an NHS Health Check) and variation in coverage; (2) uptake (the proportion of those invited who have attended an NHS Health Check) and variation in uptake; and (3) the effect of the programme, in order to provide up-to-date estimates of its delivery and impact.

METHODS
Search strategy and study selection
Full details of the search strategy are given in Appendix 1 and the study selection process is described in detail elsewhere[5]. Briefly, searches included eleven literature databases and additional internet sources encompassing both peer-reviewed and grey literature relevant to NHS Health Checks published up to November 2016.

Inclusion criteria
Quantitative observational data or analyses (cross-sectional or longitudinal) which included people eligible for an NHS Health Check and reported evidence on coverage or uptake were included. Impact studies reporting any health-related outcome which used an appropriate comparison group or a before-
and-after study design were also included. Data or analyses relating to other screening or health check services which were not NHS Health Checks were excluded, as were editorials and opinion pieces.

**Data extraction, quality assessment and synthesis**

Data were extracted independently by three researchers (JUS, AM and CS) using forms devised for this study. Reflecting the wide range of study designs, data and methods identified, existing CASP checklists[6] were adapted for the quality assessment of identified studies.

For each objective, we grouped studies according to their design. Since the programme runs in 5 year cycles, where necessary we adjusted reported coverage to a standardised measure of coverage per year per one fifth of the total eligible population (which can lead to coverage exceeding 100% if more than 20% of the eligible population attend in a given year). We categorised the health-related impact studies (objective 3) into four groups (disease detection, health-related behaviours, prescribing and individual-risk factors) and report the results in order of the degree to which observed differences between groups can be attributed to NHS Health Check attendance.

**RESULTS**

**Overview of included studies**

The searches identified 18,524 articles. We reviewed 178 full-text articles and 26 (including five from the grey literature[7–11]) were deemed relevant (Figure 1). All were observational studies. Seven used data from national datasets (including the Clinical Practice Research Datalink (CPRD)[12–15], QResearch[16] and prescribing data[10]); 19 used local data from general practices (n=17) or community settings (n=2)[7,11]. Eleven studies were assessed as high quality (Appendix Table A1). In addition to the 26 included observational studies, data identified in the additional internet searches were also extracted from PHE’s website.[17]

**Objective 1: Coverage (n=10)**

The PHE website included data on national-level coverage during the first 3.5 years of the current five year cycle (2013-4, when the NHS Health Check became a statutory requirement, to Q2, 2016-7) as well as variation in coverage over time (per quarter) and by area (at the county level). Nine further studies reported data on coverage[8,13,16,18–23] (Table 1).

1a. Reported coverage

The PHE website reported coverage of 45.6% for the whole of England (2013-4 to Q2, 2016-7), ranging from 18.9% in Surrey to 109.2% in Newham[17]. Where full-year data were available, national coverage varied between 48.1% in 2014-15 to 45.0% in 2015-6. Three of the nine published studies used
national-level data from earlier years. [13, 16, 19] The reported coverage ranged from 8.1% (2011-2012)[19] to 26.7% (2009-2013)[13]. The other six studies reported data from samples of general practices, with coverage ranging from 20% (2010-11 in Hammersmith and Fulham) [18] to 73% (2011-12 in north-east London) [24] (Table 1).

1b Variation in coverage

Three studies used multiple regression to identify factors associated with differences in coverage between population groups.[13, 18, 19] The findings from these are summarised in Table 2. Two used patient-level data. Both showed higher coverage among older people and those with a family history of coronary heart disease. The study by Artac et al. additionally reported higher coverage amongst non-smokers, those in the most deprived tertile, those without CVD co-morbidities, those registered with larger general practices, and among people from Black and South Asian ethnic groups.[18] By contrast, the study by Chang et al. found no significant association between coverage and deprivation and a lower coverage among people from Black African and Other Black ethnic groups.[13] The third study used data from 151 primary care trusts (PCT) and found those in the most deprived tertile were significantly more likely to have attended a health check, but no significant associations for age, ethnicity, population size and other PCT-level measures.[19]

A further five studies reported coverage for different population sub-groups without adjustment for covariates (Appendix Table A2) [13, 16, 18, 21, 22] The two that used national-level data during the programme’s first four years showed higher coverage amongst females, older people and those living in more deprived areas.[13, 16]

Objective 2: Uptake (n=11)

The PHE website included data on national-level uptake (2013-4 to Q2, 2016-7) as well as variation in uptake over time (per quarter) and by area (at the county level). Eleven studies reported uptake and socioeconomic factors associated with uptake in general practices (n=9) [7, 9, 11, 21, 22, 25–30] and community-based settings (n=2).[7, 11]) The study samples ranged from two[25] to 40[26] general practices incorporating between 1,380[29] and 50,485[21] patients.

2a: Reported uptake

Table 3 shows the reported uptake across the data sources. The PHE website reported uptake of 48.2% for the whole of England (2013-4 to Q2, 2016-7), ranging from 20.1% in East Riding of Yorkshire to 100% in Leicester. Where full-year data were available, national uptake varied between 47.9% in 2015-6 to 49.0% in 2013-14. Uptake in the general practice studies (n=9) ranged from 27% (four practices in eastern England)[29] to 52.9% (13 practices in north-western England) [22]. Uptake in the community settings was 45.9% (a football ground) [11] and 71.8% (a mental healthcare unit).[7]
2b: Variation in uptake

Five studies reported associations between patient characteristics and the likelihood of attending, using multivariate regression (Table 3). These consistently showed that the odds of taking up an invitation increased significantly with age and lower deprivation. Of the five studies reporting associations between uptake and sex, four also showed women were more likely to take up invitations. The fifth, a study of 37 practices in Stoke-on-Trent[32], reported the opposite with men more likely to take-up invitations. Only two studies reported the effects of ethnicity. One was in 29 practices in Ealing (West London) and found invitees of South Asian or mixed ethnicity were more likely to attend than white British, whilst there was no difference for Black or Other groups and those with missing data were less likely to attend. [27] The other was across four general practices in the East of England and found no difference in uptake between participants of white and non-white ethnicity. [29]

Five studies also reported unadjusted comparisons between invited attendees and non-attendees (Appendix Table A3).[21, 22, 27–29] All reported higher uptake in older people, but findings for deprivation were more mixed with two reporting higher uptake in those in the least deprived areas[21, 28], one with higher uptake in the most deprived[29], and two with no significant differences[22, 27]. Two studies also reported higher uptake in women and, where reported, uptake was higher in non-smokers, those with higher CVD risk and those with hypertension or raised cholesterol.

Objective 3: Impact (n=12)

Twelve studies reported evidence on short-term impact. Five included a comparison group (Table 4). Of these, two used CPRD data to examine individual-level differences over time between matched attendees and non-attendees[14, 15]. The other three reported population-level associations between coverage and outcome[10, 31, 32]. The remaining seven studies were before-and-after studies without comparison groups (Appendix Table A4). No studies of long-term health impacts or economic evaluations were identified.

3a: Disease detection (n=4)

The CPRD study by Chang et al. showed more frequent diagnosis of familial hypercholesterolemia, hypertension, CKD, peripheral vascular disease and T2DM amongst attendees compared to non-attendees during the two years following attendance, whilst stroke diagnosis was significantly less likely. [15] No significant differences in diagnoses of atrial fibrillation, coronary artery disease, heart failure or transient ischemic attack were observed. [15] The CPRD study by Forster et al. also showed more frequent diagnosis of hypercholesterolemia (high cholesterol), and of hypertension amongst men (but not women)[14].
Two further studies used small samples of general practices and reported associations between NHS Health Check coverage and disease detection after controlling for area-level characteristics (e.g. age profile and deprivation).[31, 32] The study by Caley et al.[31] identified no statistically significant associations between coverage and change in the prevalence of T2DM, hypertension, coronary heart disease, CKD or atrial fibrillation. However, the study only included 79 general practices and only 13.6% of the eligible population had received an NHS Health Check so it was under-powered to detect small differences. The second study by Lambert et al.[32] reported that the number of NHS Health Checks performed explained between 6% and 60% of the variance in incident hypertension across the different practices.

3b: Health-related behaviour (n=4)

The only study with a comparison group to report health-related behaviour reported no significant association between change in smoking prevalence (recorded within primary care records over a median of two years) and attendance at a health check.[15] Three studies reported change in smoking amongst individuals after attendance at a health check (Appendix Table A4). Two[12, 33] showed a significant reduction of at least ten percentage points in the proportion of attendees who smoked, whereas in the other the change was not statistically significant[34]. Without a comparison group, however, it is not possible to attribute these changes to the NHS Health Check. No other health-related behaviours were reported.

3c: Prescribing (n=9)

The two CPRD studies [14, 15] identified significantly greater increases in statin and anti-hypertensive prescriptions amongst attendees than matched non-attendees. For example, new statin prescriptions were initiated for 5.6% of attendees, versus 1.2% of non-attendees over a median of two-years in one of the studies[15], and by 11.0% and 7.6% over four years in the other.[14] Another study investigated national-level prescribing data and showed a significant association between coverage and high-dose statin prescribing at the PCT level in 2011, however the association was not significant for low-dose statins.[10]

Six before-and-after studies all showed an increased likelihood of a statin prescription following attendance (Appendix Table A4).[12, 13, 16, 22, 27, 34] The proportion prescribed statins after the health check ranged from 18.3% in one of the CPRD studies[12] to 49.9% in Hammersmith and Fulham[34].

3d: Individual risk factors and CVD risk (n=5)

The CPRD study by Chang et al.[15] showed significant differences in BMI, blood pressure (BP) (systolic and diastolic), modelled CVD risk and total cholesterol between attendees and matched non-
attendees during a two-year period.[15] For example, the QRISK2 mean score (% 10-year risk) fell by 0.21 (95% CI: 0.19 to 0.24), from 5.1 to 4.9 amongst non-attendees, compared to 6.7 to 6.2 amongst attendees, which is equivalent to the prevention of one cardiovascular event per 4,762 attendees. However, the sample used in the analysis was limited by missing data: only 2.3% of non-attendees had a follow-up QRISK2 score recorded. The population-level cross-sectional study by Lambert et al. also reported a strong negative association between the number of health checks provided in a particular area and incident cases of CVD.[32]

Three further before-and-after studies of attendees[12, 33, 34] identified significant reductions in diastolic BP and cholesterol levels after 12-15 months (Appendix Table A4). Two of these also reported significant reductions in obesity, CVD risk and systolic BP. [12, 34] However, the samples used in the analyses were also limited by missing data (e.g. follow-up data was unavailable for 50% of attendees in one study).[34]

DISCUSSION

Summary of main findings

In the current five year cycle starting in 2013, the most recent available evidence shows that 45.6% of eligible adults across England have attended an NHS Health Check. This percentage varies substantially across the country, from 18.9% in some areas to over 100% in others. Data from the identified studies shows higher coverage among older people, those with a family history of coronary heart disease, those living in the most deprived areas, and some ethnic groups. Uptake also varies substantially with just under half (48.2%) of all those invited taking up the invitation. The proportion accepting the invitation is also higher in older people and women but, in contrast with coverage, is lower in those living in the most deprived areas. The impact studies comparing attendees with matched non-attendees showed that attendance is associated with small increases in disease detection above routine practice, an increased likelihood of statin and anti-hypertensive prescribing (with the percentage of those with a modelled 10-year CVD risk ≥20% prescribed statins following a health check ranging between 18% to 63%), and small decreases in modelled CVD risk (the best current evidence suggests that one cardiovascular event is prevented per 4,762 attendees, equating to over 1,400 events across the country during a five year cycle). Very few studies have reported the impact of attendance on health-related behaviours.

Strengths and limitations

Nine years since the programme was introduced, and four since it became a statutory responsibility of local authorities, this is the first synthesis of quantitative evidence related to delivery or impact. A strength of our study is the systematic searches, including the OpenGrey database and additional
internet-based searches. However, in the absence of randomised trials or a step wedge evaluation of a gradual roll-out of NHS Health Checks, the synthesis is limited by the quality of the included studies.

Studies used different populations, time points (including before the programme became statutory in 2013), patient databases, and methods for identifying attendance, making pooling of data from different studies difficult. Almost all studies relied on routinely collected data for patient characteristics and health outcomes. Missing outcome data is therefore a particular problem as data are likely to be less complete in those people who have not attended a health check. This may be the reason why those who have attended are more likely to have a family history of coronary heart disease recorded, for example. There may also be systematic differences in those who attend health checks and those who don’t, leading to bias in the estimates of the impact of the programme based on studies with control groups. For example, those who have not attended a health check but do have a disease or risk factor recorded may be those in whom healthcare professionals have already clinically suspected disease, or those who consult more often. Although the two studies using CPRD which compared those who had attended with matched non-attendees[14, 15] provide the best available evidence, the general practices which contribute data to CPRD are larger[35] and potentially more engaged with research and preventive medicine than those who do not. The lack of published data on the cost of health checks or evidence on the long-term health impact prevents an assessment of the cost-effectiveness of the programme.

Implications for clinical practice, policy and research

This study shows that the estimated coverage, uptake and prescribing rates used in the Department of Health model were optimistic: all are well below expected levels. This has particular importance for policy makers and researchers for whom it highlights potential implications for future health economic modelling and the importance of using published data for new or revised models of the health check programme.[36, 37] There is also a need for further studies comparing matched attendees and non-attendees, including follow-up studies to quantify the impact of health check attendance on physical activity, diet, alcohol consumption, smoking, and potential harms such as false reassurance and anxiety which are currently unknown.

An important finding was that coverage is higher among older people and those in the most deprived areas,[38–42] presumably as a result of targeting given that uptake tended to be higher among women, older people and the less deprived. This may go some way towards alleviating concerns amongst health professionals that attendees are typically the ‘worried well’ or those least likely to benefit and indicates that, when appropriately targeted, the programme may contribute to tackling health inequalities. Despite health check attendance being below expectations, further economic evaluation evidence is necessary to determine whether or not the original modelled estimates of cost per QALY were optimistic.
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**Contributors**

AM screened articles for inclusion, extracted and synthesised the data, interpreted the findings and wrote the first draft of the manuscript. CS extracted the data, interpreted the findings and critically revised the manuscript. EH screened articles for inclusion, interpreted the findings and critically revised the manuscript. CMa interpreted the findings and critically revised the manuscript. SG, JM, CM and FW developed the protocol, interpreted the findings and critically revised the manuscript. JUS developed the protocol, screened articles for inclusion, extracted and synthesised the data, interpreted the findings and wrote the first draft of the manuscript.

**Competing Interests**

None declared.

**FIGURE LEGENDS**

Figure 1: PRISMA diagram

Figure 2: Change in the percentage of people being prescribed statins before and after attending an NHS Health Check

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A quantitative service evaluation. 2016.

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Coverage of a national cardiovascular risk assessment and management programme (NHS

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461
462
## Table 1: Overall Coverage

<table>
<thead>
<tr>
<th>Author / Year</th>
<th>Setting and time period</th>
<th>Coverage per one fifth of the total eligible population</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NATIONAL LEVEL</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public Health England[17]</td>
<td>England 2013-4 to Q2 2016-7</td>
<td>45.6%</td>
</tr>
<tr>
<td>Artac 2013[19]</td>
<td>England 2011-12</td>
<td>8.1%</td>
</tr>
<tr>
<td>Robson 2016[16]</td>
<td>England 2009-12</td>
<td>12.8%</td>
</tr>
<tr>
<td><strong>REGIONAL LEVEL</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Artac 2013[18]</td>
<td>27 (of 31) PCTs in Hammersmith and Fulham 2008-09 2010-11</td>
<td>2008-09: 32.7% 2010-11: 20.0%</td>
</tr>
<tr>
<td>Baker 2015[20]</td>
<td>83 (of 85) practices in Gloucestershire 2011-12</td>
<td>49.8%</td>
</tr>
<tr>
<td>Coffey 2014[8]</td>
<td>40 (of 47) practices in Salford 2013-14</td>
<td>34%</td>
</tr>
<tr>
<td>Cook 2016[21]</td>
<td>Not reported 2013-14</td>
<td>56.5%</td>
</tr>
<tr>
<td>Krska 2015[22]</td>
<td>13 (of 55) GP practices in Sefton, North West England 2011-12</td>
<td>47.2%</td>
</tr>
<tr>
<td>Robson 2015[24]</td>
<td>3 PCTs in East London 2009-10 2010-11 2011-12</td>
<td>2009-10: 33.9% 2010-11: 60.6% 2011-12: 73.4%</td>
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</table>
Table 2: Associations between coverage and area-level or individual-level characteristics from multivariate adjusted studies

<table>
<thead>
<tr>
<th>Author / Year</th>
<th>Description of analysis</th>
<th>Age</th>
<th>Gender</th>
<th>Ethnicity</th>
<th>Deprivation</th>
<th>Smoker</th>
<th>Family history of CHD</th>
<th>Other</th>
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<tbody>
<tr>
<td>Artac 2013[19]</td>
<td>Multivariable linear regression comparing PCT-level characteristics</td>
<td>Highest proportion of PCT population in 40-74 age range compared to lowest Coefficient -0.03 (-0.87-0.36) p=0.668</td>
<td>Not reported</td>
<td>Highest proportion of PCT population of minority ethnicity compared to lowest Coefficient 0.08 (-0.17-0.95) p=0.424</td>
<td>Least deprived tertile compared to most deprived: Coefficient -0.51 (-1.88-0.0) p=0.035*</td>
<td>---</td>
<td>---</td>
<td>Population size, QOF points, patient experience, FTE GPs, estimated proportion at high-risk and estimated CVD prevalence: ns</td>
</tr>
<tr>
<td>Chang 2015[13]</td>
<td>Multilevel logistic regression of individual-level patient characteristics</td>
<td>Compared to 40-49 years: Aged 50-59: 1.60 (1.54-1.67)* Aged 60-69: 2.47 (2.36-2.58)* Aged 70-74: 2.88 (2.49-3.31)*</td>
<td>Female: 1.01 (0.98-1.05)</td>
<td>Compared to White: Black African: 0.75 (0.61-0.92)* Chinese: 0.68 (0.47-0.96)* Other White: 0.35 (0.33-0.37)* Other Black: 0.58 (0.46-0.74)* Not recorded: 0.18 (0.17-0.19)* Prefer not to state: 0.47 (0.41-0.53)* Irish: ns Indian: ns Pakistani/Bangladeshi: ns Other Asian: ns Caribbean: ns</td>
<td>Most deprived quintile compared to least deprived: 0.91 (0.63-1.31)</td>
<td>---</td>
<td>Positive family history compared to no family history: 2.37 (2.22-2.53)*</td>
<td>---</td>
</tr>
<tr>
<td>Artac 2013[18]</td>
<td>Multilevel logistic regression of individual-level patient characteristics using data on 27 (of 31) PCTs in London</td>
<td>Compared to 40-54 years: Aged 55-64 Y1: 1.34 (1.11-1.61)* Y2: 1.79 (1.67-1.93)* Aged 65-74 Y1: 2.05 (1.67-2.52)* Y2: 2.79 (2.49-3.12)*</td>
<td>Female: Y1: 0.80 (0.67-0.94)* Y2: 1.27 (1.20-1.35)*</td>
<td>Compared to White: Black Y1: 1.05 (0.78-1.41) Y2: 1.58 (1.43-1.75)* South Asian Y1: 1.27 (0.88-1.87) * Y2: 1.50 (1.25-1.78)* Not recorded: Y1: 0.11 (0.07-0.17)* Y2: 0.08 <em>0.07-0.10)</em></td>
<td>Least deprived tertile compared to most deprived: Y1: 0.84 (0.69-1.01) Y2: 0.80 (0.73-0.87)*</td>
<td>Current smokers compared to non-smokers: Y1: 0.71 (0.61-0.83)* Y2: 0.83 (0.77-0.90)*</td>
<td>Positive family history compared to no family history: Y1: 2.49 (2.15-2.90)* Y2: 2.01 (1.87-2.16)*</td>
<td>Presence of non-CVD co-morbidities: Y1: 1.53 (1.13-1.80)* Y2: 1.75 (1.64-1.87)* Practice list size: &gt;10,000 compared to &lt;6000 Y1: 1.16 (0.51-2.65) Y2: 6.05 (0.85-43.4)*</td>
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</tbody>
</table>

* p<0.05 ns: not significant. Results presented as adjusted odds ratios unless stated otherwise. PCT – Primary Care Trust; QOF – Quality Outcomes Framework; FTE – full time equivalent; CVD – cardiovascular disease;
### Table 3: Uptake and variation in uptake of NHS Health Checks

<table>
<thead>
<tr>
<th>Study characteristics</th>
<th>Uptake</th>
<th>Multi-variate logistic regression analysis of individual-level factor affecting uptake of NHS Health Checks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Author / Year</td>
<td></td>
<td>Age</td>
</tr>
<tr>
<td>Public Health England [17]</td>
<td>Published data, whole of England</td>
<td>Whole population data</td>
</tr>
<tr>
<td>Attwood 2015[29]</td>
<td>Trial set in 4 GP practices in the East of England</td>
<td>1,380 patients Mean age: 52.4 Male: 49.7% White: 72.9%</td>
</tr>
<tr>
<td>Cochrane 2013[28]</td>
<td>Observational study using electronic practice records from 37 (of 57) GP practices in Stoke on Trent</td>
<td>10.483 high risk patients Aged &gt;55: 79.6% Aged &gt;65: 36.4% Male: 81.3%</td>
</tr>
<tr>
<td>Coffee 2015 d [7]</td>
<td>Observational study using data from 2 community medical centres in Birmingham</td>
<td>188 patients already using secondary mental health services</td>
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<tr>
<td>Coghill 2016d [9]</td>
<td>Quasi-experimental study/Electronic practice records of 17 GP practices in Bristol</td>
<td>5,678 patients</td>
</tr>
<tr>
<td>Cook 2016[21]</td>
<td>Observational study using electronic practice records from 30 (all) GP practices in Luton</td>
<td>50.485 patients Aged&gt;55: 30.5% Aged&gt;65: 7.6% Male: 53.3% White British: 32.5%</td>
</tr>
<tr>
<td>Dalton 2011[27]</td>
<td>Observational study using electronic practice records</td>
<td>5,294 high risk patients</td>
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<tr>
<td>Study</td>
<td>Design</td>
<td>Sample Size</td>
</tr>
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<td>Hooper 2014[26]</td>
<td>Observational study using data from 40 GP practices in Warwickshire</td>
<td>37,236 patients</td>
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<tr>
<td>Krska 2015[22]</td>
<td>Observational study using electronic practice records in 13 (of 55) GP practices in Sefton, North West England</td>
<td>2,892 high risk patients</td>
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<tr>
<td>Kumar 2011[25]</td>
<td>Observational study using data from 2 (of approx. 57) GP practices in Stoke on Trent</td>
<td>1,606 patients (of whom 661 were high risk patients)</td>
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<td>Sallis 2016[30]</td>
<td>Pragmatic quasi-randomised controlled trial in 4 GP practices in Medway</td>
<td>3511 patients</td>
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</table>

Results presented as adjusted odds ratios. * p<0.05 ns: not significant. a data from control arm of trial who attended NHS health checks; b reported with age interaction.

---

470 Results presented as adjusted odds ratios
471 * p<0.05 ns: not significant
472 a data from control arm of trial who attended NHS health checks; b reported with age interaction
### Table 4. Studies with a comparison group reporting the health-related impact of the NHS Health Check

<table>
<thead>
<tr>
<th>Study characteristics</th>
<th>RESULTS</th>
<th>Prescribing</th>
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<tr>
<td><strong>Author / Year</strong></td>
<td><strong>Comparison and Statistical Method</strong></td>
<td><strong>Disease detection</strong></td>
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<tr>
<td>Chang 2016[15]</td>
<td>Individual-level matched cohort study using CPRD data Baseline: April 2009 - March 2013 Follow-up: Median of 2 years</td>
<td>Difference in difference analysis comparing attendees with non-attendees with propensity score matching on age, gender, ethnicity, deprivation and region</td>
</tr>
<tr>
<td>Forster 2015[14]</td>
<td>Individual-level matched cohort study using CPRD data April 2009 - March 2013</td>
<td>Cohort study comparing attendees with non-attendees matched on age, gender and general practice</td>
</tr>
<tr>
<td>Caley 2014[31]</td>
<td>Observational study using electronic medical records in 79 GP practices in Warwickshire June 2010 – March 2013 (39 months)</td>
<td>Multivariate regression analysis reporting association between % eligible completing an NHS Health Check at practice level and change in prevalence of five conditions</td>
</tr>
<tr>
<td>Lambert 2016[32]</td>
<td>Observational study using local data returned from GP practices to commissioners in 3 health districts (101 practices) in North East England Unclear year 30 months</td>
<td>Univariate regression models reporting association between number of NHS Health Checks provided in the health district and incident cases of disease</td>
</tr>
</tbody>
</table>
* p<0.05; CPRD – Clinical Practice Research Datalink; AF - atrial fibrillation; CKD – chronic kidney disease; CAD – coronary artery disease; FH – familial hypercholesterolaemia; PVD – peripheral vascular disease; TIA – transient ischaemic attack; T2DM – type 2 diabetes; DBP – diastolic blood pressure; SBP – systolic blood pressure; BMI – body mass index; HR – hazard ratio; CHD – coronary heart disease
Objective 1: Coverage  
\[ n = 10 \]

Objective 2: Uptake  
\[ n = 12 \]

Objective 3: Impact  
\[ n = 12 \]
Appendix 1 – Search strategies

Two searches were completed. First, by Public Health England (PHE), in Medline, Embase, Health Management Information Consortium (HMIC), Cumulative Index of Nursing and Allied Health Literature (CINAHL), Global Health, PsycInfo, the Cochrane Library, NHS Evidence, Google Scholar, Google, Clinical Trials.gov and the ISRCTN registry from 1 January 1996 to 9 November 2016. Second, we performed searches in Web of Science and Open Grey over the same period. The OAIster database was unavailable at the time of the search.

Full details of the search strategy for each of the databases are provided below.

<table>
<thead>
<tr>
<th>Database</th>
<th>Search strategy</th>
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<tbody>
<tr>
<td>Ovid Medline</td>
<td>1. health check*.tw. 2. (diabetes adj3 screen*).tw. 3. (cardiovascular adj3 screen*).tw. 4. (population adj2 screen*).tw. 5. (risk factor adj3 screen*).tw. 6. (opportunistic adj3 screen*).tw. 7. medical check*.tw. 8. general check*.tw. 9. periodic health exam*.tw. 10. annual exam*.tw. 11. annual review*.tw. 12. NHSHC.tw. 13. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 14. cardiovascular adj3 prevention.tw. 15. (primary care or general practice or primary healthcare).tw 16. 14 and 15 17. Cardiovascular Diseases/ AND Primary Prevention/ 18. 16 or 17 19. 13 or 18</td>
</tr>
</tbody>
</table>
17. #15 and #16
18. #14 or #17
19. #13 or #18

Ovid Embase
1. health check*.tw.
2. (diabetes adj3 screen*).tw.
3. (cardiovascular adj3 screen*).tw.
4. (population adj2 screen*).tw.
5. (risk factor adj3 screen*).tw.
6. (opportunistic adj3 screen*).tw.
7. medical check*.tw.
8. general check*.tw.
9. periodic health exam*.tw.
10. annual exam*.tw.
11. annual review*.tw.
12. NHSHC.tw.
13. periodic medical examination/
14. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13
15. cardiovascular adj3 prevention.tw.
16. (primary care or general practice or primary healthcare).tw
17. 15 and 16
18. cardiovascular disease/ AND primary prevention/
19. 17 or 18
20. 14 or 19

Ovid HMIC
1 "health check*".af.
2 health checks/
3 (cardiovascular or vascular or heart or diabetes or stroke).af.
4 (screen* or risk).af.
5 3 AND 4
6 1 OR 2 or 5
7 cardiovascular adj3 prevention.tw.
8 (primary care or general practice or primary healthcare).tw
9 7 and 8
10 Cardiovascular diseases/ AND exp preventive medicine/
11 9 or 10
12 6 or 11

EBSCO CINAHL
S10 S1 OR S2 OR S9
S9 S5 OR S8
S8 S6 AND S7
S7 (MH "Preventive Health Care+")
S6 (MH "Cardiovascular Diseases+")
S5 S3 AND S4
S4 "primary care" or "general practice" or "primary healthcare"
S3 TX cardiovascular N3 prevention
S2 (diabetes N3 screen*) OR (cardiovascular N3 screen*) OR
(population N2 screen*) OR (risk factor N3 screen*) OR (opportunistic
N3 screen*) OR “medical check*” OR “general check*” OR “periodic
health exam*” OR “annual exam*” OR "annual review*" OR NHSHC
S1 health check*

EBSCO Global
S10 S6 OR S19 OR S3 Limiters - Publication Year: 2016
Health
S9 S7 AND S8
S8 DE "preventive medicine"
S7 DE "cardiovascular diseases"
S6 S4 AND S5
S5 "primary care" or "general practice" or "primary healthcare"
S4 TX cardiovascular N3 prevention
S3 S1 OR S2
S2 (diabetes N3 screen*) OR (cardiovascular N3 screen*) OR (population N2 screen*) OR (risk factor N3 screen*) OR (opportunistic N3 screen*) OR “medical check*” OR “general check*” OR “periodic health exam**” OR “annual exam***” OR "annual review***" OR NHSHC
S1 health check*

HDAS PsycInfo
1 "health check**".af.
2 PHYSICAL EXAMINATION/
3 HEALTH SCREENING/
4 "diabetes screen*”.af
5 "cardiovascular screen*”.af
6 "population screen*”.af
7 ("opportunistic* screen*" OR "risk factor screen**").af
8 ("medical check**” OR "general check***” OR "periodic health exam****” OR "annual exam*****” OR "annual review******“ OR NHSHC).af
9 1 OR 2 OR 3 OR 4 OR 5 OR 6 OR 7 OR 8
10 cardiovascular.ti,ab
11 prevention.ti,ab
12 10 AND 11
13 CARDIOVASCULAR DISORDERS/
14 PREVENTIVE MEDICINE/
15 13 AND 14
16 12 OR 15
17 9 OR 16

Web of Science,
Science Citation Index
“health check**” OR “diabetes screen*” OR “cardiovascular screen***” OR “population screen***” OR “risk factor screen**” OR “Opportunistic screen***” OR “medical check*” OR “general check***” OR “periodic health exam****” OR “annual exam*****” OR “annual review******“ OR NHSHC
OR
(Cardiovascular NEAR/3 prevention) AND (“primary care” OR “general practice” OR “primary healthcare”)
Limit to: England, Scotland, Wales, North Ireland

Cochrane Library
(Wiley)
#1 "health check**"
#2 (diabetes next/3 screen*) or (cardiovascular next/3 screen*) or (population next/2 screen*) or (opportunistic next/2 screen*) or ("risk factor" next/3 screen*) or "medical check*” or "general check*” or "periodic health exam**” or "annual exam***” or "annual review****“ or NHSHC
#3 cardiovascular adj3 prevention.tw.
#4 (primary care or general practice or primary healthcare).tw
#5 #3 and #4
#6 MeSH descriptor: [Cardiovascular Diseases] this term only
#7 MeSH descriptor: [Primary Prevention] explode all trees
#8 #6 and #7
#9 #5 or #8
#10 #1 or #2 or #9
NHS Evidence        “health check*” OR cardiovascular prevention primary care
TRIP database       “health check*” OR cardiovascular prevention primary care
Google Scholar     "nhs health check"
                   cardiovascular “health check”
                   cardiovascular prevention “primary care”
Google              "nhs health check"
                   cardiovascular prevention “primary care”
                   cardiovascular “health check”
Clinical trials.gov and ISRC DN registry “health check”
## APPENDIX TABLE A1: Quality assessment of included studies

<table>
<thead>
<tr>
<th>Author, date</th>
<th>Study addressed a clearly focused issue</th>
<th>Use of an appropriate method / Randomisation (for RCTs)</th>
<th>Recruitment / comparability of study groups at baseline</th>
<th>Blinding (for RCTs)</th>
<th>Exposure measurement</th>
<th>Outcome measurement</th>
<th>Comparability of study groups during study (for RCTs)</th>
<th>Follow up (for longitudinal studies)</th>
<th>Confounding factors (for non-RCTs):</th>
<th>Applicability to England</th>
<th>Overall</th>
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APPENDIX TABLE A2: Coverage for different population subgroups

**NATIONAL LEVEL**

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<th>Study, location and dates</th>
<th>Age group</th>
<th>Gender</th>
<th>Ethnicity</th>
<th>Deprivation (area-level)</th>
<th>Family history of coronary heart disease</th>
<th>Smoker</th>
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<tbody>
<tr>
<td></td>
<td>40-49</td>
<td>50-59</td>
<td>60-69</td>
<td>70-74</td>
<td>Male</td>
<td>Female</td>
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<tr>
<td>Chang 2015 England, 2009/10 to 2012/13</td>
<td>17.0%</td>
<td>22.4%</td>
<td>29.0%</td>
<td>31.2%</td>
<td>20.2%</td>
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<tr>
<td>Robson 2016 England, 2009/10 to 2012/13</td>
<td>9.0%</td>
<td>13.7%</td>
<td>19.6% (aged 60-74)</td>
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<td>12.3%</td>
<td>13.2%</td>
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**LOCAL LEVEL**

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<th>Ethnicity</th>
<th>Deprivation (area-level)</th>
<th>Family history of coronary heart disease</th>
<th>Smoker</th>
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<td></td>
<td>40-54</td>
<td>55-64</td>
<td>65-74</td>
<td>Male</td>
<td>Female</td>
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<tr>
<td>Artac 2013 Hammersmith and Fulham Jul 2008- Nov 2009</td>
<td>26.9%</td>
<td>30.5%</td>
<td>39.2%</td>
<td>32.6%</td>
<td>33.0%</td>
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<tr>
<td>Dec 2009- Mar 2011</td>
<td>17.7%</td>
<td>25.6%</td>
<td>33.1%</td>
<td>17.0%</td>
<td>22.5%</td>
</tr>
<tr>
<td>Cook 2016 Luton, 2013/14</td>
<td></td>
<td></td>
<td></td>
<td>10.1%</td>
<td>12.6%</td>
</tr>
<tr>
<td>Krska 2015 Sefton, North West England, Oct 2011-Mar 2012</td>
<td>n/a</td>
<td>31.3%</td>
<td>39.5%</td>
<td>38.3%</td>
<td>32.5%</td>
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</tbody>
</table>

*Complete list: Irish (43.4%), Other White (20.2%), Indian (42.8%), Pakistani/Bangladeshi (44.5%), Other Asian (42.0%), Caribbean (37.1%), African (33.4%), Other Black (27.4%), Chinese (30.1%), Other including mixed background e.g. White and Black Caribbean, White and Black African, White and Asian (36.8%).

bComplete list: Indian (17.7 %), Pakistani (16.1%), Bangladeshi (29.6%), Other Asian (14.6%), Caribbean (19.6%), Black African (15.7%), Chinese (15.3%), Other (15.6%)
## APPENDIX TABLE A3 Unadjusted variation in uptake for different population subgroups

<table>
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<tr>
<th>Study characteristics</th>
<th>Uptake</th>
<th>Univariate logistic regression analysis of individual-level factor affecting uptake of NHS Health Checks</th>
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<td><strong>Study design/setting</strong></td>
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<td><strong>Author / Year</strong></td>
<td>Uptake</td>
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</tr>
<tr>
<td>Attwood 2015</td>
<td>27.0%</td>
<td>For each increasing year: 1.05 (1.04-1.07)*</td>
</tr>
<tr>
<td>4 GP practices in the East of England</td>
<td>27.0%</td>
<td>For each increasing year: 1.05 (1.04-1.07)*</td>
</tr>
<tr>
<td>Cochrane 2013</td>
<td>43.7%</td>
<td>Uptake significantly higher ≥65 years (51.8% compared to 28.5% for those ≥30 and &lt;55 years)</td>
</tr>
<tr>
<td>37 (of 57) GP practices in Stoke on Trent</td>
<td>43.7%</td>
<td>Significantly higher uptake rates in older age groups</td>
</tr>
<tr>
<td>Cook 2016</td>
<td>43.7%</td>
<td>Significantly higher uptake in older age groups (45.6% for those 65-74; 41.0 for those 35-54)</td>
</tr>
<tr>
<td>30 (all) GP practices in Luton</td>
<td>43.7%</td>
<td>Significantly higher uptake in older age groups (45.6% for those 65-74; 41.0 for those 35-54)</td>
</tr>
<tr>
<td>Dalton 2011</td>
<td>44.8%</td>
<td>Significantly higher uptake in older age groups (45.6% for those 65-74; 41.0 for those 35-54)</td>
</tr>
<tr>
<td>29 (of 86) GP practices in Ealing, London</td>
<td>44.8%</td>
<td>Significantly higher uptake in older age groups (45.6% for those 65-74; 41.0 for those 35-54)</td>
</tr>
<tr>
<td>Krska 2015</td>
<td>52.9%</td>
<td>Age &gt;65: 1.93 (1.48-2.50)*</td>
</tr>
<tr>
<td>Observational study using electronic practice records in 13 (of 55) GP practices in Sefton, North West England</td>
<td>52.9%</td>
<td>Age &gt;65: 1.93 (1.48-2.50)*</td>
</tr>
</tbody>
</table>

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*Results presented as unadjusted odds ratios unless otherwise specified

*p<0.05 ns: not significant*
## APPENDIX TABLE A4. Before and after studies reporting the health-related impact of the NHS Health Check

<table>
<thead>
<tr>
<th>Study characteristics</th>
<th>Study design/Setting</th>
<th>Results</th>
<th>Individual-risk factors / CVD risk reduction</th>
<th>Prescribing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Author / Year</strong></td>
<td><strong>Study design/Setting</strong></td>
<td><strong>Health-related behaviours</strong></td>
<td><strong>CVD risk score (JBS): 28.2% (95%CI 27.3-29.1) to 26.2% (95%CI 25.4-27.1).</strong>&lt;br&gt;<strong>DBP: 80.7mmHg (80.2-81.3) to 79.6mmHg (79.0-80.1)</strong>&lt;br&gt;<strong>TC: 5.26mmol/L (5.19-5.34) to 4.98mmol/L (4.90-5.06)</strong>&lt;br&gt;<strong>Lipid ratio (TC/HDL): 4.44 (4.34-4.53) to 4.13(4.05-4.23)</strong>&lt;br&gt;No significant change in: SBP, BMI or obesity</td>
<td><strong>Increase in statin prescribing:</strong>&lt;br&gt;≥20% risk:&lt;br&gt;Male 13.8% to 61.7%&lt;br&gt;Female 15.0% to 58.4%&lt;br&gt;All 14% (95%CI 11.9-16.0) to 60.6% (95%CI 57.7-63.5)</td>
</tr>
<tr>
<td>Artac 2013</td>
<td>Observational study using electronic medical records in Hammersmith and Fulham PCT July 2008 – Mar 2011</td>
<td>No significant change in smoking status</td>
<td>**Significant reduction in: **&lt;br&gt;<strong>CVD risk score (JBS): 32.9% (SD 9.7) to 29.4% (SD 9.7)</strong>&lt;br&gt;<strong>SBP: 146 mmHg (SD 17) to 138.3 mmHg (SD 14.7)</strong>&lt;br&gt;<strong>DBP: 84.9 mmHg (SD 9.5) to 80.5 mmHg (SD 8.8)</strong>&lt;br&gt;<strong>TC: 5.7 mmol/L (SD 0.9) to 5.0 mmol/L (SD 1.0)</strong>&lt;br&gt;<strong>Lipid ratio (TC/HDL): 4.8 (SD 1.0) to 4.2 (SD 1.1)</strong>&lt;br&gt;<strong>Waist circumference: 99.5cm (SD 11.8) to 97.9cm (SD 10.7)</strong>&lt;br&gt;No significant change in: weight, BMI or HDL cholesterol</td>
<td></td>
</tr>
<tr>
<td>Chang 2015</td>
<td>Observational study using CPRD data(a random sample drawn from the national CPRD dataset) in England Apr 2009 – Mar 2013 (4 years)</td>
<td>---</td>
<td>---</td>
<td>Increase in statin prescribing:&lt;br&gt;Male 13.8% to 61.7%&lt;br&gt;Female 15.0% to 58.4%&lt;br&gt;All 14% (95%CI 11.9-16.0) to 60.6% (95%CI 57.7-63.5)</td>
</tr>
<tr>
<td>Cochrane 2012</td>
<td>Randomised trial in 38 (of 57) GP practices in Stoke on Trent Baseline: Aug 2009-Jan 2010. Follow-up: 1 year</td>
<td>Significant reduction in self-reported smoking from 55.3% (n=197/356) to 45.2% (n=161/356)</td>
<td><strong>Increase in statin prescribing:</strong>&lt;br&gt;High risk: 24.9% to 43.4%&lt;br&gt;Low risk: 27.0% to 39.6%</td>
<td></td>
</tr>
<tr>
<td>Dalton 2011</td>
<td>Observational study using electronic practice records in 29 (of 86) GP practices in London 2008-2009 (1 year)</td>
<td>---</td>
<td>---</td>
<td>Increase in statin prescribing:</td>
</tr>
<tr>
<td>Forster 2015</td>
<td>Observational study using CPRD data in England Baseline: 2010-13 (3 years) Follow-up:15 months</td>
<td>Significant reduction in the proportion of smokers: Male: -16% (95% CI -15 to -17) Female: -15% (95%CI -15 to -16)</td>
<td><strong>Statin prescription within 12 months:</strong>&lt;br&gt;≥20% risk: Male 17.6% ; Female 21.4% ; All: 18.3%&lt;br&gt;&lt;20% risk: Male 2.9% ; Female 2.7% ;All: 2.8%</td>
<td><strong>Anti-hypertensive prescription within 12 months:</strong>&lt;br&gt;≥20% risk: Male 11.1% ; Female 16.3% ; All: 12.1%&lt;br&gt;&lt;20% risk: Male 3.4% ; Female 3.4% ; All: 3.4%</td>
</tr>
<tr>
<td>Krska 2015</td>
<td>Observational study using electronic practice records in 13 (of 55) GP practices in North West England</td>
<td>---</td>
<td>---</td>
<td>Increase in statin prescribing: ≥20% risk: 19.6% to 34.6%</td>
</tr>
<tr>
<td>Robson 2016</td>
<td>Observational study using QResearch data in England</td>
<td>---</td>
<td>---</td>
<td>New statin prescription:&lt;br&gt;Attendees: 5.1% Non-attendees: 1.0%;</td>
</tr>
<tr>
<td>Baseline: April 2009 to Mar 13 (4 years)</td>
<td>Follow-up: 12 months</td>
<td>New anti-hypertensive prescription: Attendees: 3.9%; Non-attendees: 1.8%;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>