Adam Martin, Catherine L Saunders, Emma Harte, Simon J Griffin, Calum MacLure, Jonathan Mant, Catherine Meads, Fiona M Walter and Juliet A Usher-Smith

Delivery and impact of the NHS Health Check in the first 8 years:

a systematic review

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 impacts.

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 and setting
A systematic review and quantitative data synthesis. Included were studies or data reporting coverage or uptake and studies reporting any health-related impact that used an appropriate comparison group or before-and-after study design.

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

Results
Twenty-six observational studies and one additional dataset were included. Since 2013, 45.6% of eligible individuals have received a 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. Data on uptake and impact (especially regarding health-related behaviours) are limited. Uptake is higher in older people and females, but lower in those living in the most deprived areas. Attendance is associated with small increases in disease detection, decreases in modelled cardiovascular disease risk, and increased statin and antihypertensive prescribing.

Conclusion
Published attendance, uptake, and prescribing rates are all lower than originally anticipated, and data on impact are limited, with very few studies reporting the effect of attendance on health-related behaviours. High-quality studies comparing matched attendees and non-attendees and health economic analyses are required.

Keywords
coverage; general practice; impact; NHS Health Check; primary care; systematic review; uptake.

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 every 5 years. Since 2013, local authorities have had a statutory responsibility to offer the programme to all eligible individuals, with funding provided by Public Health England (PHE).[2] Echoing similar efforts in other countries to provide preventive health checks,[3,4] the programme is delivered by various providers, predominantly general practices.

The programme was introduced simultaneously nationwide without robust economic evaluation evidence from a randomised controlled trial (RCT), and with very limited available evidence on health check strategies implemented in other countries.[5,6] However, the Department of Health modelled the potential long-term cost-effectiveness of the programme.[7] In that modelling, it was envisaged that all those eligible would be invited for an NHS Health Check during the first 5-year cycle. Based on evidence from a national breast screening programme, it was expected that 75% would attend.[7] Of those attendees with high cholesterol or CVD risk (10-year risk ≥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 £2866 per quality adjusted life year (QALY) (2015–2016 prices),[8] well within the limit of what would normally be deemed cost-effective by the National Institute for Health and Care Excellence.[9]

In order to provide up-to-date estimates of delivery and impact of the NHS Health Check, the objectives of this study were to systematically identify and synthesise available evidence on:

- coverage (the proportion of the eligible population who have attended an NHS Health Check) and variation in coverage;
- uptake (the proportion of those invited who have attended an NHS Health Check) and variation in uptake; and
- the effect of the programme.

A Martin, PhD, research fellow, Academic Unit of Health Economics, Leeds Institute of Health Sciences, University of Leeds, Leeds, and RAND Europe, Cambridge. **CL Saunders**, PhD, senior research associate, Primary Care Unit, Department of Public Health and Primary Care, University of Cambridge, and RAND Europe, Cambridge. **E Harte**, MSc, analyst; **C MacLure**, MA, analyst, RAND Europe, Cambridge. **J Mant**, MD, professor; **FM Walter**, MD, principal researcher; **JA Usher-Smith**, PhD, clinical senior research associate, Primary Care Unit, Department of Public Health and Primary Care, University of Cambridge, Cambridge. **SJ Griffin**, DM, professor, Primary Care Unit, Department of Public Health and Primary Care, and Medical Research Council (MRC) Epidemiology Unit, Institute of Metabolic Science, University of Cambridge, Cambridge. **C Meads**, PhD, professor, RAND Europe, and Faculty of Health, Social Care and Education, Anglia Ruskin University, Cambridge.

Address for correspondence
Adam Martin, Academic Unit of Health Economics, Leeds Institute of Health Sciences, University of Leeds, Leeds LS2 9LJ, UK.

Email: A.Martin1@leeds.ac.uk

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How this fits in

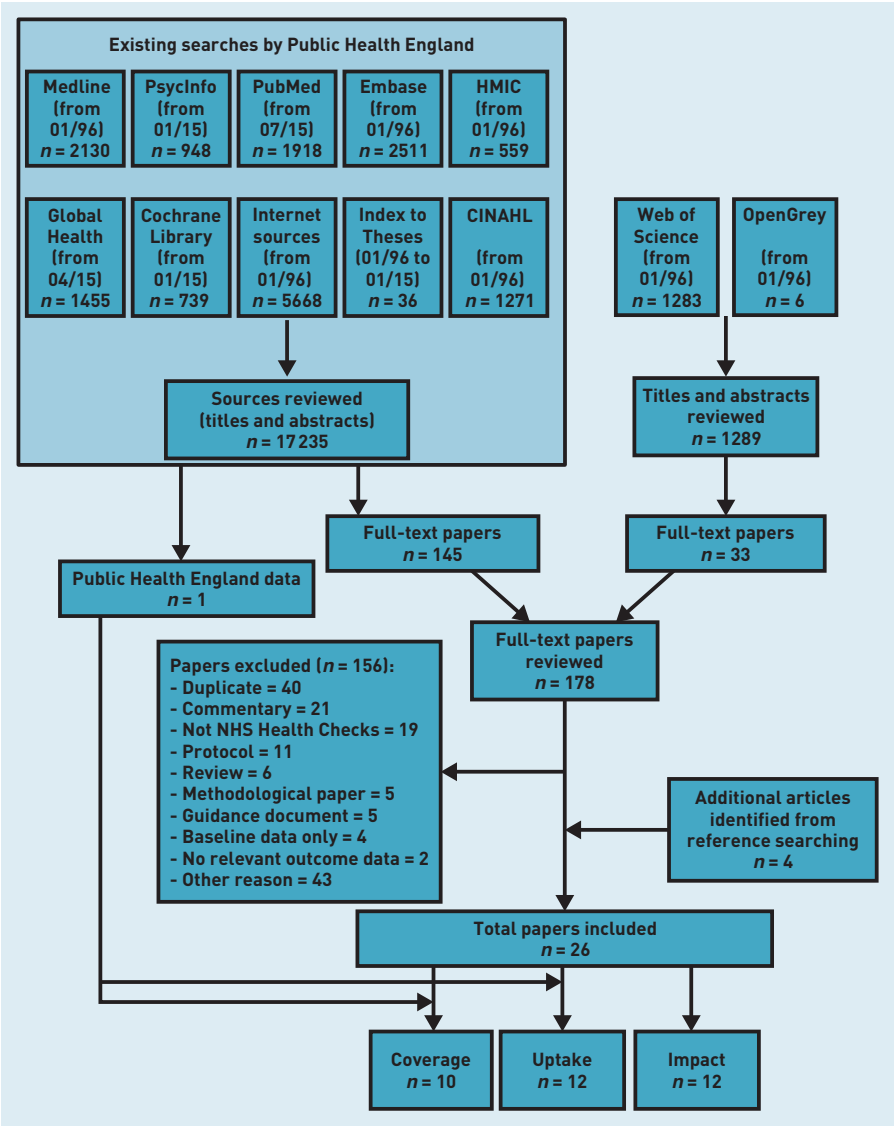
Simultaneous nationwide rollout in 2009 of the NHS Health Check programme was based on some strong assumptions about the likely impact of the programme. Almost a decade on, there remains much uncertainty about who attends and the overall health benefits. This is the first systematic review of quantitative data from the programme. Although the authors found attendance is much lower than originally anticipated, attendees cannot be readily characterised as the 'worried well' or 'easiest to reach'.

METHOD

Search strategy and study selection

Full details of the search strategy are available from the authors on request, and the study selection process is described in detail elsewhere.[10] Searches included 11 literature databases and additional internet sources encompassing both peer-reviewed and grey literature relevant to NHS Health Checks, published up to November 2016.

Figure 1. PRISMA diagram.



Inclusion criteria

Quantitative observational data or analyses (cross-sectional or longitudinal) that included people eligible for an NHS Health Check and reported evidence on coverage or uptake were included. Impact studies reporting any health-related outcome that 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 that 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 using forms devised for this study. Reflecting the wide range of study designs, data, and methods identified, existing Critical Appraisal Skills Programme (CASP) checklists[11] were adapted for the quality assessment of identified studies.

For each objective, the authors grouped studies according to their design. As the programme runs in 5-year cycles, where necessary, the authors 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). The authors categorised the health-related impact studies 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. The authors reviewed 178 full-text articles, and 26 (including five from the grey literature)[12–16] were deemed relevant (Figure 1). All were observational studies. Seven used data from large, routine, consolidated datasets with nationwide reach[15,17–22] (including the Clinical Practice Research Datalink [CPRD],[17–20] QResearch,[21] and prescribing data);[15] 19 used local data from general practices (n = 17)[13,14,23–37] or community settings (n = 2)

Table 1. NHS Health Check: overall coverage

Author, year	Setting and time period	Coverage per one-fifth of the total eligible population, %
National level		
Public Health England[38]	England, 2013–2014 to Q2, 2016–2017	45.6
Artac, 2013[22]	England, 2011–2012	8.1
Chang, 2015[18]	England, 2009–2013	26.7
Robson, 2016[21]	England, 2009–2012	12.8
Regional level		
Artac, 2013[23]	27 (of 31) PCTs in Hammersmith and Fulham,	
	2008–2009	32.7
	2010–2011	20.0
Baker, 2015[24]	83 (of 85) practices in Gloucestershire, 2011–2012	49.8
Coffey, 2014[13]	40 (of 47) practices in Salford, 2013–2014	34
Cook, 2016[29]	Not reported, 2013–2014	56.5
Krska, 2015[30]	13 (of 55) GP practices in Sefton, North West England, 2011–2012	47.2
Robson, 2015[31]	3 PCTs in East London,	
	2009–2010	33.9
	2010–2011	60.6
	2011–2012	73.4

PCT = primary care trust.

collected in particular geographic areas.[12,16] Eleven studies[15,17–23,26–28] were assessed as high quality (further information is available from the authors on request). In addition to the 26 included observational studies, data identified in the additional internet searches were also extracted from PHE's website.[38]

Coverage (*n* = 10)

The PHE website included data on national level coverage during the first 3.5 years of the current 5-year cycle (2013–2014, when the NHS Health Check became a statutory requirement, to second quarter (Q2), 2016–2017), as well as variation in coverage over time (per quarter) and by area (at the county level).[38] Nine further studies reported data on coverage (Table 1).[13,18,21–24,29–31]

Reported coverage. The PHE website reported coverage of 45.6% for the whole of England (2013–2014 to Q2, 2016–2017), ranging from 18.9% in Surrey to 109.2% in Newham.[38] Where full-year data were available, national coverage varied between 48.1% in 2014–2015 to 45.0% in 2015–2016. Three of the nine published studies used national-level data from earlier years.[18,21,22] The reported coverage ranged from 8.1% (2011–2012)[22] to 26.7% (2009–2013).[18] The other six studies reported data from samples of general practices, with coverage ranging from 20.0% (2010–2011 in Hammersmith and Fulham)[23] to 73.4% (2011–2012 in East London)[31] (Table 1).

Variation in coverage. Three studies used multiple regression to identify factors associated with differences in coverage between population groups.[18,22,23] 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 (CHD). The study by Artac *et al* additionally reported higher coverage among non-smokers, those in the most deprived tertile, those without CVD comorbidities, those registered with larger general practices, and among people from black and South Asian ethnic groups.[23] 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.[18] 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.[22]

A further five studies reported coverage for different population subgroups without adjustment for covariates.[18,21,23,29,30] The two that used data from large datasets with nationwide reach during the programme's first 4 years showed higher coverage among females, older people, and those living in more deprived areas.[18,21]

Uptake (*n* = 12)

The PHE website included data on national-level uptake (2013–2014 to Q2, 2016–2017), 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)[14,26,27,29,30,32–35] and community-based settings (*n* = 2).[12,16] The study samples were different from those used in the coverage studies and generally smaller, ranging from two[32] to 40[33] general practices, incorporating between 1380[34] and 50 485[29] patients.

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 (2013–2014 to Q2, 2016–2017), 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 2015–2016 to 49.0% in 2013–2014. Uptake in the general practice studies (*n* = 9) ranged from 27% (four practices in the East of England)[34] to 52.9% (13 practices in North West England).[30] Uptake in the community settings was 45.9% (a football ground)[16] and 71.8% (a mental healthcare unit).[12]

Table 2. Associations between coverage and area-level or individual-level characteristics from multivariable adjusted studies

Author, year	Description of analysis	Age, years	Sex	Ethnicity	Deprivation	Smoker	Family history of	Other
Artac, 2013[22]	Multivariable linear regression comparing PCT-level characteristics	Highest proportion of PCT population in 40–74 age range compared with lowest Coefficient –0.03 (–0.87 to 0.36) $P = 0.668$	Not reported	Highest proportion of PCT population of minority ethnicity compared with lowest Coefficient 0.08 (–0.17 to 0.95) $P = 0.424$	Least deprived tertile compared to most deprived: Coefficient –0.51 (–1.88 to 0.0) $P = 0.035$[a]	–	–	Population size, QOF points, patient experience, FTE GPs, estimated proportion at high risk, and estimated CVD prevalence: NS
Chang, 2015[18]	Multilevel logistic regression of individual-level patient characteristics	Compared with 40–49 years: Aged 50–59: 1.60 (1.54 to 1.67)[a] Aged 60–69: 2.47 (2.36 to 2.58)[a] Aged 70–74: 2.88 (2.49 to 3.31)[a]	Female: 1.01 (0.98 to 1.05)	Compared with white: Black African: 0.75 (0.61 to 0.92)[a] Chinese: 0.68 (0.47 to 0.96)[a] Other white: 0.35 (0.33 to 0.37)[a] Other black: 0.58 (0.46 to 0.74)[a] Not recorded: 0.18 (0.17 to 0.19)[a] Prefer not to state: 0.47 (0.41 to 0.53)[a] Irish: NS Indian: NS Pakistani/Bangladeshi: NS Other Asian: NS Caribbean: NS	Most deprived quintile compared with least deprived: 0.91 (0.63 to 1.31)	–	Positive family history compared with no family history: 2.37 (2.22 to 2.53)[a]	–
Artac, 2013[23]	Multilevel logistic regression of individual-level patient characteristics using data on 27 (of 31) PCTs in London	Compared with 40–54 years: Aged 55–64 Y1: 1.34 (1.11 to 1.61)[a] Y2: 1.79 (1.67 to 1.93)[a] Aged 65–74 Y1: 2.05 (1.67 to 2.52)[a] Y2: 2.79 (2.49 to 3.12)[a]	Female: Y1: 0.80 (0.67 to 0.94)[a] Y2: 1.27 (1.20 to 1.35)[a]	Compared with white: Black Y1: 1.05 (0.78 to 1.41) Y2: 1.58 (1.43 to 1.75)[a] South Asian Y1: 1.27 (0.88 to 1.87)[a] Y2: 1.50 (1.25 to 1.78)[a] Not recorded: Y1: 0.11 (0.07 to 0.17)[a] Y2: 0.08 (0.07 to 0.10)[a]	Least deprived tertile compared with most deprived: Y1: 0.84 (0.69 to 1.01) Y2: 0.80 (0.73 to 0.87)[a]	Current smokers compared with non-smokers: Y1: 0.71 (0.61 to 0.83)[a] Y2: 0.83 (0.77 to 0.90)[a]	Positive family history compared with no family history: Y1: 2.49 (2.15 to 2.90)[a] Y2: 2.01 (1.87 to 2.16)[a]	Presence of non-CVD comorbidities: Y1: 1.53 (1.13 to 1.80)[a] Y2: 1.75 (1.64 to 1.87)[a] Practice list size: >10 000 compared with <6000 Y1: 1.16 (0.51 to 2.65) Y2: 6.05 (0.85 to 43.4)[a]

[a]P <0.05. Results are presented as adjusted odds ratios (95% CIs) unless stated otherwise. CHD = coronary heart disease. CVD = cardiovascular disease. FTE = full-time equivalent. NS = not significant. PCT = primary care trust. QOF = Quality and Outcomes Framework. Y = year. Seven additional before-and-after studies on the impact of the NHS health check that did not have a comparison group are not reported in this table.

Variation in uptake. Five studies reported associations between patient characteristics and the likelihood of attending, using multivariable regression (Table 3).[14,26,27,34,35] 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 females were more likely to take up invitations.[14,26,34,35] The fifth, a study of 37 practices in Stoke-on-Trent,[27] reported the opposite, with males 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, while there was no difference for black or other groups, and those with missing data were less likely to attend.[26] 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.[34]

Five studies also reported unadjusted comparisons between invited attendees and non-attendees.[26,27,29,30,34] 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,[27,29] one with higher uptake in the most deprived,[34] and two with no significant differences.[26,30] Notably, the association between deprivation and uptake in the unadjusted analysis of the study across four general practices in the East of England was in the opposite direction from the multivariable analysis, which adjusted for GP practice (greater deprivation was associated with a higher odds of attending in unadjusted analysis in the study). As the authors of that study note,[34] the GP practices had different distributions of deprivation and used different invitation methods, highlighting the importance of GP surgery characteristics when assessing uptake. Two studies also reported higher uptake in women[29,34] and, where reported, uptake was higher in non-smokers, those with higher CVD risk, and those with hypertension or raised cholesterol.[26,27,30]

Impact (*n* = 12)

In all, 12 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.[19,20] The other three reported population-level associations between coverage and outcome.[15,28,36] The remaining seven studies were before-and-after studies without comparison groups.[17,18,21,25,26,30,37] No studies of long-term health impacts or economic evaluations were identified.

Disease detection (n = 4). The CPRD study by Chang *et al* showed more frequent diagnosis of familial hypercholesterolaemia, hypertension, CKD, peripheral vascular disease, and T2DM among attendees compared with non-attendees during the 2 years following attendance, while stroke diagnosis was significantly less likely.[20] No significant differences in diagnoses of atrial fibrillation (AF), coronary artery disease, heart failure, or transient ischaemic attack were observed.[20] The CPRD study by Forster *et al* also showed more frequent diagnosis of hypercholesterolaemia (high cholesterol), and of hypertension among males (but not females).[19]

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 (for example, age profile and deprivation).[28,36] The study by Caley *et al*[28] identified no statistically significant associations between coverage and change in the prevalence of T2DM, hypertension, CHD, CKD, or AF. 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 underpowered to detect small differences. The study by Lambert *et al*[36] reported that the number of NHS Health Checks performed explained between 6% and 60% of the variance in incident hypertension across the different practices.

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 2 years) and attendance at a health check.[20] Three studies reported change in smoking among individuals after attendance at a health check. Two[17,37] showed a significant reduction of at least 10 percentage points in the proportion of attendees who smoked, whereas in the other the change was not statistically significant.[25] However, without a comparison group it is not possible to attribute these changes to the NHS Health Check. No other health-related behaviours were reported.

Prescribing (n = 9). The two CPRD studies[19,20] identified significantly greater increases in statin and antihypertensive

Table 3. Uptake and variation of NHS Health Checks

Study characteristics				Multivariable logistic regression analysis of individual-level factor affecting uptake of NHS Health Checks, OR (95% CI)				
Author, year	**Study design/setting**	**Sample where reported**	**Uptake, %**	**Age**	**Sex**	**Ethnicity**	**Deprivation (area level)**	**Other**
Public Health England[38]	Published data, whole of England	Whole population data	48.2	Not reported				
Attwood, 2016[34]	Trial[a] set in four GP practices in the East of England	1380 patients Mean age: 52.4 Male: 49.7% White: 72.9%	27.0	For each increasing year: 1.05 (1.04 to 1.07)[d]	Female: 1.29 (0.95 to 1.76)	Compared with white: Other: 0.85 (0.29 to 2.52)	Most deprived quintile compared with least deprived : 0.42 (0.20 to 0.88)[d]	–[c]
Cochrane, 2013[27]	Observational study using electronic practice records from 37 (of 57) GP practices in Stoke-on-Trent	10 483 high-risk patients Aged >55: 79.6% Aged >65: 36.4% Male: 81.3%	43.7	Change in odds moving to next category higher for age ≥30 to <55, ≥55 to <65, and ≥65: 1.64 (1.51 to 1.77)[d]	Female: 0.70 (0.58 to 0.84)[d]	–	Change in odds moving to next deprivation tertile from least deprived: 1.12 (0.96 to 1.30)	Change in odds moving to next: Higher-risk category ≥15 to <25%, ≥25 to <35%, and ≥35% estimated 10-year risk: 0.90 (0.80 to 1.02) Larger practice size <3500, ≥3500 to <7000, and ≥7000 1.03 (0.88 to 1.20)
Coffee, 2015[d,12]	Observational study using data from two community medical centres in Birmingham	188 patients already using secondary mental health services	71.8	Not reported				
Coghill, 2016[d,14]	Quasi-experimental study/electronic practice records of 17 GP practices in Bristol	5678 patients	34.1	Compared with age 40–69: Age 70–74: 2.09[d]	Male: 0.82[d]	–	Least deprived quintile most likely to attend	–
Cook, 2016[29]	Observational study using electronic practice records from 30 (all) GP practices in Luton	50 485 patients Aged >55: 30.5% Aged >65: 7.6% Male: 53.3% White British: 32.5%	43.7		Not reported			
Dalton, 2011[26]	Observational study using electronic practice records from 29 (of 86) GP practices in Ealing, London	5294 high-risk patients Aged >55: 80.8% Aged >65: 40.8% Male: 80.9% White British: 21.7%	44.8	Compared with age 35–54: Age 55–64: 1.74 (1.34 to 2.25)[d] Age 65–74: 2.27 (1.47 to 3.50)[d]	Age 35–54:[b] Female 1.71 (1.03 to 2.85)[d] Aged 55–64: Female 1.22 (0.89 to 1.67) Aged 65–74: Female 0.96 (0.76 to 1.22)	Compared with white: South Asian: 1.71 (1.29 to 2.27)[d] Mixed race: 2.42 (1.50 to 3.89)[d] Black: 1.34 (0.91 to 1.98) Other: 1.15 (0.76 to 1.74) Missing: 0.51 (0.30 to 0.88)[d]	–	Practice size: Compared with 3000–5999 <3000: 2.53 (1.09 to 5.84)[d] ≥6000: 0.79 (0.33 to 1.88) Hypertension: 1.31 (1.15 to 1.51)[d] Smoker: 0.88 (0.75 to 1.02)

... continued

Table 3 continued. Uptake and variation of NHS Health Checks

Hooper, 2014[33]	Observational study using data from 40 GP practices in Warwickshire	37 236 patients	44.8	Not reported		
Krska, 2015[30]	Observational study using electronic practice records in 13 (of 55) GP practices in Sefton, North West England	2892 high-risk patients Aged >65: 69.4% Male: 78.3% White: 99.1%	52.9	Not reported		
Kumar, 2011[32]	Observational study using data from two (of approx 57) GP practices in Stoke-on-Trent	1606 patients (of whom 661 were high-risk patients) Aged >60: 31.5% Male: 56.7%	30.9	Not reported		
NHS Greenwich,[16]	Observational study using data from five community-based venues in South East London	1400 patients Aged >65: 27.5% Male: 45.1%	45.9	Not reported		
Sallis, 2016[35]	Pragmatic quasi-randomised controlled trial in four GP practices in Medway	3511 patients Mean age: 53.1 Male: 49.1%	31.4	For each increase in 10 years: 1.62 (1.50 to 1.75)[d]	Female: 1.50 (1.29 to 1.74)[d]	–	Least deprived quintile compared with most deprived 1.61 (1.14 to 2.26)[d]	–

[a]Data from control arm of trial who attended NHS Health Checks. [b]Reported with age interaction. [c]The model also controlled for GP practice (n = 4). [d]P <0.05.

prescriptions among 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 2 years in one of the studies,[20] and by 11.0% and 7.6% over 4 years in the other.[19] 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.[15]

All of the six before-and-after studies showed an increased likelihood of a statin prescription following attendance.[17,18,21,25,26,30] The proportion prescribed statins after the health check ranged from 18.3% in one of the CPRD studies[17] to 49.9% in Hammersmith and Fulham.[25]

Individual risk factors and CVD risk (n = 5). The CPRD study by Chang *et al*[20] showed significant differences in body mass index (BMI), blood pressure (BP, systolic and diastolic), modelled CVD risk, and total cholesterol between attendees and matched non-attendees during a 2-year period.[20] For example, the QRISK2 mean score (% 10-year risk) fell by 0.21 (95% confidence interval [CI] = 0.19 to 0.24), from 5.1 to 4.9 among non-attendees, compared with 6.7 to 6.2 among attendees, which is equivalent to the prevention of one cardiovascular event per 4762 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.[36]

Three further before-and-after studies of attendees[17,25,37] identified significant reductions in diastolic BP and cholesterol levels after 12–15 months. Significant reductions in CVD risk,[25,37] systolic BP,[17,37] and some (although not all) obesity-related measures[17,37] were also reported in two of the three studies. However, in addition to having no comparison group, the samples used in the analyses were also limited by missing data (for example, follow-up data were unavailable for 50% of attendees in one study).[37]

DISCUSSION

Summary

In the current 5-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

Table 4. Studies with a comparison group reporting the health-related impact of the NHS Health Check

Study characteristics			Results, OR (95% CI)			
Author, year	**Study design/setting Study time period**	**Comparison and statistical method**	**Disease detection**	**Health-related behaviours**	**Individual risk factors/ CVD risk reduction**	**Prescribing**
Chang, 2016[20]	Individual-level matched cohort study using CPRD data Baseline: April 2009 to March 2013 Follow-up: median of 2 years	Difference-in-difference analysis comparing attendees with non-attendees, with propensity score matching on age, sex, ethnicity, deprivation, and region	AF: 0.02 (–0.02 to 0.06) CKD: 0.17 (0.11 to 0.23)[a] CAD: 0.02 (–0.04 to 0.08) FH: 0.09 (0.07 to 0.11)[a] Heart failure: 0.01 (–0.01 to 0.03) Hypertension: 2.99 (2.77 to 3.21)[a] PVD: 0.03 (0.01 to 0.05)[a] Stroke: –0.03 (-0.05 to –0.01)[a] TIA: 0.008 (–0.01 to 0.03) T2DM: 1.31 (1.17 to 1.45)[a]	Smoking prevalence: –0.11 (–0.35 to 0.13)	CVD risk: –0.21% (–0.24 to –0.19)[a] SBP: –2.51 mmHg (–2.77 to –2.25)[a] DBP: –1.46 mmHg (–1.62 to –1.29)[a] BMI: –0.27 (–0.34 to –0.20)[a] Cholesterol: –0.15 mmol/L (–0.18 to –0.13)[a]	Increase in statin prescribing: 3.83 (3.52 to 4.14)[a] Increase in antihypertensive prescribing: 1.37 (1.08 to 1.66)[a]
Forster, 2015[19]	Individual-level matched cohort study using CPRD data April 2009 to March 2013	Cohort study comparing attendees with non-attendees matched on age, sex, and general practice	Hypertension: Male: +5%[a] Female: NS Hypercholesterolaemia: Male: +33%[a] Female +32%[a]	–	–	New statin prescribing: HR 1.58 (1.53 to 1.63)[a] New antihypertensive drug prescribing: HR 1.06 (1.03 to 1.10)[a]
Caley, 2014[28]	Observational study using electronic medical records in 79 GP practices in Warwickshire June 2010 to March 2013 (39 months)	Multivariable regression analysis reporting association between % eligible completing an NHS Health Check at practice level and change in prevalence of five conditions	Observed change in prevalence of T2DM, hypertension, CHD, CKD, AF was not statistically significant	–	–	–
Jamet, 2014[15]	Observational study using prescription data in 145 PCTs in England 2012 (1 year)	Multivariable regression analysis reporting association between number of NHS Health Checks completed and statin prescribing at PCT level	–	–	–	Prescriptions of high-dose statins: regression coefficient 0.094[a] Prescriptions of low-dose statins: NS
Lambert, 2016[36]	Observational study using local data returned from GP practices to commissioners in three health districts (101 practices) in North East England Unclear year 30 months	Univariate regression models reporting association between number of NHS Health Checks provided in the health district and incident cases of disease	The number of health checks performed explained almost none (≤1%) of the growth in hypertension or diabetes registers, and 6–60% of incident cases of hypertension	–	77–92% of variance between practices in numbers of incident high risk of cardiovascular disease was explained by the number of health checks performed	–

[a]P<0.05. *AF = atrial fibrillation. BMI = body mass index. CAD = coronary artery disease. CHD = coronary heart disease. CI = confidence interval. CKD = chronic kidney disease. CPRD = Clinical Practice Research Datalink. DBP = diastolic blood pressure. FH = familial hypercholesterolaemia. HR = hazard ratio. NS = not statistically significant. OR = odds ratio. PCT = primary care trust. PVD = peripheral vascular disease. SBP = systolic blood pressure. TIA = transient ischaemic attack. T2DM = type 2 diabetes.*

percentage varies substantially across the country, from 18.9% in some areas to >100% in others. Data from the identified studies show higher coverage among older people, those with a family history of CHD, 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. In the selected samples of patients and general practices in the identified studies, the proportion accepting the invitation is also higher in older people and females but — in contrast to coverage — the results are lower for 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 antihypertensive prescribing (with the percentage of those with a modelled 10-year CVD risk ≥20% who were prescribed statins following a health check ranging from 18% to 63%), and small decreases in modelled CVD risk (the best current evidence suggests that one cardiovascular event is prevented per 4762 attendees, equating to >1400 events across the country during a 5-year cycle). Very few studies have reported the impact of attendance on health-related behaviours.

Strengths and limitations

Almost a decade since the programme was introduced, and 5 years since it became a statutory responsibility of local authorities, this is the first synthesis of quantitative evidence related to delivery or impact. The systematic searches, including the OpenGrey database and additional internet-based searches, are a strength of this study. However, in the absence of randomised trials or a step-wedge evaluation of a gradual rollout 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 become statutory in 2013), databases, methods for identifying attendance, and (where multivariable regression was used) adjusted for different observable patient and general practice characteristics. Even for studies using electronic health records, coding was not reliable and so led to some researchers using combinations of entries to classify attendance.[20] This precluded the pooling of data from different studies. Although some studies, including the multivariable analyses of uptake (Table 3), relied on relatively small samples of general practices and patients, even the larger consolidated databases did not include nationally representative samples of patients or general practices. For example, general practices in the north of England are poorly represented in CPRD, and those that contribute data are larger[39] and potentially more engaged with research and preventive medicine than those that do not. Almost all studies relied on routinely collected data for patient characteristics and health outcomes. Missing outcome data are 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 CHD recorded, for example. There may also be systematic differences in those who attend health checks and those who do not, 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.

Implications for research and practice

This study identified data showing that both the anticipated coverage and uptake used in the Department of Health model were too optimistic. When judged against the (ambitious) objective of inviting all eligible individuals in each 5-year cycle, and the expected aggregate gains in population health arising from high coverage (expected in the model to be 75%), the evidence shows the programme has fallen considerably short. Since this remains the objective,[2] a question needs to be addressed about where the necessary resources and capacity should come from to achieve it. Conversely, when judged against any reasonable value-for-money criteria, the identified evidence on attendance is not sufficient to indicate a lack of cost-effectiveness. In the economic models, lower than anticipated coverage, for example, would merely reduce aggregated costs and aggregated health gains, without affecting the cost per QALY estimates.[7,40] Like other interventions (bariatric surgery, for instance)[41] and some pharmaceuticals (which might be subjected to a 'budget impact test'),[42,43] it seems NHS Health Checks may thus be simultaneously cost-effective and unaffordable.[40] A pragmatic response might be to focus attention on targeting the distribution of NHS Health Checks towards those who would benefit most, and/or towards reducing health

inequalities. The finding that coverage (the proportion of the eligible population who have attended an NHS Health Check) among those in the most deprived areas was higher than average, despite uptake (the proportion of those invited who have attended an NHS Health Check) among those groups being lower (and the findings from the study by Attwood *et al* in which the direction of association between sociodemographic characteristics and uptake was reversed after adjusting for GP practice),[34] suggests that this is already happening to some degree. Together with the finding that coverage was higher among older people, who will be at higher risk of CVD than younger people, this may go some way towards alleviating concerns among health professionals that attendees are predominantly the 'worried well' or those least likely to benefit.[44] However, given that much of the data on coverage and uptake were from different sources, the authors suggest that this should be the focus of future research. This could be supported, to some degree, through development of a slightly broader PHE dataset for the routine collection of a small number of variables on those invited and those who subsequently attend. In future years, it will also be important to distinguish between those attending for the first time and those attending follow-up NHS Health Checks after 5 years.

Although this study also showed statin prescribing to be below expectations, potentially increasing the cost per QALY, there remains a significant shortage of data on the health impacts, particularly longer term, and costs of health checks. Alongside the data on attendance identified in this study, such data are necessary for revising key assumptions in economic models of health checks,[45,46] not only in England, but potentially also internationally, where similar data are also currently limited.[5,47] There is also a need for further high-quality 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.

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