Tanner, L, Kenny, R, Still, M, Pearson, F and Bhardwaj-Gosling, Rashmi (2020) NHS Health Check Programme Rapid Review Update. Documentation. University of Sunderland and Newcastle University.

Version: UNSPECIFIED

Available under license: Creative Commons: Attribution-Noncommercial-No Derivative Works 3.0

Downloaded from: https://sure.sunderland.ac.uk/id/eprint/12980/

Which version am I reading (articles, book chapters and books)

Pre-print (or submitted version): the version of an article or chapter before any peer-review. Can be submitted to a publisher or added to a pre-print server.

AAM: Author Accepted Manuscript - The version of the article formally accepted for publication after the peer-review process. It includes the changes made by the author(s) in line with peer-reviewers' comments. It has not undergone the publisher's formatting, type-setting and copyediting.

VOR: Version of Record - The version published on the publisher's website which includes formatting, typesetting and copyediting.

Usage guidelines

Please refer to the usage guidelines at http://sure.sunderland.ac.uk/policies.html or alternatively contact sure@sunderland.ac.uk.

University of Sunderland

Newcastle University

Population Health Sciences Institute

NHS Health Check Programme Rapid Review Update

Prepared for and commissioned by Public Health England 23/04/2020

L Tanner[1], RPW Kenny[1], M Still[1], F Pearson[1], R Bhardwaj-Gosling[1, 2]

1.Population Health Sciences Institute, Newcastle University, Newcastle upon Tyne, Tyne and Wear. NE1 7RU

2. Faculty of Health Science and Wellbeing, The University of Sunderland, Edinburgh Building, City Campus, Chester Road, Sunderland, SR1 3SD

Contact Author Dr Fiona Pearson, Email: Fiona.pearson2@newcastle.ac.uk

Table of Contents

Summary 7

Introduction 7

Methods 7

Findings 8

NHS Health Check Programme Rapid Review Update 15

1. Research Aim and Objectives 15

2. Methods 16

2.1 Search strategy 16

2.1.1 Pre-completed literature searches 16

2.1.2 Additional literature search 16

2.2 Study Selection 17

2.2.1 Pre-completed study selection 17

2.2.2 Web of Science, Science Citation Index Citation Screening 17

2.2.3 Full text screening 17

2.3 Data extraction 17

2.4 Quality assessment 18

2.5 Synthesis 18

3. Results 20

3.1 Who is and who is not having an NHS Health Check? 25

3.1.1 Characteristics of those attending and not attending NHS Health Checks 32

3.1.2 Demographic differences between those attending and not attending an NHS Health Check 39

3.1.3 Key findings and interpretation 52

3.2 What factors increase take-up among population and sub-groups? 54

3.2.1 Socio-demographic factors of uptake 56

3.2.2 Invitation methods 63

3.2.3 Setting 80

3.2.4 Key findings and interpretation 84

3.3 Why do people not take up an offer of an NHS Health Check? 88

3.4 How is primary care managing people identified as being at risk of cardiovascular disease or with abnormal risk factor results? 89

3.4.1 Long-term impact of NHS Health Checks 92

3.4.2 Healthcare professionals' views towards NHS Health Checks and Delivery 95

3.4.3 Key findings and interpretation 103

3.5 What are patients' experiences of having an NHS Health Check? 105

3.5.1 Key findings 113

3.6 What is the effect of the NHS Health Check on disease detection, changing behaviours, referrals to local risk management services, reductions in individual risk factor prevalence, reducing cardiovascular disease risk and on statin and anti-hypertensive prescribing? 115

3.6.1 The effect on disease detection 124

3.6.2 The effect on changing health-related behaviours 132

3.6.3 The effect on referrals to local risk management services 136

3.6.4 The effect on reductions in individual risk factors and cardiovascular disease risk 140

3.6.5 The effect on prescribing 145

3.6.6 Modelling studies 151

3.6.7 Key findings and interpretation 153

4. Discussion 155

5. Acknowledgements 158

6. Contribution of Authors 158

7. References 159

8. Appendices 167

Tables

Table 1 Web of Science, Science Citation Index search concepts and strings 16
Table 2 An overview of studies contributing to each objective in the review update, objectives ordered based upon volume of evidence 22
Table 3 Primary studies with any data collection in 2014 or onwards 23
Table 4 Primary studies and the number of objective/s they contribute data towards 24
Table 5 Features of studies reporting characteristics of the eligible population sample 27
Table 6 Characteristics of those attending an NHS Health Check 34
Table 7 Characteristics of those not attending an NHS Health Check. 37
Table 8 GRADE assessment for the evidence contributing to Objective 1 51
Table 9 Features of studies providing data on socio-demographic factors affecting uptake of NHS Health Checks 57
Table 10 Characteristics of people who attended NHS Health Checks compared with those who were invited but did not attend (DNA) 60
Table 11 GRADE assessment for the evidence contributing to Sub-objective 2.1 62
Table 12 Features of studies providing data on the impact of different methods of inviting individuals on take-up 64
Table 13 Results of studies assessing different methods of invitation 69
Table 14 GRADE assessment for the evidence contributing to Sub-objective 2.2 74
Table 15 Qualitative studies including participants' views on the method of invitation to NHS Health Checks 76
Table 16 GRADE-CERQual confidence in the evidence contributing to Sub-objective 2.2 .. 79
Table 17 Features of studies providing data on the impact of different settings on take-up ... 81
Table 18 GRADE assessment for the evidence contributing to Sub-bjective 2.3 83
Table 19 Features of studies reporting delivery of NHS Health Checks within primary care 90
Table 20 Features of studies providing data on risk management in primary care after NHS Health Checks 94
Table 21 Features of studies providing data on healthcare professionals' views towards NHS Health Checks and Delivery 97
Table 22 GRADE assessment of evidence contributing to Objective 4 102
Table 23 Features of studies providing data on patients' experiences of having an NHS Health Checks 107
Table 24 GRADE assessment for the evidence contributing to Objective 5 112
Table 25 Features of studies reporting the impact of the NHS Health Check on health-related outcomes 118
Table 26 Summary of results of studies reporting the impact of the NHS Health Check on disease detection 126
Table 27 Estimates of the number needed to screen (reported by included studies) to detect a new case of a disease or condition across different studies 129
Table 28 GRADE assessment for the evidence contributing to Sub-objective 6.1-1/2/3 131
Table 29 Summary of results of studies reporting the impact of the NHS Health Check on health-related behaviours 133
Table 30 GRADE assessment for the evidence contributing to Sub-objective 6.2 135
Table 31 Summary of results of studies reporting the impact of the NHS Health Check on referrals to lifestyle services 137
Table 32 GRADE assessment for the evidence contributing to Sub-objective 6.3 139

Table 33 Changes in individual risk factors and cardiovascular disease risk in studies reporting changes over time amongst people who had attended NHS Health Checks.....141
Table 34 Summary of results of studies reporting the impact of the NHS Health Check on reductions in individual risk factors and cardiovascular disease risk.....142
Table 35 GRADE assessment for the evidence contributing to Sub-objective 6.4 144
Table 36 Summary of results of studies reporting the impact of the NHS Health Check on prescribing.....148
Table 37 GRADE assessment for the evidence contributing to Sub-objective 6.5 150

Figures

Figure 1 PRISMA diagram for review update 21
Figure 2 Attendance of NHS Health Checks across England from 2012-2018 26
Figure 3 Percentage of ≥60 years old attending and not attending an NHS Health Check 41
Figure 4 Percentage of males and females attending and not attending an NHS Health Check 43
Figure 5 Percentage of white and non-white people attending and not attending an NHS Health Check 45
Figure 6 Percentage of most deprived and least deprived people attending and not attending an NHS Health Check 47
Figure 7 Percentage of smokers and non-smokers attending and not attending an NHS Health Check 49
Figure 8 Uptake of NHS Health Checks across England from 2013-2019 55
Figure 9 Case detection rates amongst those attending NHS Health Checks 128
Figure 10 Change in the percentage of people being prescribed statins before and after attending an NHS Health Check 146

Summary

Introduction

This report is an update of a rapid review of evidence published on the NHS Health Checks programme in 2017. This update includes evidence from the original review (studies published between 2009 and 2016) alongside evidence indexed up until the end of December 2019. The update uses this enlarged body of evidence to re-address the following six research objectives:

1. Who is and who is not having an NHS Health Check?

2. What are the factors that increase take-up among the population at large and sub-groups?

3. Why do people not take-up an offer of an NHS Health Check?

4. How is primary care managing people identified as being at risk of cardiovascular disease or with abnormal risk factor results?

5. What are patients' experiences of having an NHS Health Check?

6. What is the effect of the NHS Health Check on disease detection, changing behaviours, referrals to local risk management services, reductions in individual risk factor prevalence, reducing cardiovascular disease risk and on statin and anti-hypertensive prescribing?

Methods

A rapid review of qualitative and quantitative data published between January 2016 and December 2019 identified using a systematic search strategy within Medline, PubMed, Embase, Health Management Information Consortium (HMIC), Cumulative Index of Nursing and Allied Health Literature (CINAHL), Global Health, PsycInfo, Web of Science, Science Citation Index, the Cochrane Library, NHS Evidence, Google Scholar, Google, OpenGrey, Clinical Trials.gov, the ISRCTN registry, and through hand searching article reference lists.

Studies identified were initially screened by two researchers for relevance to the NHS Health Checks and then against a set of pre-specified inclusion and exclusion criteria. Data were extracted on to pre-specified, piloted data pro-forma by two researchers.

A 10% sample of the data reported in the original review were checked for consistency with reporting in the primary studies from which data were extracted. As consistency was 100% previously extracted and reported data were not re-extracted without indication.

The quality of the newly included studies were assessed by a single researcher using the

relevant Critical Appraisal Skills Programme tools. Quality assessments were verified by a second reviewer.

Synthesis of quantitative data was completed as an extension to the synthesis presented in the original review. With a structured, narrative synthesis using, tables and data visualisation undertaken as appropriate. Meta-analysis was not methodologically appropriate even where feasible due to the high heterogeneity and low number of high quality studies reporting on each domain in a consistent manner.

Synthesis of qualitative data was completed as an extension to that undertaken in the original review. A three-stage thematic synthesis approach was completed with the newly identified studies in order that we could add to and revise findings identified in the original review. Completing a thematic synthesis incorporating just the new data alone to compare to the original thematic synthesis, or re-completing the whole thematic synthesis were inappropriate due to the lack of new qualitative studies identified.

GRADE, GRADE-CERQual and GRADE-Mixed methods were used to assess the certainty and confidence in the research evidence contributing to each objective or sub-objective as appropriate.

Findings

There were 97 studies (29 newly identified) addressing Objectives one to six. The 29 newly identified studies contributed data to the synthesis addressing Objectives one (n=6/29), two (n=9/31), four (n=3/21), five (n=2/22) and six (n=13/33). Of the 97 studies identified, 33 included data collected from 2014 onwards.

Who is and who is not having an NHS Health Check?

In total, 29 studies (six newly identified) contributed data to Objective one. Seven of the 29 studies reported on data from 2014 onwards.

The overall uptake of NHS Health Checks has increased by a small amount since the end of 2016, however, we are still a long way off having 75% of the eligible population attending. Attendance patterns for 2017-2018 vary by region with uptake between 41.3 and 49.2%.

There is limited new data identified on coverage, most new evidence is on the unadjusted characteristics of NHS Health Check attendees vs. non-attendees. This increasing body of evidence shows that those most likely to attend an NHS Health Check are female, white British and aged 60 or more. Further analyses are needed to understand why differences exist in the

effects of ethnicity on attendance. New evidence indicates that smokers and those from high levels of deprivation are less likely to attend. A single study using opportunistic invite within a community setting observed an increased attendance from younger individuals.

There is low certainty in this body of evidence (29 studies) due to the study designs used, high heterogeneity and inconsistency found.

What factors increase take-up among the population and sub-groups?

In total, 31 studies (nine newly identified) contributed data to Objective two. Twelve of these 31 studies reported on data from 2014 onwards.

These studies contribute evidence on the impact to uptake of the following:

Sociodemographic factors

Twelve quantitative studies (one newly identified) contained data on the demographics of those attending vs. not attending an NHS Health Check after invitation.

Findings of a newly included study, a high quality RCT, almost mirror those from studies of unadjusted characteristics of NHS Health Check attendees vs. non-attendees. The RCT showed females, those >60 years old and those with lower levels of deprivation were more likely to attend. Converse to the findings of unadjusted studies on characteristics of NHS Health Check attendees vs. non-attendees, it showed that white British were less likely to attend than those from an African/Caribbean, Asian or mixed background. Across the whole body of evidence there is a lack of consistency in findings on the impact of ethnic background on uptake. Further analysis are needed to understand these effects.

The certainty in the body of evidence informing these findings was rated as low as only one of the included studies was an RCT. However, no other criteria affected the quality of this evidence.

Invitation method

Thirteen quantitative studies (six newly identified) investigated the effects of variations in invitation method on take up of an NHS Health Check.

Evidence shows that opportunistic invites in a general practice or community setting increase uptake in particular amongst those at high risk of CVD and from ethnic minority groups. Personalised invitational letters, an SMS pre- and post-invitational letter and invite via telephone have also been shown to increase uptake. The strength of effect being greatest for

telephone invite.

The certainty in the body of evidence informing these findings was rated as 'very low' as most contributing evidence was observational and studies were identified as being at a high risk of bias.

Six qualitative studies (one newly identified) contained data on the effect of invitation method on take up of an NHS Health Check.

In the original review, telephone invitations were identified as preferred by patients due to their informative immediacy and the perceived value of this. The single newly identified study yielded no first or second order constructs leading to further analytical themes. However, its findings added richness and depth to the following themes 'Benefit of community ambassadors for ethnic minority groups' and 'Differing opinions on opportunistic invitation dependent on setting'.

Review findings for invitation method are supported with moderate to high confidence. However, data from the primary publications that informed these findings lacks adequacy. In particular, the whole body of evidence has limited richness and sufficiency to allow themes and findings to emerge or to allow for dimensional comparisons.

Setting

Two newly identified quantitative studies assessed whether the setting of the NHS Health Checks (community or pharmacy or general practice) influenced uptake.

Uptake did not differ dependent on whether invite was to a general practice or community pharmacy, however, when NHS Health Checks were completed opportunistically there was higher uptake at community outreach services. A greater number of those at high risk of CVD and from hard-to-reach groups were more likely to take-up an NHS Health Check if it was opportunistic, in both community and general practice settings. However, opportunistic methods can only target people attending the settings within which they are conducted. Qualitative data shows the need to allow those taking up an opportunistic invite time to digest the invite information and to allow for informed decision making on their attendance.

The certainty in this evidence was rated as very low as both contributing studies are observational, and showed imbalances in baseline characteristics between groups as well as being deemed at risk of bias due to plausible confounding.

Why do people not take up an offer of an NHS Health Check?

There were no new studies informing why people do not take up an offer of an NHS Health Check. Ten studies in the original review found reasons for non-attendance were as follows: a lack of knowledge on the purpose of the NHS Health Check, time constraints and an aversion to preventative medicine. These analytical themes have been identified within the qualitative data on individual's experiences of NHS Health Checks, indicating their applicability and transferability.

How is primary care managing those at Risk of CVD?

No further studies were identified reporting on delivery, recall systems, lifestyle advice provided or service availability. It is likely the large regional variation in NHS Health Check delivery and post-delivery management (lifestyle advice, referral to services or interventions and follow up) identified in the original review remain.

Long-term impact of NHS Health Checks

One (newly identified) large, high quality quantitative study found NHS Health Checks were associated with a decrease in CVD risk, BMI, smoking prevalence, blood pressure and total cholesterol. Reductions could be due to improved patient management as lifestyle advice, smoking cessation, prescriptions for statins and for anti-hypertensives all increased amongst those who had an NHS Health Check. However, onward referral to lifestyle services varied geographically. There was also an increase in the detection of new morbidities, however, the effect varied by gender and deprivation level. Although this data is from a single study, the study recruited nationally across England and could therefore be representative of the wider population.

Healthcare professionals views towards NHS Health Checks and Delivery

Eighteen (three newly identified) studies provided qualitative data on how NHS Health Checks affect risk management and health-care workers views of this. These data contribute to the synthesis of healthcare workers views on the implementation and delivery of the NHS Health Checks programme. No new first or second order constructs leading to further analytical themes were identified. Extracted findings aligned with the analytical theme of 'Doubts about long term cost-effectiveness' and 'Inadequate training'. Studies identified add adequacy, richness and thickness to the body of evidence included within the previously conducted thematic synthesis.

Confidence in the evidence supporting concepts and outcomes on how CVD risk is managed in primary care were judged as being moderate mainly due to a sparsity of quantitative

evidence, plausibility of responder bias and potential lack of objectivity in studies identified.

What are patients' experiences of having an NHS Health Check?

Nine quantitative studies and 17 (two newly identified) qualitative studies provided data on patients experiences of NHS Health Checks.

There were no newly identified quantitative studies reporting patients' experiences. Previously high levels of satisfaction with the programme were reported. However, satisfaction is likely linked with temporal factors and new patient survey findings could plausibly differ.

Two newly identified qualitative studies report patients' experiences of having an NHS Health Check. No new first or second order constructs that lead to new analytical themes were identified within these studies. Extracted findings aligned with the analytical themes on 'Understanding of the risk score', 'Quality of information (format detail and personalisation)' and being 'A potential trigger for behaviour change'. The following barriers to change were identified: 'Pressure to change rather than facilitation from practitioners', 'Perceived genetic determinism (including of longevity)', 'Practical issues in joining change interventions', 'Environmental factors', 'Resources such as access to services', 'Cost and time to the individual' which are not always controllable.

Evidence contributing quantitative or qualitative data to the concept of patients' experiences of the NHS Health Checks were rated as low to moderate, with inferences made reflected across both data types.

What is the effect of the NHS Health Check on:

<u>Disease detection</u>

There were 17 studies (five newly identified) reporting data on disease detection.

NHS Health Checks led to an overall increase in the detection of raised risk factors and morbidities (raised hyperglycemia, pre-diabetes, diabetes mellitus, cholesterol, hypertension, chronic kidney disease), however, the effect varied between diagnoses and in relation to gender and deprivation level.

The certainty in the body of evidence on disease detection was judged to be very low due to large variations in effect (likely due to ecological effects) and indirectness.

<u>Changing behaviours</u>

There were six studies (one newly identified) which assessed the impact of attendance at an

NHS Health Check on health behaviour change.

The only intended behaviour change assessed is smoking. Findings from the newly identified study indicate net reductions in smoking prevalence for NHS Health Check and control participants over a six-year period following the intervention. However, comparative reduction in smoking was greater for participants in the control group. Three studies in the earlier review reported NHS Health Check participants were more likely to stop smoking compared to baseline and, or, non-attendees. However another study reported no significant change over time in smoking prevalence amongst NHS Health Check attendees following the intervention.

The certainty in the evidence is very low due to the observational study types identified, opportunistically collated self-report outcome data with high risk of bias, inconsistency and imprecision.

Referrals to local risk management services

Ten studies (four newly identified) report the effect of NHS Health Checks on referrals to local risk management.

There was consistent evidence across the studies that amongst those attendees of an NHS Health Check compared to non-attendees stop smoking advice and weight management advice were more commonly given. As well as evidence of increases in referrals to smoking cessation, dietician support, a physical activity service or an alcohol service.

The certainty in the evidence was rated as very low due to the observational nature of the studies included, confounding, risk of bias, inconsistency in outcome measurement, poor internal validity and large heterogeneity of effects.

Reductions in risk at the individual level

Five studies (one newly identified) included data on the effect of the NHS Health Check on risk factor prevalence and cardiovascular disease risk.

Across the studies, after an NHS Health Check the following risk factors decreased: BMI, diastolic blood pressure, total cholesterol and cardiovascular risk. Results for other risk factors were inconsistent across studies although none saw an increase.

The certainty in the body of evidence was rated as ‘very low’ as study designs were mainly observational and the largest study had high risk of bias related to the outcome which could lead to poor internal validity.

Reducing prescribing of statins/anti-hypertensive medication

Sixteen studies (four newly identified) report prescribing after an NHS Health Check. All report an increase in statin prescribing amongst those who attend an NHS Health Check. Four of five studies report an increase in anti-hypertensive prescribing; a single cohort study reports a decrease in anti-hypertensive prescribing. The certainty in the evidence on prescribing was rated as low because the majority of data came from observational studies and heterogeneity of effects was present.

Modelling

In the earlier review, three microsimulation studies were identified which assessed the cost-effectiveness of the NHS Health Checks programme based on different implementation approaches. A further three economic modelling studies were identified. Two of these studies were allied with one another assessing implementation and re-design scenarios using demographic data from Liverpool's population, risk factor exposures and CVD epidemiology to assess health benefits, equity and cost effectiveness. The third assessed whether the impact of the NHS Health Checks on BMI were sufficient to justify its costs. The findings from the newly identified studies indicated that equitability and cost-effectiveness of the NHS Health Check Programme would be increased through the addition of policies targeting dietary consumption; through combining current provision, with targeting of the intervention towards deprived areas; and that modest changes in BMI from the NHS Health Check programme are associated with significant cost-saving benefits making the programme cost-effective.

NHS Health Check Programme Rapid Review Update

1. Research Aim and Objectives

Our aim was to update the rapid evidence synthesis on the NHS Health Check Programme undertaken in 2016 by researchers as well as patient and public representatives (Usher-Smith *et al, 2016*).[1]

Our specific objectives being to:

Identify evidence published on NHS Health Checks since 2016 utilising a combination of pre-identified bibliographic records and citations identified by a Web of Science, Science Citation Index search update
Extract relevant data from published evidence on NHS Health Checks since 2016 and conduct quality appraisal of those identified studies
Summarise evidence included in the original review (Usher smith *et al*) and newly identified evidence from the search update in order to re-address the following research objectives:

1. Who is and who is not having an NHS Health Check?
2. What are the factors that increase take-up among the population and sub-groups?
3. Why do people not take up an offer of an NHS Health Check?
4. How is primary care managing people identified as being at risk of cardiovascular disease or with abnormal risk factor results?
5. What are patients' experiences of having an NHS Health Check?
6. What is the effect of the NHS Health Check on disease detection, changing behaviours, referrals to local risk management services, reductions in individual risk factor prevalence, reducing cardiovascular disease risk and on statin and anti-hypertensive prescribing?

2. Methods

2.1 Search strategy

2.1.1 Pre-completed literature searches

Each quarter, Public Health England (PHE) completes a literature search for new evidence on the NHS Health Check programme. Medline, PubMed, 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 are searched for relevant references. These searches have identified references from between January 1996 and December 2019 which have then been screened for their relevance to the NHS Health Checks.

2.1.2 Additional literature search

We agreed with PHE that Web of Science, Science Citation Index would be searched in addition to the pre-completed searches.

Table 1 Web of Science, Science Citation Index search concepts and strings

Search Concept 1 – Health Check or screen	Search Concept 2 – cardiovascular disease prevention	Search Concept 3 - primary care setting
("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)	(Cardiovascular NEAR/3 prevention) AND ("primary care" OR "general practice" OR "primary healthcare")	("primary care" OR "general practice" OR "primary healthcare")

Search concepts shown in Table 1.Web of Science, Science Citation Index search concepts and strings were combined using Boolean operators as follows:

> ((Health Check or Screen) OR (Cardiovascular Disease Prevention)) AND (Primary Care Setting).

The inbuilt Web of Science, Science Citation Index platform filter functions were used to limit the searches by the geographic setting (England, Scotland, Wales, Northern Ireland) of the research. Identified citations were added to those provided by PHE and de-duplication took place in EndNote X9 using the automated function.

2.2 Study Selection

2.2.1 Pre-completed study selection

PHE searches for and screens citation titles and abstracts relevant to NHS Health Checks in-house. The in-house screening of citations has not been independently verified by report authors.

2.2.2 Web of Science, Science Citation Index Citation Screening

Two of three reviewers (FP, RK or LT) independently screened the citations identified against inclusion and exclusion criteria (Appendix 1). Decisions between both reviewers were moderated as necessary by a third reviewer (FP).

2.2.3 Full text screening

Following initial screening, full texts of the included studies identified from methods described in sections 2.2.1 and 2.2.2 were retrieved. Each study underwent a second stage (full text) screening and selection process by two reviewers (RK or LT).

Studies reporting data relevant to Objectives 1-6 outlined in section were included and others with no pertinent data excluded. Reasons for exclusion at this stage were individually documented and are reported in a PRISMA flow diagram (see Figure 1).

2.3 Data extraction

Excel-based data extraction pro-forma were piloted, then used to aid extraction of relevant quantitative data that aligned to the reporting and synthesis of data from the earlier review.[1] We did not extract data on any new domains for this work. Studies containing quantitative data were double data extracted (LT and RK). Any discrepancies between reviewers was resolved by a third reviewer (FP).

Word-based data extraction pro-forma were piloted, then used to aid extraction of pertinent qualitative data including direct quotes, meanings, concepts and themes in duplicate (MS and FP). Duplicate extraction was completed for each paper by two reviewers with differing academic backgrounds so as not to subconsciously affect the data being extracted and synthesized (reporter bias).

The data extraction pro-forma can be accessed as supplementary files via the contact author.

A 10% sample of the data reported in the original review were checked for consistency with

reporting in the primary studies from which data were originally extracted. As consistency was identified as 100%, previously extracted and reported data were not re-extracted unless specifically indicated.

2.4 Quality assessment

Quantitative and qualitative study quality assessment was conducted by a single reviewer (RK, LT or MS) and then checked by a second reviewer (RK, LT or FP). Where needed, disagreement was resolved by a third reviewer (RBG or FP). CASP guidelines, relevant to the study design of the published study being assessed, were used to assess quality.[2]

We collated data at outcome level on risk of bias, imprecision, inconsistency, indirectness and publication bias for each review question (including data on studies within the original review and review update) in order to be able to give an overview of the certainty of evidence informing each research question outcome using the GRADE approach.[3 4]

2.5 Synthesis

To give an overview of the whole body of evidence, data from the original review and from the new studies is included in the review update.

Synthesis of quantitative data were completed as an extension to that in the original review. A structured, narrative synthesis using tables and data visualisation as appropriate was undertaken. Meta-analysis was not methodologically appropriate even where feasible due to the high heterogeneity and low number of high quality studies reporting on each domain in a consistent manner.

Newly identified qualitative studies were coded then mapped to the descriptive and analytic themes described in the original review by two reviewers (MS and FP). This was done through iterative reading and coding of the findings of the newly identified primary studies. Illustrative quotations from the new studies have been included in the report alongside the analytical themes they were mapped on to.

Synthesis of qualitative data were completed as an extension to that undertaken in the original review. A three-stage thematic synthesis approach was completed with the newly identified studies in order that we could add to and revise original findings. Completing a thematic synthesis incorporating just the new data alone to compare to the original thematic synthesis, or re-completing the whole thematic synthesis were inappropriate in this instance due to the few qualitative studies identified.

Studies included within the original review and the review update do not inform the synthesis for each research objective and sub-objective in a mutually exclusive manner, tables were created to give an ‘at a glance’ overview of the evidence informing each objective and where it informs more than one research .

The National Institute for Health and Care Excellence published new guidelines on statin use and prescribing in February 2014. Given this, we have also produced an ‘at a glance’ overview of evidence informing each objective that incorporates any data collected during and post 2014. Due to a lack of granularity in reporting on study period all studies including any data from “2014” onwards are identified within this table.

A single reviewer (LT or MS) implemented the GRADE approach to rate the certainty of, or confidence in, the evidence informing the interpretation of each research question addressed within the review. The decisions made were moderated by a single reviewer (FP). GRADE was used to rate certainty and inform interpretation of research question outcomes where quantitative data alone was used in answering the research question.[3] GRADE-CERQual was used to rate confidence in the body of evidence where qualitative data alone was informing the research question.[4] A developing GRADE method was used to rate the certainty and inform interpretation of research question outcomes where mixed qualitative and quantitative data was used in answering the research question. The GRADE profiler software (GRADEPRO) was used to input data to create 'Summary of findings' tables.

3. Results

A search strategy, as previously described, was implemented in the Web of Science, Science Citation Index limited between Jan 2016 and December 2019. This identified 616 citations. Citations were screened in duplicate (by FP, RK and LT) excluding 580 as irrelevant and identifying 36 publications needing full text review.

PHE staff implemented searches between November 2016 and November 2019. Abstracts and titles were screened for relevance to NHS Health Checks by PHE staff identifying 81 publications for full text review.

The full text of 117 publications were screened for relevance. Of these 117 publications, 88 were excluded for the following reasons: duplicates (21), not relevant to a research objective (25), study design (35), population (3), intervention (2), outcome (2). No additional studies were identified through reference searching.

In the review update, 29 studies were identified and contributed data to answering one or more objectives (see Figure 1, Table 2 and Table 4). These studies add to the body of evidence identified within the original review[1] an overview of how many studies identified in each review, the original or the update has been given in Table 2**.** Objectives are either wholly informed by quantitative data, by qualitative data or some by a mixture of both data types (see Table 2). Those studies that include any data collected during "2014" onwards are highlighted within Table 3. Individual studies contributed data to either a single objective or a combination of the objectives addressed within the review, Table 4 illustrates the number of studies contributing data to multiple objectives, indicating where studies are being assessed across the body of evidence more than once.

Figure 1 PRISMA diagram for review update

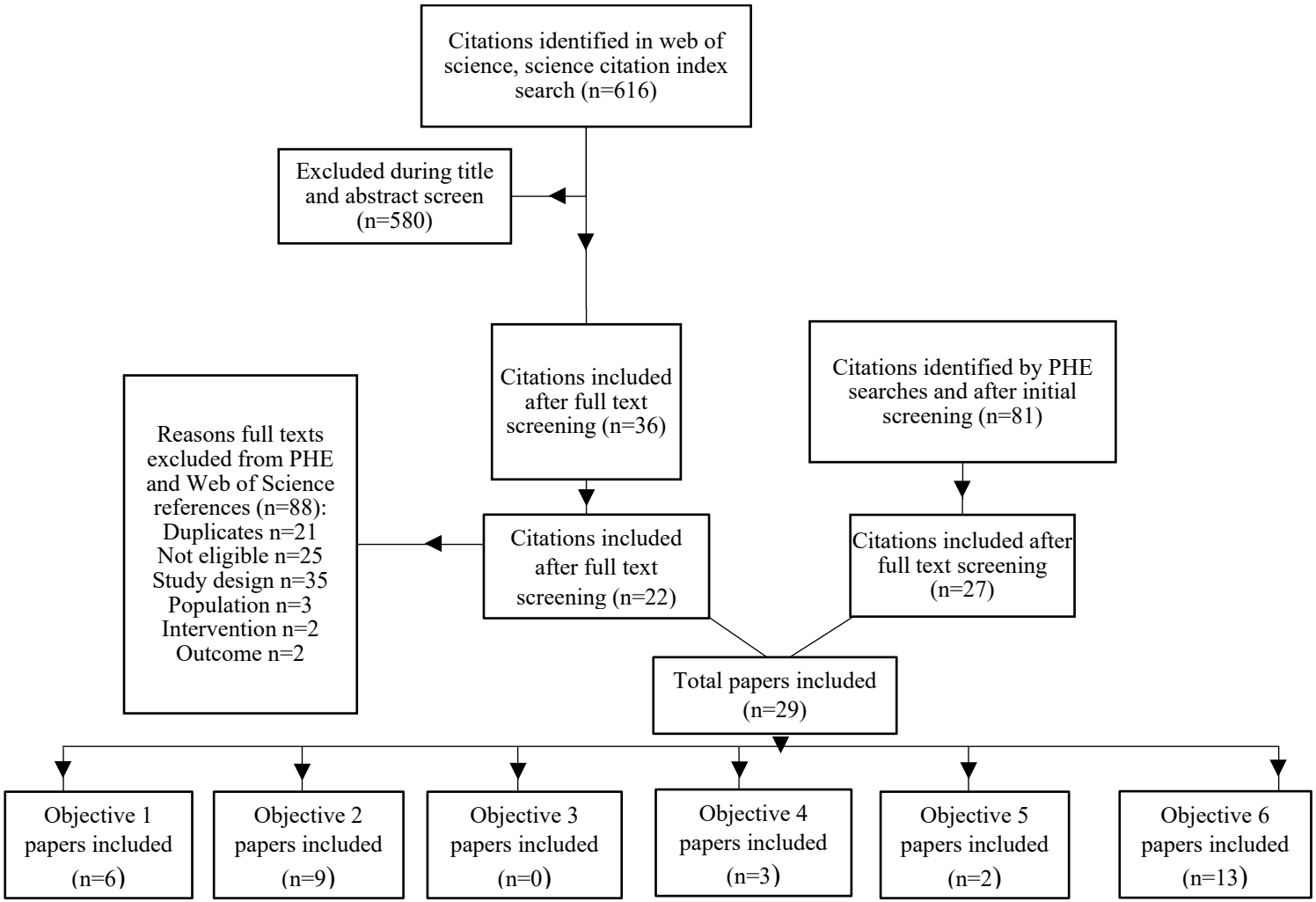
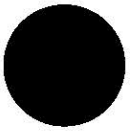
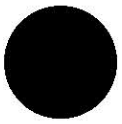


Table 2 An overview of studies contributing to each objective in the review update, objectives ordered based upon volume of evidence

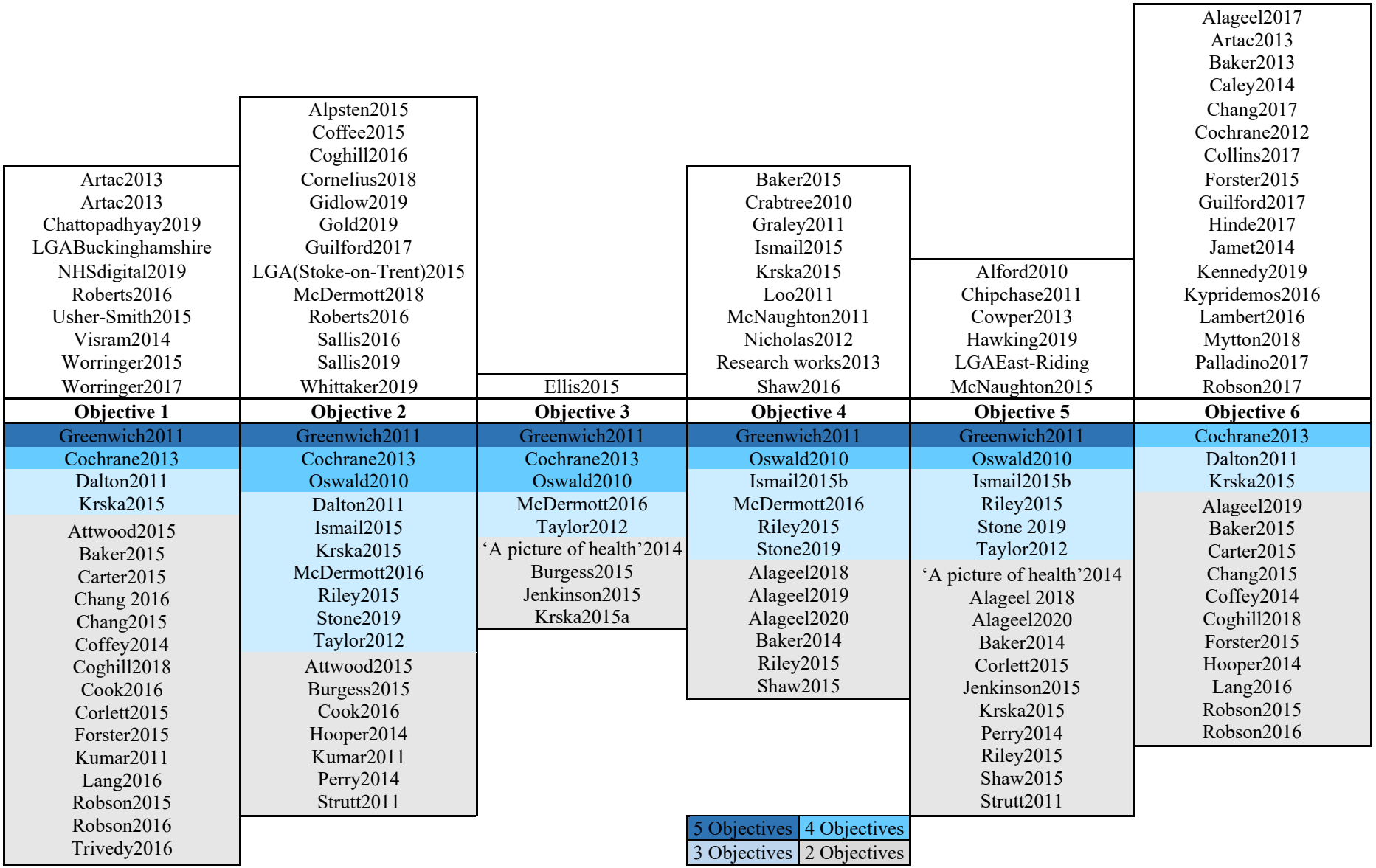
Objective	Number of studies contributing data to answer objective		Total studies now included	Studies contributing data to objectives at a glance*
	Original Review	Review Update		
6. What effect do NHS Health Checks have on: disease detection, behaviour change, referral to local risk management services, reduction in individual risk factor prevalence, cardiovascular disease risk and prescribing?	20	13	33	
2. What factors increase population and sub-group uptake?	22	9	31	
1. Characteristics of those attending and not attending NHS Health Check?	23	6	29	
5. What are patients' experiences of having an NHS Health Check?	20	2	22	
4. How is primary care managing people identified as being at risk of cardiovascular disease?	18	3	21	
3. Why don't people take up an NHS Health Check?	10	0	10	

Circle proportionate to included study number, black shading representative of studies contributing quantitative data, white shading representative of studies contributing qualitative data and grey shading representative of studies contributing both quantitative and qualitative data. *Roberts is counted as a single study

Table 3 Primary studies with any data collection in 2014 or onwards

	Objective 1	Objective 2	Objective 3	Objective 4	Objective 5	Objective 6
At least partial data collection in or post 2014	Carter2015 Chattopadhyay2019 Coghill2018 Cook2016 NHSdigital2020 Trivedy2016 Usher-Smith2015	Alpsten2015 Coffee2015 Cook2016 Gold2019 Guilford2017 McDermott2016 McDermott2018 Sallis2016 Sallis2019 Stone2019 Roberts2016 Whittaker2019	McDermott2016	Alageel2019 McDermott2016 Riley2015	Alageel2018 Alageel2020 Hawking2019 Riley2015 Stone 2019	Alageel2019 Coffey2014 Carter2015 Coghill2018 Collins2017 Collins2020 Forster2015 Guilford2017 Hinde2017 Kennedy2019 Kypridemos2016 Palladino2017 Robson2017
All data collection pre-2014	Artac2013 Artac2013 Attwood2015 Baker2015 Chang 2016 Chang2015 Cochrane2013 Coffey2014 Corlett2015 Dalton2011 Forster2015 Greenwich2011 Krska2015 Kumar2011 Lang2016 LGABuckinghamshire Roberts2016 Robson2015 Robson2016 Visram2014 Worringer2015 Worringer2017	Attwood2015 Burgess2015 Cochrane2013 Coghill2016 Cornelius2018 Dalton2011 Gidlow2019 Greenwich2011 Hooper2014 Ismail2015 Krska2015 Kumar2011 LGA(Stoke-on-Trent)2015 Oswald2010 Perry2014 Riley2015 Strutt2011 Taylor2012	‘A picture of health’2014 Burgess2015 Cochrane2013 Ellis2015 Greenwich2011 Jenkinson2015 Krska2015a Oswald2010 Taylor2012	Alageel2018 Alageel2020 Baker2014 Baker2015 Crabtree2010 Graley2011 Greenwich2011 Ismail2015 Ismail2015b Krska2015 Loo2011 McNaughton2011 Nicholas2012 Oswald2010 Research works2013 Riley2015 Shaw2015 Shaw2016 Stone2019	‘A picture of health’2014 Alford2010 Baker2014 Chipchase2011 Corlett2015 Cowper2013 Greenwich2011 Ismail2015b Jenkinson2015 Krska2015 LGAEast-Riding McNaughton2015 Oswald2010 Perry2014 Riley2015 Shaw2015 Strutt2011 Taylor2012	Alageel2017 Artac2013 Baker2013 Baker2015 Caley2014 Chang2015 Chang2017 Cochrane2012 Cochrane2013 Dalton2011 Forster2015 Hooper2014 Jamet2014 Krska2015 Lambert2016 Lang2016 Mytton 2018 Robson2015 Robson2016

Table 4 Primary studies and the number of objective/s they contribute data towards



Studies contributing data to a single objective are listed above objective labels; studies below contribute data to two or more objectives (see key)

3.1 Who is and who is not having an NHS Health Check?

Prior to the initiation of the NHS Health Check programme, it was anticipated that all eligible individuals would be invited to the prevention programme over a five-year period.[5 6] The eligible population is defined as those aged 40-74, who have no prior diagnosis of vascular disease and are not being prescribed statins and, or, anti-hypertensives.[5 6] It was expected that there would be an uptake of 75%.[5 6]

One source of information identified in this updated review was data published by NHS Digital and PHE, which presents data on attendance from 2012 to 2018.[7 8] The evidence suggests that the national average attendance is 44.2%, with variation across regions (range = 41.3-49.2%; see Figure 2 for national and regional attendance percentages). As of 2018, therefore, the attendance rates are still well below the original economic modelling assumption of 75%. Furthermore, the attendance rates at a local authority level are even more variable. In 2017-2018 attendance varied from 19.5% to 75.8%. The lowest attendance was observed in Wokingham, while the highest was found in Leicester (see the NHS Digital dashboard: https://digital.nhs.uk/data-and-information/publications/statistical/nhs-health-check-programme/2012-13-to-2017-18). In the current review an additional six published studies were identified as including relevant data for this objective (Chang *et al*, 2016[9]; Chattopadhyay *et al*, 2019[10]; Coghill *et al*, 2018[11]; Lang *et al*, 2016[12]; NHS Digital 2020[7 8]; Woringer *et al*, 2017[13]). All of these studies are of an observational study design.[9-14] The characteristics of these studies are shown in Table 5. Data from the study by Chang *et al*, 2016 was reported within the previous review for Objective six, however, we felt data they presented was also relevant to Objective one and this has been extracted as part of the review update.[9]

Figure 2 Attendance of NHS Health Checks across England from 2012-2018 (data from NHS Digital)[7 8]

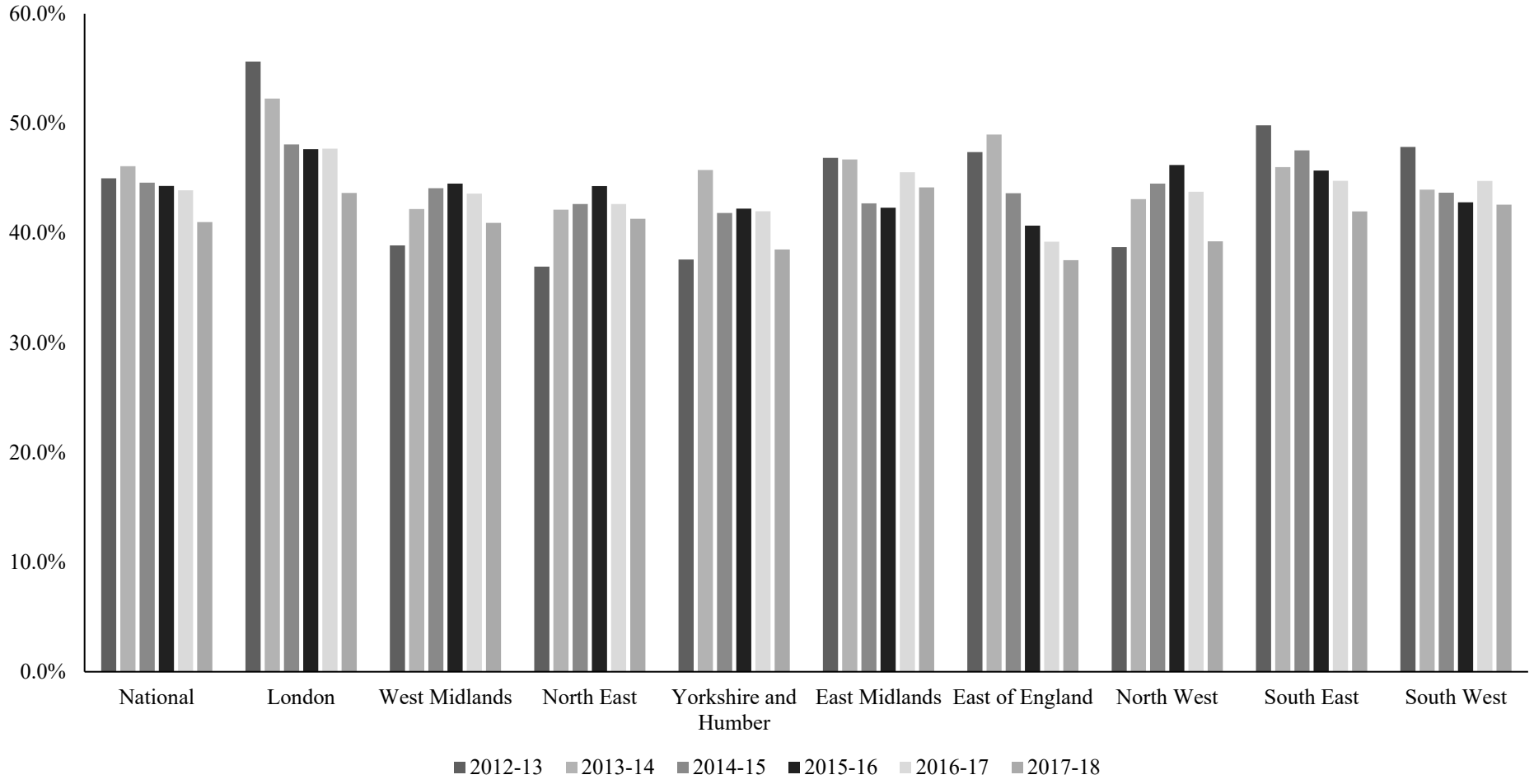


Table 5 Features of studies reporting characteristics of the eligible population sample

Author (date) Sample type	Study design Data source	Setting Study time period	Eligible population [if not reported then NHS Health Check population shown in brackets][a]	Age	Gender	Ethnicity	Index of Multiple Deprivation (IMD)
Chang *et al* (2016)[9]* National	Observational study CPRD	462 GPs across England electronic medical records 2009-2013 (4 years)	138,788				
Chattopadhyay *et al* (2019)[10]* Community	Observational cross sectional study Leicester health and wellbeing survey	Leicester January 2015 to June 2015 (6 months)	979				
Coghill *et al* (2018)[11]* Community	Observational cross sectional study Electronic patient records	38 (of 52) GPs in Bristol 18th Feb to 23rd Oct 2014 (8 months)	31,881	Mean (SD) = 52.4 (9.8) Median (IQR)= 50 (44-60)	Male = 52%	White = 63.8%	5th quintile = 24%
Lang *et al* (2016)[12]* Regional	Observational cross sectional study Primary care electronic health records	9 GPs across the West Midlands October 2008 to June 2009 (8 months) Screening assessment if needed: January 2009 to May 2010 (1 year and 4 months)	7,987	Mean = 60	Male = 48.4%		10 = 21.1%
Woringer *et al* (2017)[13]* Community	Observational cross sectional study Health Options dataset	38 (of 90) Local authorities across eight regions of England	43,177	Aged >50 = 33.35%	Male = 37.8%	White = 92.2%	IMD median (IQR) = 30.15 (25.97 – 34.33)

		January 2008 to Oct 2013 (5 years and 9 months)					
NHS digital (2020)[7 8]* National	Experimental statistics Electronic database (Version 2 (updated 27.02.2020))	England April 2012 to March 2018 (6 years)	6,524 practices (90% coverage)				
Artac *et al* (2013)[15] National	Observational cross sectional study Mandatory PCT data returns collated by DoH	151 NHS PCTs in England April 2011 to March 2012 (1 year)	Whole of England PCT-level data			Ethnic minority = 12.1%	Mean = 23.6
Chang *et al* (2015)[16] National	Observational study CPRD data	England April 2009 to March 2013 (4 years)	95,571 (random sample of CPRD data)	Aged >60 = 60.2%	Male = 20.2%	British = 35.8%	
Forster *et al* (2015)[17] National	Observational study CPRD data	England 2010-2013 (3 years)	[140,356]				
Robson *et al* (2016)[18] National	Observational study QResearch data	England April 2009 to March 2013 (4 years)	1,679,024	Age >60 = 22.2%	Male = 49.6%	White = 63.4%	Most deprived (5th quintile) = 20%
Artac *et al* (2013)[19] Regional	Observational cross sectional study Electronic medical records	27 (of 31) PCTs in Hammersmith and Fulham, London 2009-2011 (2 years)	[Year 1 = 4,548 (high risk)] [Year 2 = 35,364]	Year 1 Age >65 = 34.2% Year 2 Age >65 = 5.89%	Year 1 Male = 78.4% Year 2 Male = 45.2%	Year 1 White = 71.4% Year 2 White = 56.8%	
Attwood *et al* (2016)[20] Regional	Trial[b] Data collected during trial	4 general practices in the East of England Not reported	1,380	Mean = 52.4	Male = 49.7%	White = 72.9%	Most deprived (5th quintile) = 18.6%

Baker *et al* (2015)[21] Regional	Observational cross sectional study Electronic medical records	83 (of 85) general practices in Gloucestershire July 2011 to July 2012 (1 year)	210,513				
Carter *et al* (2015)[22] Regional	Observational cross sectional study Electronic medical records	65 general practices in Leicester City Clinical Commissioning Group April 2009 to March 2014 (5 years)	[53,799]				
Cochrane *et al* (2013)[23] Regional	Observational cross sectional study Electronic practice records	37 (of 57) general practices in Stoke-on-Trent August 2009 to January 2010 (6 months)	[10,483 (high risk patients)]				
Coffey *et al* (2014)[24] Regional	Observational study Electronic records	40 (of 47) general practices in Salford Not reported	57,486				
Cook *et al* (2016)[25] Regional	Observational study Electronic practice records	30 (all) general practices in Luton April 2013 to March 2014 (1 year)	50,485	Age >55 = 30.5% Age >65 = 7.6%	Male = 53.3%	White British = 32.5%	
Dalton *et al* (2011)[26] Regional	Observational study Electronic practice records	29 (of 86) general practices in Ealing, London 2008-2009 (1 year)	[5,294 (high risk patients)]				
Krska *et al* (2016)[27] Regional	Observational study Electronic practice records	13 (of 55) general practices in Sefton, North West England Not reported (assumed first year of	2,892	Aged >65 = 69.4%	Male = 78.3%	White = 99.1%	

		NHS Health Checks since high risk patients)					
Kumar *et al* (2011)[28] Regional	Observational study NHS Health Check data	2 (of approx. 57) general practices in Stoke on Trent 2008 to 2010 (assumed two years)	[1,606 (661 high risk patients)]				
Roberts *et al* (2016)[29] Regional	Observational study Electronic practice records	General practices in Buckinghamshire Not reported	[12,190]				
Robson *et al* (2015)[30] Regional	Observational study Electronic practice records	139 (of 143) general practices in North East London April 2009 to April 2012 (3 years)	144,451	Aged >60 = 10.8%		White = 42.2%	
Usher-Smith *et al* (2015)[31] Regional	Observational study Electronic practice records	1 general practice in the East of England 1 April 2011 to 1 Dec 2014 (3 years and 8 months)	[1,646]				
Corlett *et al* (2016)[32] Community	Observational study Electronic practice records	Four community pharmacies within a London CCG February-August 2013 (6 months) Not reported	[190]				
LGA Buckinghamshire (2015)[33] Community	Evaluation	Community venues	[>3,800]				
NHS Greenwich (2011)[34] Community	Observational study NHS Health Check data	5 community based venues in Greenwich, South East London (e.g. Charlton Athletic Football Ground)	[1,400]				

		May-June 2011 (2 months)					
Roberts *et al* (2016)[29] Community	Observational study NHS Health Check data	Community venues in Buckinghamshire	[3,849]				
Trivedy *et al* (2017)[35] Community	Observational study NHS Health Check	7 cricket venues in England 11 cricket events held during 2014 and 2015	[513]				
Visram *et al* (2014)[36] Community	Formative evaluation	Community venues in Durham	[101]				
Worringer *et al* (2015)[37] Community	Observational study NHS Health Check data	Community venues 8 regions of England across 29 local authorities	[41,570]				

*and a bold outside border denotes new studies included from the review update; Chang (2016)[9] is new to the synthesis for this objective

[a]High risk patients are defined as those with an estimated cardiovascular risk >20% in the next 10 years.

[b]The intervention arm of the trial (physical activity) was not relevant to this review. Data reported on trial non-participants who attended the Health Check were extracted.

PCT: Primary Care Trust; CPRD: Clinical Practice Research Datalink; CCG: Clinical Commissioning Group; DoH: Department of Health; QOF; Quality Outcomes Framework; CVD: cardiovascular disease

3.1.1 Characteristics of those attending and not attending NHS Health Checks

Six studies were identified in this review (Chang *et al*, 2016[9]; Chattopadhyay *et al*, 2019[10]; Coghill *et al*, 2018[11]; Lang *et al*, 2016[12]; NHS Digital 2020[7 8]; Woringer *et al*, 2017[13]), and combined with 18 studies from the previous review. The characteristics of those studies reporting data on who attended an NHS Health Check are in Table 6. Additionally, those studies that reported characteristics of those not attending an NHS Health Check are in Table 7. The newly identified studies include three studies with national data (Chang *et al*, 2016[9]; NHS Digital 2020[7 8]), one with regional data (Lang *et al*, 2016[12];), and three with community level data (Coghill *et al*, 2018[11]; Chattopadhyay *et al*, 2019[10]; Woringer *et al*, 2017[13]). Woringer and colleagues[13] assessed attendance of NHS Health Checks in community outreach services (38 local authorities across England), making comparisons to the general population. As identified in the previous review, there remains to be large variations in the age, gender, ethnicity, deprivation level and cardiovascular risk profiles of those who are having, and not having, an NHS Health Check. However, there is poor reporting of some studies leading to a lack of data granularity on those attending.

The newly reviewed studies that include national data used the clinical practice research datalink (Chang *et al*, 2016[9]) or NHS Digital data assets (NHS Digital 2020[7 8]). The CPRD is a collation of de-identified patient data from a network of general practices across the UK, covering approximately 7% of the population (Chang *et al*, 2016[9]). The data utilised by NHS Digital comes from general practices too. Data collection is automatic and extracted using NHS Digital's General Practice Extraction Survey, using relevant data extraction codes (data is audited to ensure accurate identification of NHS Health Check activity) between 2012 and 2018.[7 8] Together CPRD and NHS Digital provide coverage for all 151 local authorities across England. Both datasets can be considered to be representative of the population of England.

The only regional data from new studies included in this review was attained from nine general practices across the West Midlands (Lang *et al*, 2016[12]). This study utilised electronic health records from their included general practices. The three studies that utilised community level data were obtained from the Leicester health and wellbeing survey (Chattopadhyay *et al*, 2019[10]), 38 general practices in Bristol (Coghill *et al*, 2018[11]), and 38 local authorities across England (Woringer *et al*, 2017[13]). Chattopadhyay and colleagues survey data was commissioned by Leicester city council (public health division).[10] The authors then extracted data regarding demographics and whether they had attended an NHS Health Check or not. Coghill *et al* obtained their data from electronic health records from their included general

practices. Finally, Woringer and colleagues obtained their data from community providers specifically using Health Options software and point of care testing.[13] These NHS Health Checks were performed opportunistically, rather than through written invitational measures and therefore may not be comparable to the other literature mentioned here.[13]

Table 6 Characteristics of those attending an NHS Health Check

Author (date) Sample type	Attendees (n)	Age	Male %	White %	IMD (most deprived) %	CVD risk >20%	Smoke %	BMI>30 %	Family CHD history %
Chang *et al* (2016)[9]* National	29,672	Mean = 53.5	42.5	54.8	19.3				
Chattopadhyay *et al* (2019)[10]* Community	637	Mean = 55.3	55.7	69	% most deprived tertile 1.26		17.6		
Coghill *et al* (2018)[11]* Community	13,733	>60 = 34.7%	47	84.6	21.6				
Lang *et al* (2016)[12]* Regional	2,321				30.7				
Woringer *et al* (2017)[13]* Community	43,177	>60 =22%	36.2	92.2	Mean = 30.2				
NHS Digital (2020)[7 8] * National	2012-13 = 733,944 2013-14 = 974,267 2014-15 = 1,146,781 2015-16 = 1,161,027 2016-17 = 1,141,554 2017-18 = 1,108,841	>60 (excludes over 70) 2012-13 = 30.9% 2013-14 = 27.6% 2014-15 = 24.9% 2015-16 = 23.6% 2016-17 = 23.6% 2017-18 = 24.6%	2012-13 = 47.6 2013-14 = 46.2 2014-15 = 44.7 2015-16 = 44.8 2016-17 = 45.3 2017-18 = 46	2012-13 = 81.5 2013-14 = 80.2 2014-15 = 79.6 2015-16 = 78.5 2016-17 = 77.8 2017-18 = 77.9					
Chang *et al* (2015)[16]	20,409		45.3	71.4	19.1	4.6	17.3	26.3	10.8

Author (date) Sample type	Attendees (n)	Age	Male %	White %	IMD (most deprived) %	CVD risk >20%	Smoke %	BMI>30 %	Family CHD history %
National									
Forster *et al* (2015)[17] National	140,356	>65 = 20.5%	46.5		18	17	18.1	22.3	
Robson *et al* (2016)[18] National	214,295	>60 = 34%	47.9	86.4	23.3	11.6	17.7	21.2	6.9
Artac *et al* (2013)[19] Regional									
Attwood *et al* (2015)[20] Regional	179	Mean = 56.6	42.5	80.4	14.8				
Baker *et al* (2015)[21] Regional	20,973	45-49 = 17.3%	45.2	British or mixed British = 94.8		9/1	9.3	15.5	
Carter *et al* (2015)[22] Regional	53,799	>60 = 30.5%	47.5	45.8		10.8	23.7	Mean = 27.4	
Cochrane *et al* (2013)[23] Regional	4,580	>65 = 43.1%	83.6		% from most deprived tertile 71.7	CVD risk >35 = 15.6			
Dalton *et al* (2011)[26] Regional	2,370	>65 = 41.6%	80.5	19.9	% from most deprived tertile 36.6		35.4	26	
Krska *et al* (2015)[27] Regional	1,070	>65 = 74.4%	80.9	99.1	9.7	92	18.1	BMI > 25 = 75.6	56.7
Kumar *et al* (2011)[28] Regional	497	>60 = 40.6%	56.9						
Roberts *et al* (2016)[29] Regional	12,190		50	South Asian = 3	13				

Author (date) Sample type	Attendees (n)	Age	Male %	White %	IMD (most deprived) %	CVD risk >20%	Smoke %	BMI>30 %	Family CHD history %
Robson *et al* (2015)[30] Regional	50,651	>60 (Y3 only) = 14.8%		46.9		10.5			
Usher-Smith *et al* (2015)[31] Regional	1,646	58.1	54.6		% from most deprived tertile 92	10.8			
Corlett *et al* (2016)[32] Community	190	>65 = 7.4%	42.1	52.6		8	12.3	17.4	
LGA Buckinghamshire (2015)[33] Community	Mosques = 155 Costcutter stores = 20 Adult learning centre >20 Bus stations = 55 Manufacturing firm = 45 Football club = 71		Mosques = 72 Costcutter stores = 50 Adult learning centre Bus stations = 75 Manufacturing firm = 69 Football club = 100	Mosques; South Asian = 95 Costcutter stores; South Asian = 25 Adult learning centre; South Asian = 22	Adult learning centre = 50 Bus stations = 57				
NHS Greenwich (2011)[34] Community	620	>60 = 40.6%	39.4	59	22	25	16	47	25
Roberts *et al* (2016)[29] Community	3,849	Mean = 54	38	78	30				
Trivedy *et al* (2016)[35] Community	513	Male mean = 49 Female mean = 47	63.2	84	NR				
Visram *et al* (2014)[36] Community	101	>60 = 18%	46.5		18	12.8			

*and a bold border outside denotes new studies included from the review update; Chang (2016)[9] is new to the synthesis for this objective

Table 7 Characteristics of those not attending an NHS Health Check.

Author (date) Sample type	Non-Attendees (n)	Age	Male %	White %	IMD (most deprived) %	CVD risk >20%	Smoke %	BMI>30 %	Family CHD history %
Chang *et al* (2016)[9]* National	109,116	Mean = 50.1	50	54.8	15.7				
Chattopadhyay *et al* (2019)[10]* Community	342	Mean = 53.8	49.4	69.8	0.9		24.9		
Coghill *et al* (2018)[11]* Community	18,031	>60 = 20.2%	55.7	48.1	26				
Woringer *et al* (2017)[13]* National	2,793,398	>60 = 35.6%	49.2	94	Mean = 24.14				
NHS Digital[7 8]* National	2012-13 = 896,383 2013-14 = 1,139,691 2014-15 = 1,422,966 2015-16 = 1,462,634 2016-17 = 1,459,634 2017-18 = 1,594,623	>60 (excludes over 70) 2012-13 = 20.8% 2013-14 = 18.7% 2014-15 = 16.2% 2015-16 = 15.6% 2016-17 = 15.9% 2017-18 = 16.6%	2012-13 = 53.9 2013-14 = 53 2014-15 = 52 2015-16 = 51.7 2016-17 = 51.9 2017-18 = 52.1	2012-13 = 67.9 2013-14 = 66.1 2014-15 = 64.5 2015-16 = 63.3 2016-17 = 62.8 2017-18 = 62.6					
Robson *et al* (2016)[18] National	1,467,729	>60 = 20.5%	49.8	60.1	19.4	1.9	22.4	27.5	0.3

Author (date) Sample type	Non-Attendees (n)	Age	Male %	White %	IMD (most deprived) %	CVD risk >20%	Smoke %	BMI>30 %	Family CHD history %
Attwood *et al* (2015)[20] Regional	844	Mean = 52	50.6	69.3	14.8				
Cochrane *et al* (2013)[23] Regional	5,903	>65 = 31.2%	79.5		Tertile = 74.9	CVD risk >35 = 13.7			
Dalton *et al* (2011)[26] Regional	2,924	>65 = 40.2%	81.2	23.1	Tertile = 36.5		43.9		
Krska *et al* (2015)[38] Regional	953	>65 = 56.6%	80.1	99	10		42.9	>25 = 73.7	67.4

*and a bold border outside denotes new studies included from the review update; Chang (2016)[9] is new to the synthesis for this objective

3.1.2 Demographic differences between those attending and not attending an NHS Health Check

This section aims to highlight the observed demographic differences in those attending and not attending. The most commonly reported key demographics were age, sex, ethnicity, level of deprivation and smoking status. Of the newly identified studies (n = 6) three were pre 2014 (Chang *et al,* 2016[6]; Lang *et al*, 2016[9]; Woringer *et al,* 2017[10]) and three included data from 2014 onwards (Coghill *et al*, 2018[8]; Chattopadhyay *et al*, 2019[7]; NHS Digital[7 8]). Dates of data collection, where reported by study authors, can be seen in Table 5 in the third column.

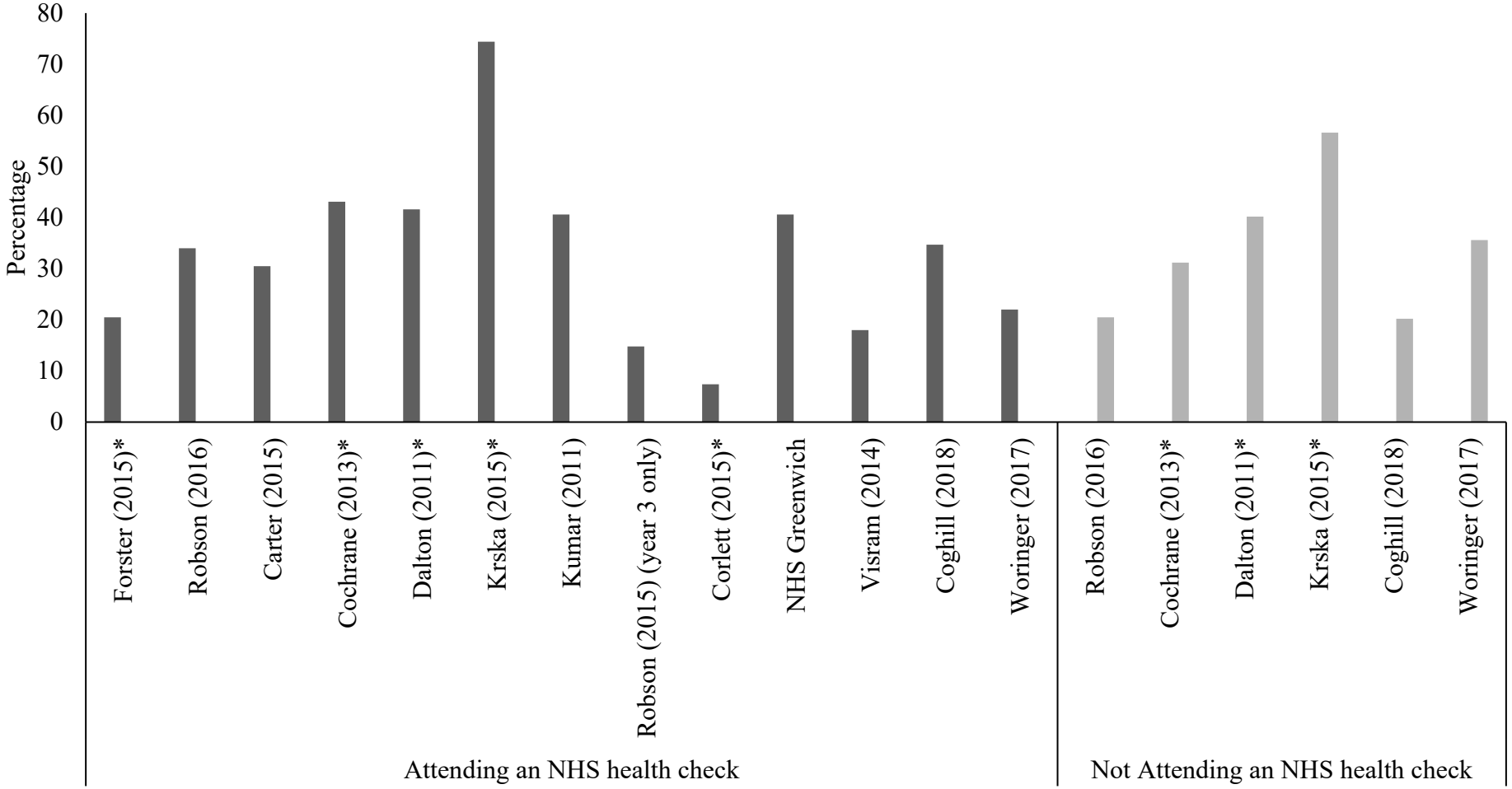
3.1.2.a Age

The previous review suggested that older patients were more likely to attend an NHS Health Check. Multiple studies support this (Artac *et al*, 2013[19]; Attwood *et al*, 2015[20]; Chang *et al*, 2015[16]; Chang *et al* 2016[9]; Chattopadhyay *et al*, 2019[10]; Coghill *et al*, 2018[11]). The use of adjusted odds ratios (AOR) has shown across multiple studies that older people are more likely to attend, than their younger counterparts (Artac *et al*, 2013[19]; Attwood *et al*, 2015[20]; Chang *et al*, 2015[16]; Coghill *et al*, 2018[11]). Regional data from Attwood and colleagues suggest that older people are slightly more likely to attend (AOR: 1.05, 95% CI: 1.04-1.07).[20] Community level data from Coghill *et al* supports this notion, with an increase in likelihood to attend as age increases, compared to those who were aged 40-49 years (50-59yrs, AOR: 1.36, 95% CI: 1.21-1.53; 60-69yrs, AOR: 2.19, 95% CI: 1.8-2.68; ≥70yrs, AOR: 2.53, 95% CI: 1.89-3.39).[11] Further community data also shows that older adults were more likely to attend a Health Check (Chattopadhyay *et al*, 2019).[10] Furthermore, national data from Chang and colleagues, using the non-matched t-test comparison also supports the notion that older people are more likely to attend, than not attend (mean age = 53.5 vs. 50.1 years, $p < 0.001$).[9]

There is some contrasting evidence, with Lang and colleagues (2016; regional data) showing that while 55-59 year olds were more likely to attend than 50-54 year olds (AOR: 1.2, 95% CI: 1.03-1.4), there was a non-significant trend of less people attending in the older age groups (60-64yrs, AOR: 1.15, 95% CI: 0.99-1.35; 65-69yrs, AOR: 1.1, 95% CI: 0.91-1.32; 70-74yrs, AOR: 0.99, 95% CI: 0.8-1.23).[12] In addition, a study using opportunistic methods in a community setting observed that younger patients were more likely to attend (Woringer *et al*, 2017).[13] This could be due to the times at which services were available (after working hours), which allowed for a greater attendance of younger patients who may have other responsibilities during usual general practice hours. Overall, however, the evidence from

multiple datasets suggests that older adults (≥60 years old) are more likely to attend an NHS Health Check. Figure 3 illustrates the numbers of over 60 year olds attending and not attending their Health Check appointments.

Figure 3 Percentage of ≥60 years old attending (left) and not attending (right) an NHS Health Check.* denotes studies that bars reflect ≥65 years



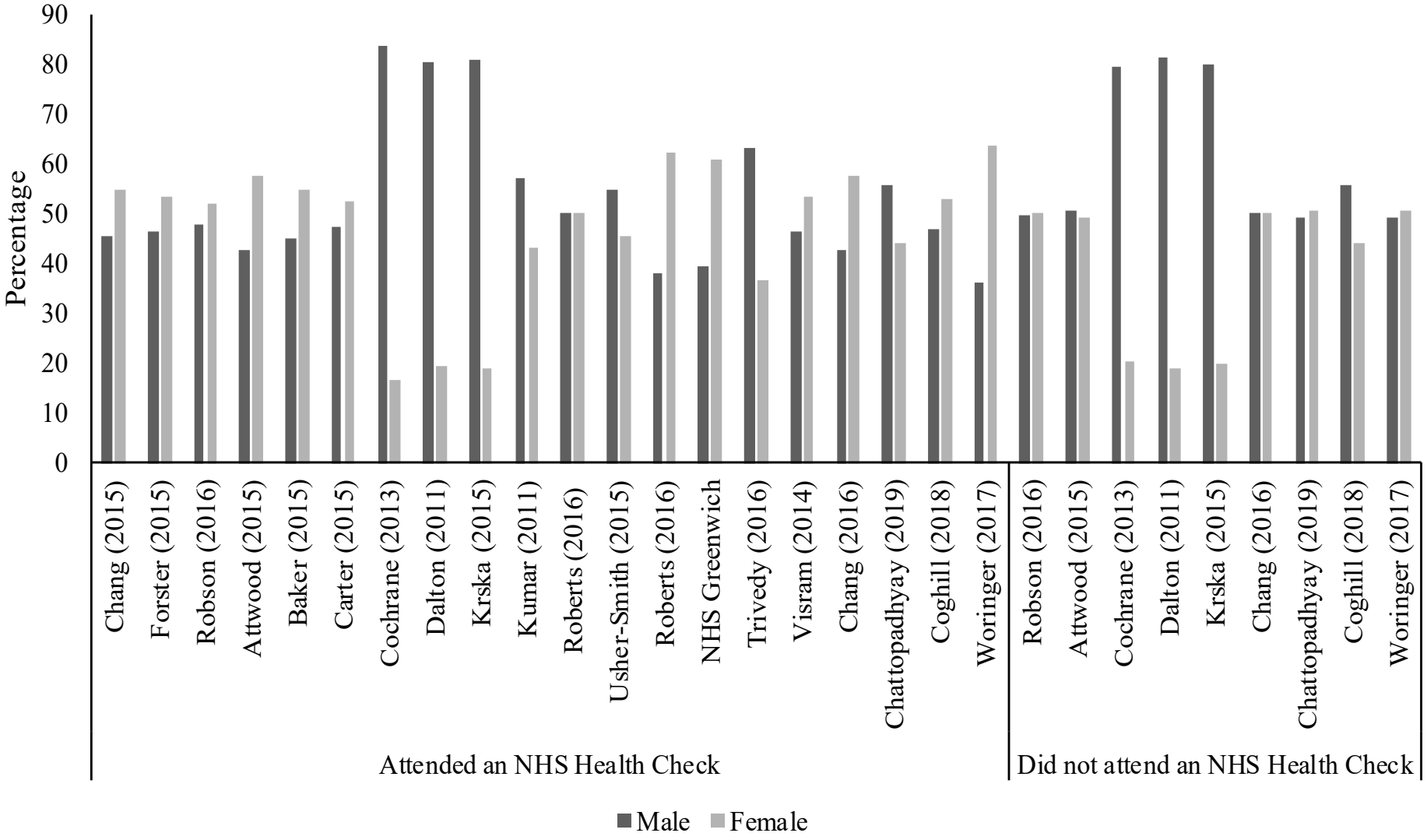
3.1.2.b Sex

There are some reported differences between males and females attending. Most of the evidence suggests that females are more likely to attend an NHS Health Check than males. At a national level the NHS Digital dataset (See Figure 4, Table 6 and Table 7) shows a trend from 2012 to 2018 that males are less likely to attend. This data shows males not attending has a range of 51.7-53.9%, while those attending an NHS Health Check range from 44.7-47.6%. This trend is supported by the CPRD data which suggests that a higher proportion of females attended NHS Health Checks ($p < 0.001$; Chang *et al*, 2016[16]).

Further support for females being more likely to attend than males comes from data that use AOR analysis (Attwood *et al*, 2015[20]; Lang *et al*, 2016[12]). Attwood and colleague's analysis suggest that females are slightly more likely to attend than males, although this was not statistically significant (AOR: 1.29, 95% CI: 0.95-1.76).[20] Further evidence shows a statistically significant likelihood that males attend NHS Health Checks less often than females (Lang *et al*, 2016: AOR: 0.75, 95% CI: 0.67-0.84).[12] These results are attained from the West Midlands and may be transferrable to similar regions and communities in England.[11] [12]

Some community data also shows that females were more likely to attend than males (Coghill et al 2018[11]; Woringer et al 2017[13]). Coghill and colleagues also suggests that males are less likely to attend a Health Check than females, when checks are done opportunistically ($p < 0.001$).[11] There is, however, some evidence that females may not always be more likely to attend (Chattopadhyay *et al*, 2019 (AOR: 0.78, 95% CI: 0.6-1.01)).[10] Overall, the evidence suggests that males are less likely to attend an NHS Health Check than females. Figure 4 shows the percentages of males and females attending/not attending an NHS Health Check for studies that reported the information. Overall, this figure supports the claim that males are less likely to attend than females.

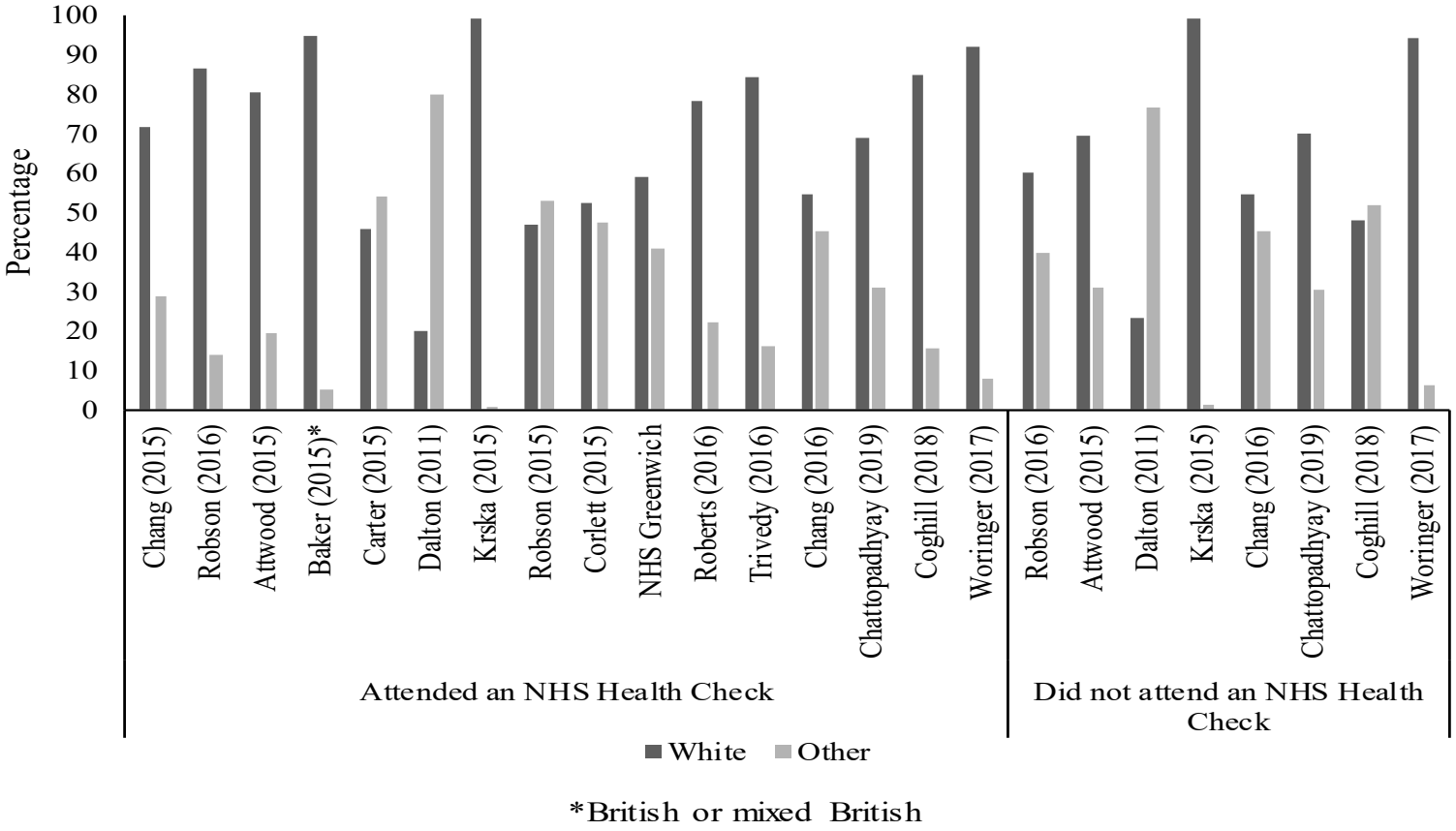
Figure 4 Percentage of males and females attending (left) and not attending (right) an NHS Health Check



3.1.2.c Ethnicity

Data from NHS Digital (See Figure 5, Table 6 and Table 7) show that from 2012-2018 a higher percentage of White British individuals attend an NHS Health Check (range: 77.8-81.5%) than do not attend a Health Check (range: 62.3-67.9%) compared to Non White British individuals. Studies report a mixture of attendance rates for white and non-white groups, with clear variations across studies (See Figure 5). There is, however, little evidence to suggest which ethnic groups are more likely to attend an NHS Health Check. Chang and colleagues (2016), using the CPRD dataset suggest that white people are more likely to attend at a national level ($p < 0.001$),[9] supporting the data from NHS Digital 2020.[7] [8] This could, however, vary at regional and community levels. Attwood *et al* (2015) provided unclear results that non-white people are less likely to attend than white people at a regional level (AOR: 0.85, 95% CI: 0.29-2.52).[20] Whilst at a community level Chattopadhyay and colleagues (2019) suggest that non-white people are more likely to attend than white people (AOR: 1.66, 95% CI: 1.26-2.18).[10] There are clear discrepancies and further analysis are needed to understand why differences exist in the effects of ethnicity on attendance.

Figure 5 Percentage of white and non-white people attending (left) and not attending (right) an NHS Health Check



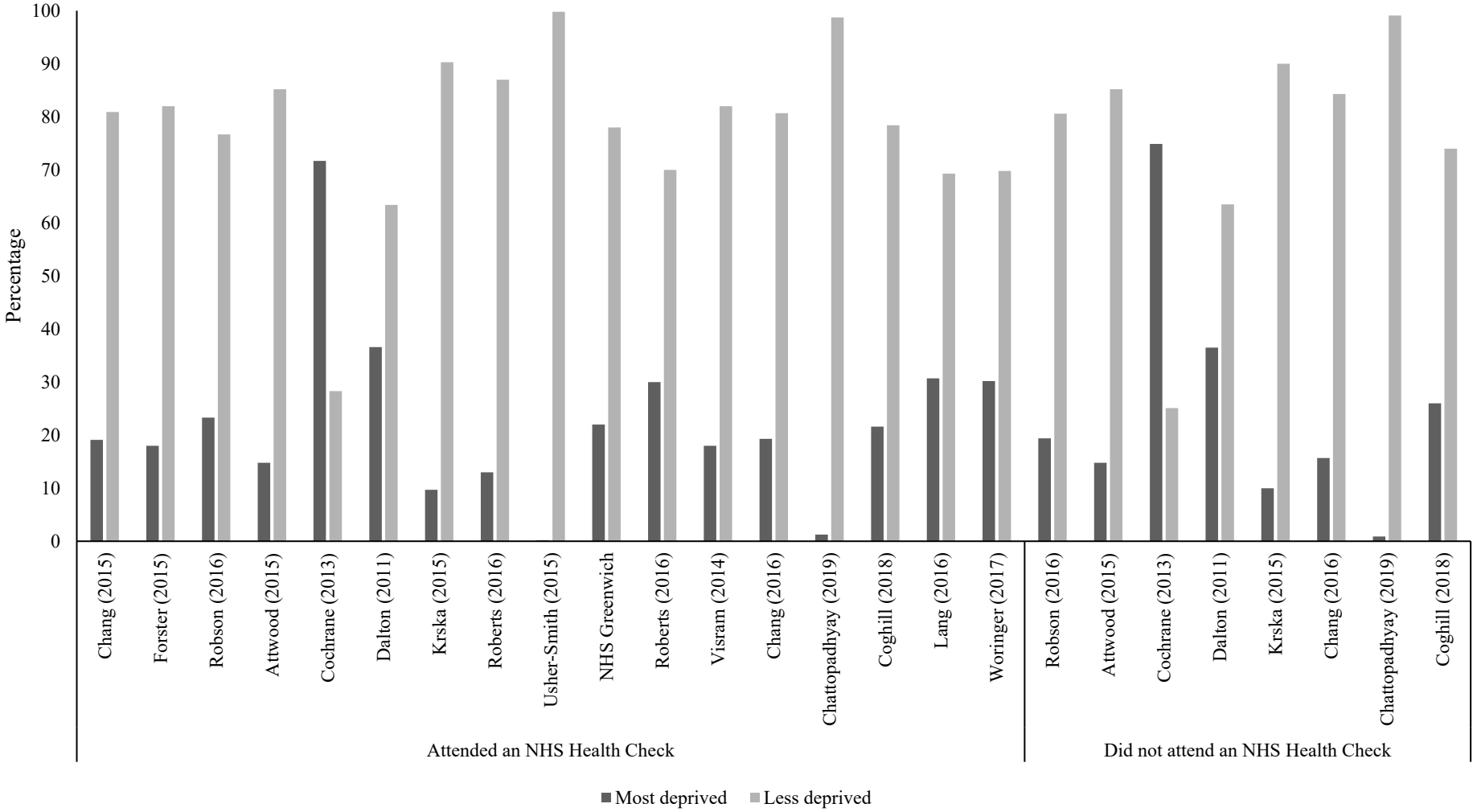
*British or mixed British

3.1.2.d Deprivation levels

The original review identified that coverage of the NHS Health Checks was greater amongst those individuals from a more deprived background. The review update finds that those who are least deprived are most likely to attend. Attwood and colleagues (2015) show that compared to the first quintile (least deprived) of the index of multiple deprivation (IMD) people from the fifth IMD were less likely to attend (AOR: 0.42, 95% CI: 0.2-0.88).[20] Coghill *et al* (2018)[11], report a non-statistically significant reduction in attendance for those in the fifth IMD compared to the first (AOR: 0.8, 95% CI: 0.52-1.24). At a national level there is evidence that those of a higher level of deprivation are less likely to attend an NHS Health Check (Chang *et al*, 2016).[9] Additionally, Chattopadhyay and colleagues (2019) found a decrease in attendance in the fourth IMD (AOR: 0.57, 95% CI: 0.35-0.9), but not the fifth IMD (AOR: 1.37, 95% CI: 0.36-5.24), when compared to the first quintile.[10] The sample size for the fifth quintile in this study was very small (n = 11), which could be the cause of the large variation observed.[10]

Opportunistic checks may improve attendance amongst those from a higher deprivation level (Woringer *et al*, 2017). The authors observed a statistically significant difference (p <0.05) between attendees and the general population (IMD mean = 30.15 vs. 24.14, respectively).[13] Overall, the new evidence suggests that those at a higher level of deprivation are less likely to attend an NHS Health Check than those from a lower level of deprivation (See Figure 6).

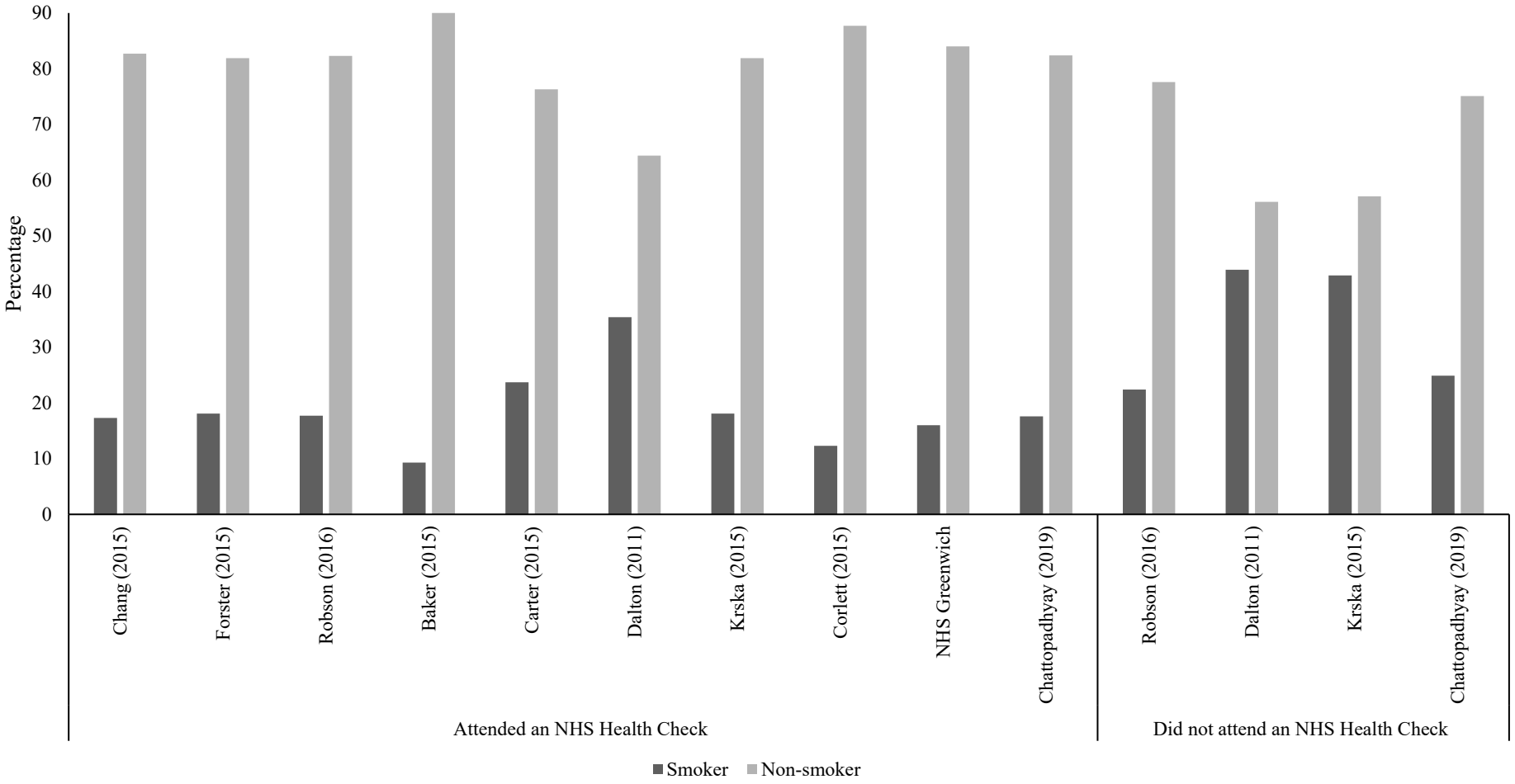
Figure 6 Percentage of most deprived and least deprived people attending (left) and not attending (right) an NHS Health Check



3.1.2.e Other identified differences attenders and non-attenders

There is some evidence to suggest that smoking status influences attendance. Two of the newly reviewed studies (Chattopadhyay *et al*, 2019; Lang *et al*, 2016) suggest that those who smoke are less likely to attend an NHS Health Check, compared to non-smokers (AORs: 0.6 [95% CI: 0.43-0.8] and 0.48 [95% CI: 0.42-0.56], respectively).[10 12] Studies that report smoking status also show that there are a higher number of non-smokers who attend NHS Health Checks (see Figure 7).

Figure 7 Percentage of smokers and non-smokers attending (left) and not attending (right) an NHS Health Check



Chattopadhyay and colleagues also assessed the effect of religion on attendance, with evidence suggesting those of a non-Christian religion were more likely to attend (AOR: 1.54, 95% CI: 1.13-2.1) than Christians.[10] Those with no religious background were less likely to attend (AOR: 0.66, 95% CI: 0.47-0.91).[10] This data comes from one small community-based study. It is therefore difficult to make any inferences about the wider population until further studies are complete assessing religious beliefs and attendance rates.[10]

The GRADE approach was used to assess the strength of evidence addressing the question 'who is and who is not having an NHS Health Check?' for which quantitative data were used. Twenty nine studies were included in the analysis. The overall score was low as most of the studies had an observational design (no RCTs were included) and the studies were not downgraded further for any criteria (See Table 8).

Table 8 GRADE assessment for the evidence contributing to Objective 1

Certainty assessment							Certainty	Importance
№ of studies	**Study design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**		
29	observational studies[a]	not serious[b]	not serious[c]	not serious	not serious[d]	none	⊕⊕◯◯ LOW	IMPORTANT

a. One study had a quasi-experimental design, the others were observational studies of various designs.

b. A significant proportion of the studies were rated low for baseline imbalances between groups and lack of control for confounding, however the purpose of this question was to assess variations in NHS Health Check attendance vs. non-attendance between population sub-groups in relation to social characteristics, therefore imbalances in characteristics between the intervention and control groups were expected and these are likely to reflect reality.

c. Overall the results indicate that older persons and females were most likely to attend an NHS Health Check. The results were less consistent in relation to ethnicity. Results tended to vary according to the sample size and geographic coverage of each study. Studies also varied in relation to setting and the cardiovascular risk profile of participants, therefore inconsistencies were not unexplained.

d. The overall sample size is large.

3.1.3 Key findings and interpretation

Findings from the original review

- There are large variations in the age, gender, ethnicity, deprivation level and cardiovascular risk profile of those attending an NHS Health Check across the different regions of the country.
- Comparison of the variations in coverage are made difficult by the different definitions used with coverage often confused with uptake.
- National and regional studies consistently report higher coverage amongst older individuals, those from deprived areas, those with a family history of coronary heart disease, and non-smokers. Additionally, female coverage is consistently higher, unless high-risk individuals have been explicitly targeted.
- Multivariate analysis suggests that increasing age, higher deprivation, being a non-smoker and the presence of a family history of coronary heart disease are independent predictors of attending an NHS Health Check.
- Coverage amongst different ethnic minority groups varies but is comparable with or higher than white British groups in many of the studies.
- Findings went against suggestions that those receiving an NHS Health Check were predominantly white British with low cardiovascular risk and from areas of low deprivation.
- Data from community studies show how these settings could be used to target particular socio-demographic groups.

Findings informed by the updated review

- Further evidence indicates that females are more likely to access an NHS Health Check. One study, however, using opportunistic methods found an increase in attendance for males. This evidence was from a community setting and supports previous review findings that this setting could be used to target specific socio-demographic groups with low attendance.
- National data indicates that adults aged 60 and over are more likely to receive an NHS Health Check.
- In contrast to the previous review, there was some evidence to suggest that those from the highest level of deprivation were less likely to attend an NHS Health Check.

- Smokers are less likely to attend an NHS Health Check. They are considered a high-risk group and their lack of attendance could affect the rates at which the NHS Health Checks detect disease rates. However, the body of evidence informing this finding is small and further research is needed.

Overview of findings

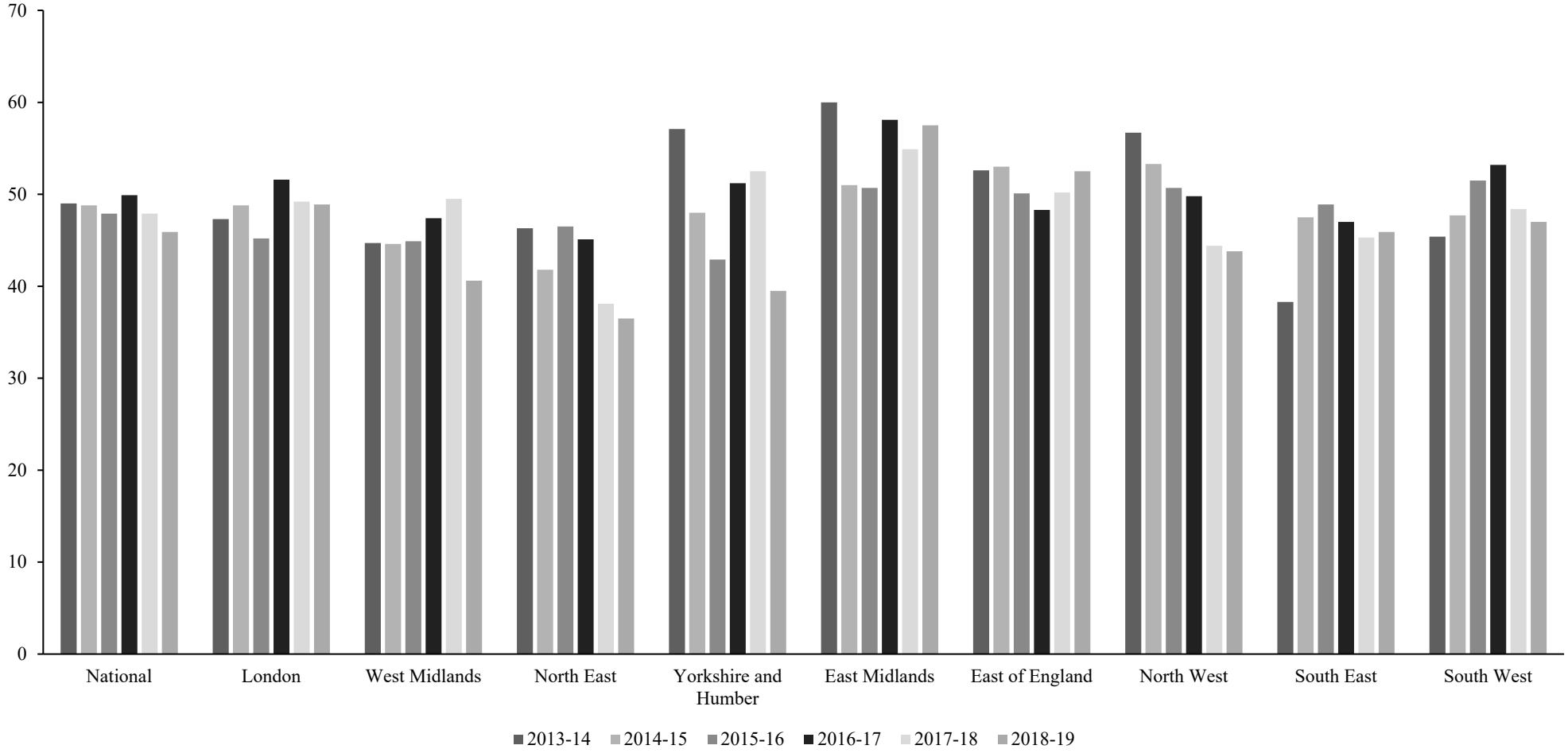
- Twenty-nine studies, six newly identified contributed data to Objective one. Following the GRADE approach, the overall certainty in the evidence was low as most of the studies had an observational design (no RCTs were included). Evidence was not downgraded for any other criteria although inconsistency of findings was highlighted.
- Seven of the 29 studies reported on data from 2014 onwards.
- Most of the newly identified evidence came from assessments of unadjusted characteristics of NHS Health Check attendees vs. non-attendees.
- Poor reporting regarding the variation in implementation remains as does the inconsistency in what is meant when the term coverage and uptake are used.
- In general, females are more likely than males to attend an NHS Health Check. Although community settings may encourage male attendance.
- Older people and non-smokers are more likely to attend an NHS Health Check.
- There is conflicting evidence regarding NHS Health Check attendance by level of deprivation.

3.2 What factors increase take-up among population and sub-groups?

The NHS Health Check has maintained an uptake of between 45-50%. Recent national data published by PHE reports an uptake of 45.9% for 2018/2019. This, however, varies by region (see Figure 8) and constituency. In the North East in 2018/19, for example, uptake varied between 25% (County Durham) and 61% (Stockton-on-Tees). The original economic evaluation utilised an uptake rate of 75%, which is still much higher than the current trend highlighted in Figure 8.[5]

This section aims to highlight potential reasons behind this variation in uptake. Firstly, socio-demographic factors and uptake are discussed. Secondly, the effect of the method of invitation. Third, and finally, the factors relating to the setting in which the NHS Health Check is delivered.

Figure 8 Uptake of NHS Health Checks across England from 2013-2019 (data from PHE: NHS Health Check data)[5]



3.2.1 Socio-demographic factors of uptake

The previous review (Usher-Smith *et al*, 2016) identified 11 quantitative studies that provided data on socio-demographic factors affecting uptake of NHS Health Checks, defined as those who attend an NHS Health Check as a proportion of those who have been invited.[1] The current review includes one further study that reports on socio-demographic factors affecting uptake of NHS Health Checks (McDermott *et al*, 2018[39]; see Table 9). McDermott and colleagues conducted a randomised control trial (RCT) assessing uptake via standard invitation letter or a question-behaviour effect (QBE) questionnaire (with/without financial incentive) followed by the invitation letter. This was assessed in 18 general practices across two boroughs in London.[39]

This study included a high percentage of people from the most deprived quintile (30.4%), but a low percentage of over 60-year olds (13.5%) compared to the majority of the previously reviewed studies.[39] Only Cook *et al* (2016) had a lower percentage of older individuals included, 7.6% of over 65-year olds.[25] Whilst the percentage of males and those from a white ethnic background were similar to those in the studies identified by the previous review.[1] As McDermott *et al* (2018) recruited from two boroughs of London there is potentially a lack of generalisability from their results to other areas of the country.[39] Overall, the newly identified study provides consistent results regarding socio-demographic factors affecting uptake of NHS Health Checks highlighted by the earlier review found (see Table 9).[39] And, whilst there is only one additional study reporting on uptake, it is a large RCT of high quality.[39]

Table 9 Features of studies providing data on socio-demographic factors affecting uptake of NHS Health Checks

Author (date)	Study design Data source	Setting Study time period	Recruitment	Sample size/ Study population[a]	Age	Gender	Ethnicity	IMD (Most deprived)
McDermott *et al* (2018)[39]*	Randomised control trial	18 general practices in two participating boroughs July 2013 to December 2014 (1 year and 5 months)	Invitation to attend NHS Health Check by either standard letter, QBE questionnaires followed by invite, or QBE questionnaire and financial incentive to complete it followed by invite.	12,459 patients (12,052 in final analysis)	>60 = 13.5%	Male = 54.2%	White = 37.1%	5th quintile = 30.4%
Attwood *et al* (2015)[20]	Trial Trial data[b]	4 general practices in the East of England	Invitation to attend NHS Health Check and a physical activity trial	1,380 patients	Mean = 52.4	Male = 49.7%	White = 72.9%	5th quintile = 18.6%
Cochrane *et al* (2013) [23]	Observational Study Electronic practice records	37 (of 57) general practices in Stoke on Trent August 2009 to January 2010 (6 months)	Invitation to attend NHS Health Check	10,483 high risk patients	>55 = 79.6% >65 = 36.4%	Male = 81.3%		
Coffee *et al* (2015) [40]	Observational study Case study data	2 community medical centres in Birmingham (where patients are already accessing mental healthcare) October 2014 to June 2015 (8 months)	Invitation to attend NHS Health Check	188 patients already using secondary mental health services				
Coghill *et al* (2016)[41]	Quasi-experimental Electronic practice records	17 general practices in Bristol	Invitation to attend NHS Health Check (two methods: by letter or by telephone)	5,678 patients				
Cook *et al* (2016)[25]	Observational study Electronic patient records	30 (all) general practices in Luton April 2013 to March 2014 (1 year)	Face-to-face, letter or telephone invitation	50,485 patients	>55 = 30.5% >65 = 7.6%	Male = 53.3%	White British = 32.5%	

Author (date)	Study design Data source	Setting Study time period	Recruitment	Sample size/ Study population[a]	Age	Gender	Ethnicity	IMD (Most deprived)
Dalton *et al* (2011)[26]	Observational study Electronic practice records	29 (of 86) general practices in Ealing, London 2008-2009 (1 year)	Invitation to attend NHS Health Check	5,294 high risk patients	>55 = 80.8% >65 = 40.8%	Male = 80.9%	White British = 21.7%	
Hooper *et al* (2014)[42]	Observational study NHS Health Checks data	40 general practices offering NHS Health Checks in Warwickshire April 2010 to March 2013 (3 years)	Invitation to attend NHS Health Check	37,236 patients				
Krska *et al* (2015)[27]	Observational study Electronic practice records	13 (of 55) general practices in Sefton, North West England Assumed first year of NHS Health Checks since high risk patients	Invitation to attend NHS Health Check	2,892 high risk patients	>65 = 69.4%	Male = 78.3%	White = 99.1%	
Kumar *et al* (2011)[28]	Observational study NHS Health Checks data	2 (of approx. 57) general practices in Stoke on Trent 2008-2010 (assumed 2 years)	Invitation to attend NHS Health Check	1,606 (of whom 661 were high risk patients)	>65 = 31.5%	Male = 56.7%		
NHS Greenwich (2011)[34]	Observational study NHS Health Checks data	5 community based venues in Greenwich, South East London (e.g. Charlton Athletic Football Ground) May 2011 to June 2011 (2 months)	Invitation to attend NHS Health Check PLUS (the national scheme plus people at risk of falls and alcohol dependency)	1,400 patients	>65 = 27.5%	Male = 45.1%		
Sallis *et al* (2016)[43]	Pragmatic quasi-randomised controlled trial	4 general practices in Medway 2013	Invitation to attend NHS Health Check either standard or enhanced letter	3,511 patients	Mean = 53.1/52.8	Male = 46.7/49.1%		

*****and a bold border outside denotes new studies included from the review update

[a]High-risk patients are defined as those with an estimated cardiovascular risk >20% in the next 10 year

[b]The intervention arm of the trial (physical activity) was not relevant to this review. However, data reported on trial non-participants who attended the Health Check were extracted.

The overall uptake in the three trial arms of the RCT reported by McDermott e*t al* was 15.3% across the 18 included general practices in London.[39] The lowest reported uptake in the previous review was 27% over four general practices in the East of England (Attwood *et al*, 2015).[20] Both figures are far lower than the mean uptake of 44.1% reported in the original review.[1] The uptake among older adults (60 and over) was, however, higher than their younger counterparts (20% vs. 15%, respectively), which is similar to previous observations.

The majority of the previous evidence was obtained via observational study designs, whilst McDermott and colleagues implemented a more scientifically rigorous RCT design.[39] The results are, however, only a representation of two boroughs in London and may not necessarily be generalisable to a wider population.[39]

Table 10 Characteristics of people who attended NHS Health Checks compared with those who were invited but did not attend (DNA)

Author (Date)	Setting	Uptake (%)	Age		Gender / Ethnicity		Deprivation (area-level)	
			Attended	DNA	Attended	DNA	Attended	DNA
McDermott *et al* (2018)[39]*	18 general practices in two London boroughs	15.3	>60 = 17.3%	>60 = 12.8%	46.3% male 26.5% white	55.6% male 39% white	% most deprived quintile: 4.6%	30.5%
Attwood *et al* (2015)[20]	4 general practices in East England	27.0	Mean = 56.6	52.0	42.5% male[a] 80.4% white	50.6% male[a] 69.3% white	Median IMD score: 18.3[b]	13.3[b]
Cochrane *et al* (2013)[23]	37 (of 57) general practices in Stoke on Trent	43.7	>55 = 86.7% >65 = 43.1%	>55 = 74.1% >65 = 31.2%	83.6% male	79.4% male	% living in most deprived tertile: 71.7%	74.9%
Coghill *et al* (2016)[44]	17 general practices in Bristol	34.1	Not reported	Not reported	7.2% minority	11.7% minority[c]	Mean IMD score: 43.0	42.3[c]
Cook *et al* (2016) [25]	30 (all) general practices in Luton	43.7	>55 = 35.3% >65 = :11.8%[d]	>55 = 25.8% >65 = 4.4%[d]	46.8% male 44.3% white British[e]	58.3% male 23.4% white British[e]	Not reported[f]	
Dalton *et al* (2011)[26]	29 (of 86) general practices in Ealing, London	44.8	>55 = 82.4% >65 = 41.6%	>55 = 80.0% >65 = 40.2%	80.5% male 19.9% white British	81.2% male 23.1% white British	% living in most deprived tertile: 36.7%	36.4%
Krska *et al* (2015) [38]	13 (of 55) general practices in Sefton, North West England	52.9	>65 = 74.1%	>65 = 56.6%	80.9% male 99.1% white	80.1% male 99.0% white	% living in most deprived quintile: 9.7%	10.0%
Kumar *et al* (2011)[28]	2 (of approx. 57) general practices in Stoke on Trent	30.9	>60 = 40.6%	>60 = 27.4%	56.9% male	56.5% male	Not reported	
NHS Greenwich (2011)[34]	5 community venues in Greenwich	45.9	>65 = 25.1%	>65 = 29.6%	46.6% male	43.9% male	% most deprived quintile: 19.5%	16.0%

*and a bold outside border denotes new studies included from the review update

[a] In univariate logistic regression analyses, female gender was statistically significant: 1.50 (1.16 to 1.95)

[b] In univariate logistic regression analyses, the most deprived quintile was associated with increased likelihood of attendance: 2.90 (1.84 to 4.58)

[c] All patients invited, including those who attended

[d] In univariate analysis ages 60-64, 65-69 and 70-74 had significantly higher uptake

[e] In univariate analysis White British, White Irish, Indian, Bangladeshi, Caribbean, and Chinese all had significantly higher uptake and African had significantly lower uptake

[f] In univariate analysis, the least deprived quintile had significantly higher uptake and the most deprived quintile significantly lower uptake

McDermott and colleagues (2018) presented adjusted odds ratios (AOR) for 18 general practices in two London boroughs, adjusted for trial arm, gender, age group, ethnicity, and IMD quintile.[39] They found that males were less likely to attend than females; AOR: 0.74, 95% confidence interval (CI): 0.69 to 0.80, p <0.001.[39] While those who were 60 or older were more likely to attend than younger than 60 years old patients; AOR: 1.43, 95% CI: 1.20 to 1.71, p <0.001.[39] When considering ethnic background those of an African/Caribbean, Asian or Mixed background were more likely to attend than those of a white ethnic background (AOR: 2.15, 95% CI: 1.86 to 2.49, p <0.001; AOR: 2.03, 95% CI: 1.63 to 2.67, p <0.001; AOR: 3.09, 95% CI: 2.07 to 4.62, p <0.001, respectively).[39] Concerning deprivation, those from the second least deprived quintile more likely to attend than those from the most deprived; AOR: 2.78, 95% CI: 1.87 to 4.12, p <0.001).[39] Whilst there was no significant difference between the most deprived (fifth quintile), fourth and third quintiles (all $p > 0.1$).[39]

The previous review identified two studies reporting that males were less likely to attend (Coghill *et al*, 2016; Sallis *et al*, 2016) than females.[41 43] While Dalton and colleagues (2011) reported this was only the case for those aged below 54 years, with those above 54 years old showed no statistically significant differences.[26] Cochrane *et al* (2013) observed a statistically significant reduction in uptake for females.[23] Overall, the newly identified study supports the literature stating that males are less likely to partake in an NHS Health Check than females.

When considering deprivation level, previous studies identified that those from the least deprived economic status were most likely to attend (Attwood *et al*, 2015; Cochrane *et al*, 2013; Coghill *et al*, 2016; Sallis *et al*, 2016).[20 23 41 43] The findings from McDermott and colleagues support this finding.

Minimal data is available regarding ethnic background. With the consideration that the new study by McDermott *et al* only considered two boroughs in London, it is unlikely that these findings provide any further clarity on ethnic background and uptake. This is especially true given that the study area encapsulates many people from a non-white ethnic background (see Table 10).[39] .

Twelve quantitative studies were included in the GRADE assessment of the identification of demographic factors for NHS Health Check uptake. Only one study was an RCT therefore the body of evidence was regarded as being observational and therefore downgraded to ‘low’. This body of evidence was not downgraded for any other criteria (Table 11).

Table 11 GRADE assessment for the evidence contributing to Sub-objective 2.1

Certainty assessment							Certainty	Importance
№ of studies	**Study design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**		
12[20 23 25-28 34 39-43]	observational studies[a]	not serious[b]	not serious[c]	not serious	not serious[d]	none	⊕⊕◯◯ LOW	IMPORTANT[d]

a. One study was a randomised controlled trial, one study had a quasi-randomised design; the remaining studies were non-randomised studies, mainly experimental.

b. Six (50%) of the studies received a 'low' rating for domains relevant to the risk of bias, however four of these the issues were in relation to baseline imbalances and confounding, however the purpose of this research objective is to identify sociodemographic differences between attendees and non-attendees. Only two of twelve studies received a low rating for domains relevant to the risk of bias (exposure and outcome measurement and blinding). However, in the context of the NHS Health Checks programme, where the intervention is obvious and data are routinely collected and subject to inaccuracies, these issues don't necessarily indicate poor quality research methods were used.

c. Generally, older people, females and individuals from least deprived background were most likely to attend NHS Health Checks. The results in relation to ethnic group were mixed. Variations in results across studies are likely to reflect heterogeneity between studies, including different methods and geographical coverage.

d. The sample size overall, across the included studies, was large.

e. Total number of NHS check attendees, from studies in which these data were reported.

3.2.2 Invitation methods

3.2.2.a Quantitative studies

In addition to the seven quantitative studies in the previous review, a further six studies have been identified reporting the impact of differing methods for inviting patients to an NHS Health Check (Cornelius *et al*, 2018; Gidlow *et al*, 2019; Gold *et al*, 2019; Gulliford *et al*, 2017; McDermott *et al*, 2018; Sallis *et al*, 2019).[39 45-49] Five of these studies are RCTs, and one was a cohort study. Further details can be found in Table 12.

Two of the newly identified studies examined the effect of behavioural modifications to the invitation (Cornelius *et al*, 2018; McDermott *et al*, 2018 [39 45]). They both attempted this by implementing the QBE, which was also used by one of the previously reported studies (McDermott *et al*, 2017)[50]. Both newly identified studies appear to use the same dataset, comparing the QBE alone or with financial incentive (£5) against the standard invitation method (letter).[39 45] They both report uptakes of 14.4% for the control condition, 15.8% for the QBE alone, and 15.9% for the QBE and incentive group.[39 45] McDermott and colleagues also report that uptake was higher (within the first six months of randomisation) in those who returned, compared to those who did not return, the QBE questionnaire (QBE = 32.5 vs. 10.8%; QBE and Incentive = 32.8 vs. 10.4%).[39] A complier-average causal effect analysis estimated the difference in Health Check uptake to be greater for QBE arm compared to a standard invitation (6%, 95% CI: 0.8 to 11.3%, $p = 0.024$).[39 45] The QBE and incentive arm was also greater compared to the standard invite in this analysis (5.9%, 95% CI: 0.8 to 10.9%, $p = 0.022$).[39 45] The most likely construct associated with the increase of uptake was the "intentions" construct (AOR: 1.37, 95% CI: 1.27 to 1.48, $p < 0.001$; adjusted for each construct and clustering by general practice; Cornelius *et al*, 2018).[39 45] There were no statistically significant changes in risk difference for the QBE vs. standard invitation (1.43%, 95% CI: -0.12 to 2.97%, $p = 0.07$) or the QBE and incentive vs. standard invitation (1.52%, 95% CI: -0.03 to 3.07%, $p = 0.054$).[39 45] This range is comparatively lower compared to previous research, estimating 3-4% change in uptake (Sallis *et al*, 2016).[43]

Four studies compared different invitational methods on the effect of uptake (Gidlow *et al*, 2019; Gold *et al*, 2019; Gulliford *et al*, 2017; Sallis *et al*, 2019).[46-49] Three of these studies were RCTs (Gidlow *et al*, 2019; Gold *et al*, 2019; Sallis *et al*, 2019).[46 47 49] All three used the standard invitational letter as their control condition. Comparing different letters (Gidlow *et al*, 2019; Sallis *et al*, 2019) or leaflets (Gold *et al*, 2019), to their respective control conditions.[46 47 49]

Table 12 Features of studies providing data on the impact of different methods of inviting individuals on take-up

Author (Date)	Study Design Data Source	Setting Study time period	Sample size	Age	Gender	Ethnicity	IMD
Cornelius *et al* (2018)[45]*	Three arm randomised control trial	18 general practices in two London boroughs: Lambeth and Lewisham Each practice participated for a minimum of 12 months	12,459 Intervention = 7,957 Control = 4,095				
Gidlow *et al* (2019)[46]*	Three arm randomised control trial	9 general practices in Staffordshire 12 months	4,614	Mean = 50.2	Male = 47.6%	White British = 93.9%	
Gold *et al* (2019)[47]*	Three arm randomised control trial	38 general practices in Lewisham and North East Lincolnshire Within 6 months of receiving invitation, before November 2018	11,038				
Gulliford (2018)[48]*	Cohort	18 general practices in two London boroughs July 2013 to June 2015 (2 years)	6,184 (1,074 of whom were high risk patients)	>60 = 12.5%	Male = 40.1%	White = 21.6%	5th quintile = 27.9%
McDermott (2018)[39]*	Randomised control trial	18 general practices in two participating boroughs July 2013 to December 2014 (1 year and 5 months)	12,459 patients (12,052 in final analysis)	>60 = 13.5%	Male = 54.2%	White = 37.1%	5th quintile = 30.4%
Sallis (2019)[49]*	Double blind randomised control	28 general practices in the London	12,244				

Author (Date)	Study Design Data Source	Setting Study time period	Sample size	Age	Gender	Ethnicity	IMD
	trial with a mixed 2x4x2 factorial design	Borough of Southwark 1st Nov 2013 to 31st Dec 2014 (1 year)					
McDermott *et al* (2016)[50]	Three-arm randomised trial and cohort study	18 general practices in Lambeth and Lewisham 2013-2015 (2 years)	12,459	Median = 45 (IQR = 40-54)		White = 39%	
Alpsten *et al* (2015)[51]	Trial	28 general practices in Southwark 2013-2014 (1 year)	13,800				
Sallis *et al* (2016)[43]	Pragmatic quasi-randomised controlled trial	4 general practices in Medway 2013	3,511 patients Intervention = 1,756 Control = 1,755	Control/Intervention Mean = 53.1/52.8	Control/Intervention Male = 46.7%/49.1%		
Kumar *et al* (2011)[28]	Observational study Quality improvement report	2 general practices in Stoke-on-Trent 2008-2010 (2 years)	1,606 patients	40-49 = 40% 50-59 = 28% 60-75 = 32%	Male = 57%		
Coghill *et al* (2016)[44]	Quasi-experimental study Electronic practice records	17 general practices in Bristol in the lowest LSOAs	5,678 Intervention = 2,399 Control = 3,279				
Cook *et al* (2016)[25]	Observational study Electronic practice records	30 (all) general practices in Luton 2013-2014 (1 year)	12,048 (sample size by intervention method not stated)	>55 = 30.5% >65 = 7.6%	Male = 53.3%	White British = 32.5%	
Stoke on-Trent Local Government	Pre and post study	1 general practice in Stoke-on-Trent					

Author (Date)	Study Design Data Source	Setting Study time period	Sample size	Age	Gender	Ethnicity	IMD
Association (2015)[52]							

*and a bold outside border denotes new studies included from the review update

Gidlow and colleagues (2019) also had a telephone invitation arm, while Sallis (2019) included a yes/no SMS pre and post letter invitations.[49 53] Gold and colleagues (2019) implemented two new leaflet styles (loss-framed: 'don't miss out'; gain-framed: 'make the most of life'), which were shorter than the standard leaflet (two pages, instead of four).[47] Uptake was similar across all conditions, with no statistically meaningful differences observed: 17.6% for the standard leaflet, 17.4% for the loss-framed leaflet, and 18.2% for the gain-framed leaflet.[47] However, the usage of pre and post SMS reminders increases uptake, compared to a control letter without SMS (uptake 18%; Gold *et al*, 2019).[47] The largest uptake was observed in the time-limited letter, with pre and post reminder SMS (30% uptake).[47] Both the open-ended and time-limited letters, with a post reminder SMS increased uptake to 28% and 27%, respectively.[47] These findings are in conjunction with a study reported in the previous review observing a positive effect of pre and post invite SMS (Alpsten *et al*, 2015).[51]

In the study by Gidlow and colleagues (2019), they showed that telephone invitations had greater uptake (47.6%).[53] This was compared to the standard letter (30.9%, p <0.001) and a personalised CVD risk letter, although the latter uptake difference was not statistically significant (31.3%, p = 0.812).[53] These results are in agreement with a study by Cook and colleagues (2016) reported in the original review, which identified uptake rates were increased through telephone invitations, although they also observed that face-to-face invites were more successful overall.[25] Gidlow *et al* (2019) also provide a cost analysis, which suggests for every 1000 patients invited using personalised letters (compared to standard letters), 40 extra NHS Health Checks would be expected at no extra cost. Whilst for every 1000 patients invited by telephone (compared to standard letters) an additional 180 NHS Health Checks could be expected at an extra cost of £240 (£0.24/patient).[53] There is clear evidence building for successful usage of telephone invitations.

The remaining cohort study (Gulliford *et al*, 2017) assessed uptake rates between the standard invitational letter and opportunistic invites NHS Health Checks across 18 general practices in two London boroughs.[48] This study was not concerned directly with the differences in uptake between the conditions, but specifically the uptake of those who identified at greater CVD risk (i.e. risk score ≥ 10%).[48] They observed uptake was greater in an opportunistic setting for those at high risk, compared to standard invite methods (22.2 vs. 15.3%, respectively).[48] Furthermore, those from the most deprived quintile were associated with higher CVD risk in opportunistic NHS Health Checks, compared to invitational NHS Health Checks (22.4 vs. 15.3%).[48] These results highlight that those who are at greater CVD risk may be better targeted

with opportunistic NHS Health Checks (see Table 13).

Table 13 Results of studies assessing different methods of invitation

Author (Date)	Setting	Intervention group(s)	Comparison group	Outcome/ Unadjusted analysis	Subgroup or supplementary analysis	Adjusted analysis
Cornelius *et al* (2018)[45]*	18 general practices in two London boroughs: Lambeth and Lewisham	1) QBE questionnaire with standard invitation 2) QBE questionnaire plus £5 incentive voucher plus standard invitation letter	Standard invitation	Control: 14.4% uptake 1) 15.8% uptake 2) 15.9% uptake	Uptake reported for automated vs. in-practice recruitment showed no significant differences	
Gidlow *et al* (2019)[53]*	9 general practices in Staffordshire	1) Telephone invitation 2) Personalised invitational letter with patients CVD risk	Standard invitation	Control: 30.9% uptake 1) 47.6% uptake 2) 31.3% uptake	Telephone invites statistically increased uptake compared to standard invitation, but not personalised invites.	Higher likelihood of attending with increasing age ($p < 0.01$). Females more likely to attend then males ($p < 0.01$). Least deprived areas more likely to attend ($p< 0.05$). Reduced likelihood of attending as CVD risk increased ($p < 0.01$).
Gold *et al* (2019) [47]*	38 general practices in Lewisham and North East Lincolnshire 2018	1) Loss-framed leaflet (2-sided) 2) Gain-framed leaflet (2-sided)	Standard leaflet (4-sided)	Control: 17.6% uptake 1) 17.4% uptake 2) 18.2% uptake	Bayes factor analysis indicated it was 416 times more likely that the null hypothesis was true (i.e. the leaflets do not affect uptake).	Lower uptake in males compared to females (14.7% vs. 20.6%, $p < 0.001$). Higher uptake associated with increasing age ($p < 0.001$).
Gulliford *et al* (2017)[48]*	18 general practices in two London boroughs Jul 2013 - 2015	Opportunistic	Standard invitation	CVD risk % Control: 15.3% uptake Intervention: 22.2% uptake	Opportunistic checks more frequent in those over 60 years old (59%) than those under (53%).	Elevated CVD risk for opportunistic checks (AOR: 1.7, 95% CI: 145-1.99).

Author (Date)	Setting	Intervention group(s)	Comparison group	Outcome/ Unadjusted analysis	Subgroup or supplementary analysis	Adjusted analysis
					Opportunistic checks more frequent in 5th IMD (60%) than third (55%) or second (12%).	
McDermott *et al* (2018)[39]*	18 general practices in two participating London boroughs Jul 2013- Dec 2014	1) QBE questionnaire with standard invitation 2) QBE questionnaire plus £5 incentive voucher plus standard invitation letter	Standard invitation	Control: 14.1% uptake 1) 15.8% 2) 15.85%	Difference for QBE vs. control was 1.43% (95% CI: -0.12 to 2.97%, $p = 0.07$) Difference for QBE + incentive vs. control was 1.52% (-0.03 to 3.07%, $p = 0.054$)	QBE slightly increased uptake (AOR: 1.13, 95% CI: 1-1.27, $p = 0.04$) QBE + incentive slightly increased uptake (AOR: 1.13, 95% CI: 1.02-1.26, $p = 0.02$) Males had lower uptake (AOR: 0.74, 95% CI: 0.69-0.8) Those >60 years old more likely to take up (AOR: 1.43, 95% CI: 1.2-1.71) Non-white ethnicity more likely to take up (AOR range: 1.28 to 3.09) 2nd IMD most likely to uptake compared to the 5th (AOR: 2.78, 95% CI: 1.87-4.12)
Sallis *et al* (2019)[49]*	28 general practices in the London Borough of Southwark	Four letter types: 1) Standard invite 2) Open-ended invite 3) Time-limited invite	Standard invitation with no SMS	Almost all letter and SMS combinations increased uptake compared to control		Time-limited letter with pre and post SMS had the largest uptake

Author (Date)	Setting	Intervention group(s)	Comparison group	Outcome/ Unadjusted analysis	Subgroup or supplementary analysis	Adjusted analysis
	Nov 2013- Dec 2014	4) Social norms invite SMS: 1) Pre-invitation; yes or no 2) Post-invitation; yes or no		(18% uptake), with increases of up 12%		(AOR: 1.86, 95% CI: 1.31-2.17).
McDermott *et al* (2017)[50]	18 general practices in Lambeth and Lewisham	1) QBE questionnaire plus standard invitation letter 2) QBE questionnaire plus £5 incentive voucher plus standard invitation letter	Standard national invitation letter	Control uptake: 14.4% 1) 15.8% uptake 2) 15.9% uptake	Consistent across subgroups of gender, ethnicity and deprivation quintile, but weak evidence of a gender effect in men than women	
Alpsten *et al* (2015)[51]	28 general practices in Southwark	1) Invitation letter including a deadline commitment 2) Invitation letter including a deadline commitment plus primer and reminder SMS 3) Invitation letter including deadline commitment plus reminder text message only	Standard national invitation letter	Control uptake: 18% 1) 21% uptake 2) 30% uptake 3) 27% uptake	None presented Follow up visits to General Practices post outreach Health Check	
Sallis *et al* (2016)[43]	4 general practices in Medway	Letter modified in four ways using behavioural insights: 1) Simplification 2) Prominence of action statement to book an appointment 3) Statement 'you are due to attend your Health Check' as opposed to 'invited' 4) Inclusion of a tear-off slip with space to record details of appointment with instructions to stick it to their fridge	Standard national invitation letter	Control uptake: 29.3% Intervention uptake: 33.5%	The intervention was more effective in some practices (interaction OR for practice 1.76 (95% CI: 1.18-2.64)	AOR: 1.26 (95% CI: 1.09-1.47)
Kumar *et al* (2011)[28]	2 general practices in Stoke-on-Trent	Drop-in clinics or booked appointment	Booked appointments alone	Offering drop-in clinics or booked appoints more cost-effective		
Coghill *et al* (2016)[44]	17 general practices in Bristol in the lowest LSOAs	Telephone invitation from community link worker	Invitational letter	Control uptake: 34% Intervention uptake: 24%	Letters sent within 2 weeks of telephone invite reinforced the intervention (OR: 3.26). Letters	Intervention practices had more attenders from ethnic minorities

Author (Date)	Setting	Intervention group(s)	Comparison group	Outcome/ Unadjusted analysis	Subgroup or supplementary analysis	Adjusted analysis
					sent 9 months before phone call decreased uptake (OR: 0.57)	and from more deprived areas compared with control practices
Cook *et al* (2016)[25]	30 (all) general practices in Luton 2013-2014 (1 year)	1) Face-to-face invitation 2) Telephone invitation from General Practitioner	Invitational letter	Control uptake: 29.5% 1) 71.9% uptake 2) 43% uptake	Variation by age and ethnicity	
Stoke on Trent Local Government Association (2015)[52]	1 general practice in Stoke-on-Trent	Standard invitation letter with pre-booked appointment time	Standard invitation letter	Control (before): 52% Intervention (after): increased "substantially"		Of note; did not attend rate was high

*and a bold border outside denotes new studies included from the review update

Twelve studies investigated the effects of variations in invitation method on NHS Health Check uptake. The overall body of evidence was rated as 'very low', as >50% of studies were not RCTs and were therefore classified as being observational, and the same proportion scored low for one or more domain which could introduce bias into the study results (see Table 14).

Table 14 GRADE assessment for the evidence contributing to Sub-objective 2.2

Certainty assessment: Are variations to the invitation method compared to national standard invitation letter associated with increased NHS Health Check attendance?							Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations		
12[25 28 39 43-45 47-53]	observational studies[a]	serious[b]	not serious[c]	not serious	not serious[d]	None	⊕◯◯◯ VERY LOW	

a. 6 RCTs; N=2 quasi-randomised trials; the remaining studies used observational designs.

b. Most (>50%) of studies scored low for one or more domain that could introduce bias into the study results.

c. The standard national invitation letter was generally associated with reduced uptake compared to variations. The variations differed between studies, therefore differences in relative uptake between groups in each study are expected.

d. The sample size was large (in the thousands) across studies.

3.2.2.b Qualitative Studies: Healthcare Workers Experiences of Telephone Invitation Method

Experiences of the invitation process

The previous review contained five qualitative studies looking at the experience of invitation method (see Table 15). It identified that NHS Health Check attendees when asked directly, expressed a preference for telephone or in person invitations rather than being contacted by post or e-mail. These methods were perceived to be the most 'immediate and direct' means of contact and allowed invited attendees to immediately ask questions about the programme. Alongside these data, a single observational study at risk of confounding found that telephone invitations may improve uptake.[34]

Stone *et al* 2019[54] is the only new study identified contributing qualitative data to research Objective 2. This was a local study conducted with 10 primary care providers in Bristol that were using telephone outreach to invite and facilitate NHS Health Checks in deprived and non-white British communities. Data were collected in semi-structured interviews with those implementing the invite process, telephone outreach workers (TOW) and primary care practitioners (PCP). The implementers were from divergent ethnic backgrounds and the majority were from low socio-economic positions.

Table 15 Qualitative studies including participants' views on the method of invitation to NHS Health Checks

Author/ year	Type of report	Study period	Location of study	Setting of NHS Health Check	Data collection method	*n*	Method of recruitment to study	Participant characteristics
Stone *et al* 2019[54]*	Journal article	2019	Bristol	10 general Practices	Semi-structured face-to-face interviews	10	Invite to attendees of an intervention training meeting	15 females, 13 males Somali (3), South Asian (3), Black British (2), White British (2); IMD: 1st most deprived decile (4), 2nd (3), one each from 3rd, 4th and 5th deciles
Greenwich *et al* 2011[34]	Evaluation report	2011	Greenwich	Community	Open ended questionnaire, focus groups and in-depth phone interviews	612 survey responses 4 focus groups and 31 interviews	Recruited from community outreach services providing NHS Health Checks	Ethnic minority participants: 42% female
Ismail *et al* 2015[55]	Journal article	Not given	Not specified	general practices	Semi-structured interviews	45 baseline 38 follow-up	Purposive sampling from a list provided by 5 participating general practices	21 female, 24 male. Average age: 58. Ethnicity: 37 White, 5 South Asian and 3 African Caribbean
Perry *et al* 2014[56]	Journal article	2010	Knowsley	Community	Interviews and focus groups	36	Letter or telephone invitation to all 38 people who were at high risk of CVD and had attended an NHS Health Check in the past 12-18 months were invited. The remaining attendees at low risk of CVD were purposively sampled for gender, age and risk score.	3 focus groups: 1 for high risk scores [6 males], 2 for low risk scores (17 females and 7 males) 6 semi-structured interviews (2 females and 4 males with high risk score)
Riley *et al* 2015[57]	Journal article	2013	Bristol inner-city	Community	Semi-structured interviews	16	Participants were recruited via their attendance of community outreach events.	7 females, 9 males All from black and minority ethnic populations

Author/ year	Type of report	Study period	Location of study	Setting of NHS Health Check	Data collection method	*n*	Method of recruitment to study	Participant characteristics
Strutt *et al* 2011[58]	Masters thesis	2010	Darlington, Co. Durham, UK	Two general practices	Semi-structured face-to-face interviews	16	Invitation letters or telephone	7 females, 9 males White, South-Asian, and Middle Eastern

*and a bold border outside denotes new studies included from the review update

The study by Stone *et al* found that amongst the implementers of telephone invitations TOW were more positive than PCP staff and had a clearer overview of the purpose of NHS Health Checks in general as well as the motivation for using a telephone outreach approach to engaging at risk patients from deprived areas. However, PCP staff noted that allocating staff time to NHS Health Checks telephone invitation outreach led to loss of other appointment capacity and expressed doubt about the benefit. TOW felt the questions they asked were repeated by clinical staff in appointments and that they (TOWs) were the least skilled in sensitive health conversations. They also identified that there was poor adaptation of the telephone outreach method and NHS Health Check for those targeted, until they as ambassadors highlighted divergent need.

> Q1 *"First they were giving us very early appointments, early mornings, which were not suitable for Bangladeshis because, most of them work in the evening, late nights, so they want later appointments, so we questioned that and that was made available"* [54]
>
> Q2 *"The alcohol one, alcohol question as a nation who are Muslim who I am dealing with, they are not going to admit even if they are…they are not going to tell me, so that's only the hardest part"* [54]

The inability to give invite recipients a direct point of contact, was seen as a barrier to resolving difficulties diminishing the value and immediacy of telephone contact.

The intervention was still seen as an effective way to signpost primary prevention services. This study mapped on to the following theme identified within the original review: 'Benefit of community ambassadors', particularly for ethnic minority groups, and 'Preference for telephone contact'.

The body of qualitative evidence identifying how invitation method effects uptake lacks in adequacy. In particular the richness, amount and depth of data on conceptual detail, of included evidence is low. As is the thickness of the data precluding further contextual interpretation. Studies are completed within a limited range of settings and with homogenous participant groups hindering data sufficiency and the ability to allow for dimensional comparisons.

Table 16 GRADE-CERQual confidence in the evidence contributing to Sub-objective 2.2

Finding	Studies contributing to findings (see report reference list)	Methodological limitations	Coherence	Adequacy	Relevance	CERQual assessment of confidence in the evidence	Explanation of CERQUAL assessment
Differing views on opportunistic recruitment depending on setting	Greenwich *et al* (2011) [34] Ismail *et al* (2015)[55] Perry *et al* (2014)[56] Riley *et al* (2015)[57]	Most papers were highly rated in terms of quality, with only one being rated overall as medium quality[34]. Two papers scored low in ethical issues[34 57] and one in rigour [34]	There were no or few concerns identified in any of the papers as they all presented similar data to the findings presented in the review.	Three papers had minor concerns due to not presenting a rich picture of the data gathered.[34 55 56] The other had no or few minor concerns.[54 57]	One of the papers had moderate concerns as the quote presented in the review was not clearly linked to the theme and the paper did not otherwise refer to this theme.[55]	Moderate confidence	Reduced grade due to moderate concern and minor concerns around ethical issues and richness of data
Benefit of community ambassadors, particularly for ethnic minority groups	Riley *et al* (2015)[57] Stone *et al* (2019)[54]*	One paper was medium[54] and one high rated, both scored lower in their description of the relationship between researcher and participants.	There were no or few concerns identified in either paper in this domain.	None or few minor concerns	None or few minor concerns in either paper	High confidence	No reason to downgrade
Preference for telephone contact	Stone *et al* (2019)[54]* Strutt *et al* (2011)[58] Greenwich *et al* (2011)[34]	Greenwich and Stone medium quality overall[34 54], Strutt high quality overall[58]	No coherence concerns	Moderate concern due to richness of data gathered[58]	No concerns	Moderate confidence	Reduced grade due to concerns on richness of data

3.2.3 Setting

Two quantitative studies (Roberts *et al*, 2016[29]; Whittaker *et al*, 2019[67]: see Table 17 for details) evaluated uptake in a general practice setting compared to an alternative (outreach service; Roberts *et al*, 2016 or community pharmacy; Whittaker *et al*, 2019).[29 67] Roberts and colleagues specifically targeted uptake in hard-to-reach groups, using opportunistic methods in either a general practice or outreach service.[29] Outreach services included 23 different types of venues, ranging from places of worship to leisure facilities, with each contributing approximately 4% of the total outreach NHS Health Checks.[29] Approximately three times the amount of checks were completed in general practices, compared to outreach services.[29] Those who were from the most deprived background were more likely to attend an outreach service than a general practice (30 vs. 13%, respectively).[29] Additionally, those of a south Asian ethnicity showed a higher uptake in outreach services, compared to general practices (11 vs. 3%).[29 67] In contrast, males had an increased uptake at general practices than outreach services (50 vs. 38%), this is similar to the findings of Whittaker (2019), who observed more females attending the community pharmacy than males for a Health Check (60% of attendees were female).[67] Overall, there were a higher number of checks at general practices, compared to outreach services (n = 12,190 vs. 3,849). [29 67] Outreach services may increase uptake of NHS Health Checks in two hard-to-reach groups: south Asians and people from deprived areas.[29 67] In contrast, Whittaker (2019) found minimal difference in uptake of NHS Health Checks after invitation, with similar numbers attending a general practice or a community pharmacy (264 (20.9%) vs. 234 (23.4%), respectively).[67] Given the differences in methods of invitation (opportunistic vs. letter invite), it could be that patients feel more engaged during opportunistic checks than invitational.[29 67] This would make them more likely to attend. Additionally, opportunistic NHS Health Checks could be important for attracting hard-to-reach groups.[29 67]

There were no further qualitative studies identified reporting the influence of setting on uptake. Six studies in the original review[1] generated the following findings: the convenience of community settings and the sense of duty to attend general practitioner appointments. The quantitative evidence adds further support to the themes identified.

Table 17 Features of studies providing data on the impact of different settings on take-up

Author (Date)	Study Design Data Source	Setting Study time period	Sample size	Age	Gender	Ethnicity	IMD
Roberts *et al* (2016)[29]*	Retrospective cohort evaluation Electronic records	Opportunistic checks in Buckinghamshire 1st Nov 2013 to 20th Sept 2014 (1 year)	16,039 (recorded NHS Health Check) Outreach services = 3,849 General practices = 12,190	Outreach services only Mean = 54	Outreach services only Male = 38%	Outreach services only White = 78%	Outreach services only 5th quintile = 30%
Whittaker *et al* (2019)[67]*	Retrospective with control group Electronic records	1 local authority area in the North West of England 1st April 2015 to 1st March 2016 (1 year)					

*and a bold border outside denotes new studies included from the review update

Two quantitative studies assessed whether the setting of the NHS Health Checks (community or pharmacy vs. general practice) influenced uptake. The evidence was initially rated as low due to the observational nature of these studies. The evidence was further downgraded based on 'risk of bias' due to imbalances in baseline characteristics between groups and confounding (see Table 18).

Table 18 GRADE assessment for the evidence contributing to Sub-objective 2.3

Certainty assessment							Certainty
№ of studies	**Study design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	
2 [29 67]	observational studies	serious [a]	not serious [b]	not serious	not serious [c]	none	⨁◯◯◯ VERY LOW

a. Both studies scored low for imbalances in baseline characteristics between groups and confounding.

b. One study reported higher uptake in general practices whereas the other reported similar attendance between settings. This variation is likely to reflect heterogeneity between studies in relation to the population, mode of invitation and the type of non-general practice setting in which the NHS Health Checks were performed.

c. Overall sample size across the two studies was large (in the thousands)

3.2.4 Key findings and interpretation

Findings from the original review

- There is a lack of national-level data reporting the characteristics of those who take-up the invitation to an NHS Health Check and those who do not.
- Regional studies report uptake between 27% and 53% (mean = 44.1%) in different general practice settings.
- There is consistent evidence that older people are more likely to take-up an invitation for an NHS Health Check than younger people. Additionally, some evidence suggests uptake in less deprived areas is higher.
- Data suggests that younger females have greater odds in taking up an invitation compared to younger males. While older males are more likely to take up an invitation than younger males. Further research is needed to substantiate these findings.
- One study showed a variation in take-up across different ethnic groups, but that study had large amounts of missing data and was based in an area which has a large number of general practitioners of south Asian origin. Findings are unlikely to be generalisable.
- Simple modifications to the invitation letter based on behavioural insights were associated with a 3-4% increase in uptake. This is a small increase but would be easily implemented and could lead to an increase in over 100,000 people receiving NHS Health Checks nationwide.
- Text message invites or reminders may improve uptake by up to 9%, however, this finding was only based on single trial, which was not fully reported and is at risk of bias.
- Telephones invitations may improve uptake, but again the finding was based on one observational study.
- Face-to-face invitations in general practices increased uptake compared to written invitation (71.9% vs. 29.5%). It is likely these were done opportunistically, and this type of invitational method should be encouraged.
- Data was sparse from community settings on NHS Health Check uptake.
- Endorsement of the NHS Health Checks by a community ambassador or engagement worker appears to be important for ethnic minority groups.

- Qualitative studies suggest that community settings are more convenient than general practices.
- Moving NHS Health Checks out of general practices may lose the 'sense of duty' to attend described by participants.

Findings informed by the updated review

- Only one newly identified study reports the characteristics of those who uptake invite to an NHS Health Check and those who do not. This study confirms previous trends that males are less likely to attend, as well as those under 60 years old.
- The previous review suggested community settings may improve uptake, however, recent evidence indicates community pharmacies would have a similar uptake to general practices.
- Recent evidence supports the notion that opportunistic invites improve uptake regardless of setting. This evidence is based on two separate cohort studies completed in North West England and Buckinghamshire. Further work should be completed to assess the viability and cost-effectiveness of opportunistic invitation across differing settings.
- A higher number of those at increased CVD risk and from hard-to-reach groups were more likely to take-up a Health Check if it was opportunistic. However, informing data was only collected in London and may not be generalisable to other geographic settings.
- Further evidence shows that sending text messages pre- and post-invitational letters can increase uptake particularly if the letter is time limited. This evidence is now supported by two high quality RCTs.
- Further evidence of telephone invites increasing uptake has been identified, including a high-quality RCT. The cost analysis suggested this would provide an additional 180 NHS Health Checks per 1,000 patients, at an extra cost of £240 (£0.24/patient). Evidence from the same study indicates that a personalised letter containing CVD risk information would also increase uptake (extra 40 NHS Health Checks per 1,000 patients) with no extra costs incurred.
- The original review suggested behavioural modifications to the NHS Health Check invitation could increase uptake by 3-4%, however, recent evidence suggests

behavioural modifications may only increase uptake by 1.4%.

- Those implementing telephone invites felt that on the whole they were effective. However, the following barriers to telephone invite were identified 'Limited clinician time', 'Under-trained telephone outreach workers' and 'Ill adapted processes for those being targeted'.
- Telephone Outreach Workers and Primary Care Practitioners were able to act as community ambassadors for the health check promoting uptake amongst those of non-white British ethnicity.
- Setting acted as a barrier to outreach workers; the inability to offer reverse contact hindered phone contact.

Overview of findings

- Twelve quantitative studies, one newly identified, were included in the GRADE assessment pertaining to the identification of demographic factors for NHS Health Check uptake. Only one identified study was an RCT so the body of evidence was regarded as being observational and downgraded to 'low'. However, this body of evidence was not downgraded for any other criteria.
- Twelve studies investigated the effects of variations in invitation method on NHS Health Check uptake. The overall body of evidence was rated as 'very low', as >50% of studies were observational, and the same proportion scored low for one or more domain which could introduce bias into the study results.
- The findings on invitation method coming from the qualitative studies are supported with moderate to high confidence, however, across all findings the data lacked adequacy and richness.
- Evidence from both the PHE online material and published articles suggest that uptake is still below the 75% used in the original PHE modelling.
- There is still a lack of large scale, national level studies reporting characteristics of those who take-up an invitation to an NHS Health Check and those who do not. Only one further study (McDermott *et al*, 2018) presented such information.
- Opportunistic invitational methods, dependent on setting, may provide greater uptake and attendance than written methods.

- Adaptations to invitation methods provided mixed results, with behavioural adaptations showing lower increases in uptake than previously stated.
- The use of a personalised invite, SMS message or telephone invite seem to be a viable option for increasing uptake of NHS Health Checks.

3.3 Why do people not take up an offer of an NHS Health Check?

There were no new studies identified that reported on the reasons individuals did not take up the offer of an NHS Health Check. Ten studies had been identified by the previous review with key reasons for not taking up an NHS Health Check offer listed as follows: a lack of knowledge on the purpose of the NHS Health Check, time constraints impacting on attendance, an aversion to preventative medicine. The key findings of this objective flagged within the previous review remain unchanged.[1]

3.4 How is primary care managing people identified as being at risk of cardiovascular disease or with abnormal risk factor results?

Four new studies were identified. One is quantitative (Alageel *et al*, 2019[68]) and considers the long term impact of the NHS Health Check. The other three studies are qualitative (Alageel *et al*, 2018[69], Alageel *et al* 2020[70] and Stone *et al 2019*[54]) and identify views of healthcare professionals towards the NHS Health Checks. These studies are discussed in further detail in the below sub-sections. See Table 20 and Table 21 for study details.

No further studies were identified reporting variations in delivery, recall systems, lifestyle advice provided or service availability. It is likely findings on this from the original review remain valid. That the large variation in NHS Health Check delivery, lifestyle advice given post check, referral to lifestyle services or interventions and continued follow up prevails. For study details see Table 19.

Table 19 Features of studies reporting delivery of NHS Health Checks within primary care[1]

Author, year	Type of report	Study period	Location of study	Setting of NHS Health Check	Data collection method	*n*	Method of recruitment to study	Participant characteristics
Baker 2015[21]	Journal article	Not given	South West England	30.1% of total practices delivering NHS Health Checks	Surveys including quantitative and qualitative questions	25	Identified randomly via the County Medical List to ensure geographic spread	2 general practitioners, 14 practice managers, 6 practice nurses, 2 healthcare assistants and 1 administrator
Baker 2014[71]	Journal article	2012	Gloucester	83 general practices	Content analysis of cross-sectional survey	1,011 (43%)	Survey sent to all patients who had completed an NHS Health Check within a 2-month period	55.2% female 19% 56-60 years 10.8% 40-45 years 96% white British
Greenwich 2011[34]	Report	2011	Greenwich	Community	Open ended questionnaire	11	All (12) clinicians delivering community outreach services providing NHS Health Checks were invited	Healthcare assistants, nurses, pharmacists and health trainers
Graley 2011[72]	Journal article	2010	North West London	8 (all) primary care trusts	Survey	8	No details given	NHS Health Check leads of each primary care trust
Ismail 2015[73]	Journal article	Not given	Not specified	General practices	Semi-structured interviews	45 baseline 38 follow-up	Purposive sampling from a list provided by 5 participating	21 female, 24 male. Average age: 58. Ethnicity: 37 White, 5 South

Author, year	Type of report	Study period	Location of study	Setting of NHS Health Check	Data collection method	*n*	Method of recruitment to study	Participant characteristics
							general practices	Asian and 3 African Caribbean
Krska 2016[27]	Journal article	2011	Sefton, an area of North West England	33 (of 55) general practices	Postal survey with free text responses	83 (76% of practice managers, 24% of general practitioners)	Personally addressed letters of invitation with a covering letter to all practice managers and general practitioners at 55 practices	40 practice managers and 43 general practitioners
Nicholas 2013[74]	Journal article	2011	Two London boroughs	70 (of 96) general practices	Survey including free-text responses	65	Invitations to all 96 general practices	25 practice managers, 8 general practitioners, 16 practice nurses, 2 healthcare assistants, 3 administrators and 14 not specified
Oswald 2010[75]	Evaluation report	2009 – 2010	Teesside	13 general practices	Semi-structured interviews	25	Letter of invitation to practice managers	8 practice managers, 14 practice nurses, 1 general practitioner, 1 healthcare assistant, 1 pharmacist

3.4.1 Long-term impact of NHS Health Checks

NHS Health Checks aim to help attendees understand their level of CVD risk. Those who are identified as being at risk of CVD or with abnormal risk factor results need to be supported to take appropriate action to reduce their risk. The main following concern of this section is the long-term impact of NHS Health Checks on CVD risk.

A single study (Alageel *et al*, 2019)[68] longitudinally assessed cardiovascular risk factor values in England. This was completed over a six-year follow-up period, with a matched control analysis, using electronic health records. The main aim of the study was to evaluate the long-term impact of risk management interventions delivered in primary care, with emphasis on whether the NHS Health Check was favourable for those attending compared to non-attendees. To accomplish this, the authors employed an interrupted-time series analysis, using data from the CPRD. This dataset covers approximately 7% of the UK population and is therefore considered representative of the wider population in the UK. As NHS Health Checks are only available in England, the authors only included participants based in England (see Table 20 for study details).[68]

Most of the patients were aged 45-54 (cases = 41.2%; controls = 45.1%). Males accounted for 49% of Health Check patients and 53% of controls. Additionally, most of the patients were from the 2nd quintile of deprivation index (cases = 23.2%; controls = 22%). At baseline cases and control were similar for body mass index (BMI; 27 vs. 21.3 kg/m^2, respectively), systolic blood pressure (129 vs. 129.3 mmHg), and diastolic blood pressure (79.2 vs. 79.3 mmHg). A higher proportion of the controls were smokers (21 vs. 27%). Changes over time in risk factors (BMI, smoking, blood pressure, and cholesterol measures) were assessed using an interrupted time series (ITS) analysis. Patients' records were divided into one-year periods, from five years prior to the index date up to a maximum of six years after. [68]

The ITS analysis revealed that the mean BMI following a Health Check was 0.3 kg/m^2 (95% CI: 0.2-0.39 kg/m^2) lower after the six-year follow up. The control patients had an observable increase trend in BMI over time (0.08, 0.07 to 0.09 kg/m^2 per year, $p < 0.001$). Additionally, after the six-year period Health Check patients had a smoking reduction of 4% compared to a reduction of 2% in controls (AOR: 0.9, 95% CI: 0.87-0.94). Mean systolic and diastolic blood pressure were also lower overall in the Health Check attendees compared to the control group, with a mean decrease after six years of 1.43 mmHg (95% CI: 1.16-1.7mmHg) for systolic and 0.93 mmHg (95% CI: 0.75 to -1.11 mmHg) for diastolic blood pressure. A reduction in total

cholesterol over the six-year period was also present in Health Check patients (0.05, 95% CI: 0.03-0.07), whilst HDL cholesterol was slightly higher after six-years (0.01, 95% CI: 0.002-0.02).[68]

Overall, the findings from Alageel (2019) suggest that NHS Health Check patients were able to reduce their CVD risk factors. With key effects of the NHS Health Check programme: an increase in provisions of risk management advice (weight management advice was provided to NHS Health Check patients in a 2:1 ratio compared to controls), greater provision of risk management interventions (smoking cessation advice, referrals and medication were higher amongst NHS Health Check patients). Whilst this is a single study, it has recruited from across England and the results could therefore be representative of the wider population.[68]

Table 20 Features of studies providing data on risk management in primary care after NHS Health Checks

Author (publication date)	Study design Data source	Setting Study time period	Sample size/ Study population	Age	Gender	Ethnicity	IMD (Most deprived)
Alageel *et al* (2019)[68]*	Controlled interrupted time series CPRD	Primary Care 1st April 2010 – 31st Dec 2013 (2 years and 8 months)	450,801 Health Check = 127,891 Controls = 322,910	Health Check: >65 = 13.7% Controls: >65 = 9.7%	Health Check: Male = 49.4% Controls: Male = 52.9%		Health Check: 5th quintile = 21.7% Controls: 5th quintile = 20.9%

*and a bold border outside denotes new studies included from the review update

3.4.2 Healthcare professionals' views towards NHS Health Checks and Delivery

Fifteen studies from the original review reported views of healthcare workers towards NHS Health Checks and in particular around implementation of the programme.[1] Evidence was found to indicate some healthcare professionals could see the benefit of the programme for their patients. The main concerns raised were around inequality of uptake and doubts about the evidence behind the programme and the cost-effectiveness.

The review update identified a further three studies reporting healthcare professionals views towards NHS Health Checks and their delivery (see Table 21).[54 69 70] Findings added adequacy to the body of evidence available although data sufficiency still lacks. The richness and thickness of the included studies increased, further conceptual detail came from newly included studies allowing for improved contextual interpretation. Although no new analytical themes were identified, a potential emerging theme given constructs identified could be 'Lack of resource to stimulate behaviour change'. The amount and depth of the data hindered emergence of new themes and findings.

<u>Doubts about long term cost-effectiveness</u>

General practitioners seemed more negative towards NHS Health Checks than other practitioners. They had particular concerns about the cost-effectiveness of the programme.[69 70]

> Q3 *"I don't think that the health check scheme works, because I think it is targeting the wrong population….. best done opportunistically when we see patients alongside other health issues, which might be more relevant even"*[70]

> Q4 *"I think we're slightly apathetic about it from a GP point of view, just because I don't know, it's more soft work that we don't get a definite outcome from"* [70]

<u>Inadequate training</u>

Healthcare practitioners were concerned about having the right level of knowledge and skills needed to implement an NHS Health Check, and how completion of the NHS Health Checks linked to their professional role and identity.[54 69 70] Whilst conversely, general practitioners felt healthcare practitioners were more suited to delivery of the NHS Health Checks as it is allied to the health promotion focused work they undertake.[54 69 70] They felt healthcare practitioners would be able to gain more personal information from the patients, be more motivating to them and provide them with more tailored information.[54 69 70]

<u>Lack of resource to stimulate behaviour change</u>

Alageel *et al* (2018) also identified behaviour change as challenging, due to environmental factors, and resources such as access to services, cost and time which were not always within individual control.[69]

Table 21 Features of studies providing data on healthcare professionals' views towards NHS Health Checks and Delivery

Author, year	Type of report	Study period	Location of study	Setting of NHS Health Check	Data collection method	*n*	Method of recruitment to study	Participant characteristics
Alageel *et al* 2020[70]*	Article	Not Reported	South East London (Lewisham and Lambeth)	General practices	Semi structured interviews interview mode: Face to face (13), Phone (9)	353 invited, 26 agreed	Invited by general practitioner based on NHS Health Check results	12 male; Age: 40-55 (3), 56–70 (18); Smoker (3), ex-smoker (5), non-smoker (14); Ethnicity: UK White (18); African-Caribbean (2), European (1), mixed (1); IMD (1 most deprived): 1(4), 2(10), 3(4), 4(3), 5(0), missing (1); Co morbidities: None recorded (13); thyroid (1), high BP (3), MH problems (2), prostate cancer (1), HIV (1), Arthritis (1)
Alageel *et al* 2018[69]*	Article	July – November 2016	Lewisham and Lambeth	23 general practices	30 face to face interviews			male (6), female (24); general practitioners (10), practice nurse (20)
Stone *et al* 2019[54]*	Journal article	2019	Bristol	10 general practices	Semi-structured face-to-face interviews	10	Invite to attendees of an intervention training meeting	15 females, 13 males Somali (3), South Asian (3), Black British (2), White British (2); IMD: 1st most deprived decile (4), 2nd (3), one each from 3rd, 4th and 5th deciles
Alford *et al* 2010[76]	Evaluation report	Not given	Knowsley	Community	Interviews and focus groups	36	No details given	19 female, 17 male 13 high risk score, 23 low risk score
Baker *et al* 2014[71]	Journal article	2012	Gloucester	83 general practices	Content analysis of cross-sectional survey	1,011 (43%)	Survey sent to all patients who had completed an NHS Health Check within a 2 month period	55.2% female 19% 56-60 years 10.8% 40-45 years 96% white British
Chipchase *et al* 2011[77]	Report	2011	East and North Birmingham	2 general practices	Face-to-face semi-structured interviews	10	Attendees to NHS Health Checks in the first two weeks of February 2011	8 female, 2 male

Author, year	Type of report	Study period	Location of study	Setting of NHS Health Check	Data collection method	*n*	Method of recruitment to study	Participant characteristics
							received a recruitment letter	
Corlett *et al* 2016[32]	Journal article	2013	London	4 pharmacies	Telephone interviews with sample of survey respondents	19	Invitation for a semi-structured telephone interview included with survey sent to all those who had attended an NHS Health Check within a 4 week period	Not given
Greenwich *et al* 2011[34]	Report	2011	Greenwich	Community	Open ended questionnaire, focus groups and in-depth phone interviews	612 survey responses 4 focus groups and 31 interviews	Recruited from community outreach services providing NHS Health Checks	Ethnic minority participants: 42% female
Ismail *et al* 2016[55]	Journal article	Not given	Not specified	General practices	Semi-structured interviews	45 baseline 38 follow-up	Purposive sampling from a list provided by 5 participating general practices	21 female, 24 male. Average age: 58. Ethnicity: 37 White, 5 South Asian and 3 African Caribbean
Jenkinson *et al* 2015[78]	Journal article	2013	Torbay	4 general practices	Telephone or face-to-face interviews	17	Letters of invitation sent to a random sample identified by general practices from lists stratified by age and gender of those who had not responded to an invitation to an NHS Health Check within 4 weeks.	12 females, 5 males 6 employed, 1 unemployed, 10 retired

Author, year	Type of report	Study period	Location of study	Setting of NHS Health Check	Data collection method	*n*	Method of recruitment to study	Participant characteristics
McNaughton *et al* 2011[79]	Journal article	Not given	Tees Valley	8 pharmacies	Semi-structured interviews	20	Postal invitation	10 primary care trust members, 8 pharmacists, 2 representatives from Local Pharmaceutical Committee
Nicholas *et al* 2013[74]	Journal article	2011	2 London boroughs	70 (of 96) general practices	Survey including free text responses	65	Invitations to all 96 general practices	25 practice managers, 8 general practitioners, 16 practice nurses, 2 healthcare assistants, 3 administrators and 14 not specified
Oswald *et al* 2010[75]	Evaluation report	2009 – 2010	Teesside	13 general practices	Semi-structured interviews	25	Letter of invitation to practice managers	8 practice managers, 14 practice nurses, 1 general practitioner, 1 healthcare assistant, 1 pharmacist
Research works 2013[80]	Research report	2013	Not given	Not given	Semi-structured interviews	12	Contacts provided by Commissioners with snowballing recruitment	General practitioners, practice managers, healthcare assistant, nurse practitioner, physical activity development officer, health bus workers and a community pharmacist
Riley *et al* 2015[57]	Journal article	2013	Bristol inner-city	Community settings	Semi-structured interviews	4	Participants were recruited via their involvement with community outreach events.	1 practice nurse, 1 healthcare assistant, 1 engagement worker and 1 health trainer
Riley *et al* 2016[81]	Journal article	2013-14	Bristol	11 general practices	Semi-structured interviews	15	18 were invited with purposive sampling	5 general practitioners, 5 practice nurses, 3 healthcare assistants, 2 pharmacists
Shaw *et al* 2015[82]	Journal article	2010-11	Birmingham and Black Country	General practices and community	Semi-structured interviews	31	Recruited through lead clinicians	9 general practitioners, 6 practice managers, 4 practice nurses, 6 healthcare assistants, 1 alternative provider director, 1 call centre manager, 2 call centre operatives and 2 alternative provider registered practice nurses

Author, year	Type of report	Study period	Location of study	Setting of NHS Health Check	Data collection method	*n*	Method of recruitment to study	Participant characteristics
Shaw *et al* 2016[83]	Journal article	Not Reported	Birmingham	General practices	Semi-structured interviews	9	Recruitment undertaken by local NHS trust. No further details provided	All general practitioners

*and a bold border outside denotes new studies included from the review update

Support for the concept of management of people identified as being at risk of CVD, as an outcome of the NHS Health Checks intervention, received an overall rating of moderate in the GRADE-mixed methods assessment. This was due to differential ratings, from low to strong, across individual domains (see Table 22).

Table 22 GRADE assessment of evidence contributing to Objective 4

The outcome concept	Number of studies per design	Combined sample size	Importance of the outcome to the NHS Health Check programme	Evidence supporting outcome concept
Management of people identified as being at risk of CVD[21 34 39 55 57 68-70 73-75 79-88]	Observational = 4 Qualitative = 13 Mixed methods = 5	129, 841	Critical	Moderate

3.4.3 Key findings and interpretation

Findings from the original review

- The funding, design and freedom in implementation given to local authorities and general practices is reflected in the way the NHS Health Checks were introduced.
- Differences in lifestyle improvements were reported. Specifically, variations in referrals and provision of lifestyle services were identified.
- Some evidence suggests that healthcare professionals could see the benefit of the programme for their patients. However, nearly half of healthcare professionals in one survey did not view it as important nor beneficial for their patients due to inequality of uptake, doubts about the evidence behind the programme and perceived lack of cost-effectiveness.
- The main challenges to implementation were identified as IT-based, impact on practice workload, funding, difficulty getting people to make changes to their lifestyle, limited access to follow-up services, and inadequate training.
- Similar challenges were reported across community and pharmacy settings.

Findings informed by the updated review

- A single quantitative study was newly identified as providing information on how NHS Health Checks affect risk management. This is a large-scale study.
- NHS Health Checks were associated with a decrease in CVD risk over a six-year period with possibly clinically relevant reductions in BMI, smoking and blood pressure.
- An increase in provisions of risk management advice and risk management interventions were seen amongst those who attended NHS Health Checks.
- Three qualitative studies reporting healthcare professionals' views towards NHS Health Checks and delivery were newly identified.
- In these studies doubts about equality and long-term cost-effectiveness of NHS Health Checks were prevalent amongst general practitioners.
- The training for delivery of an NHS Health Check was felt inadequate amongst those seen as best placed to deliver them.
- Resource at an individual and societal level was seen to be a barrier to initiating

behaviour change.

Overview of findings

- Confidence in the evidence from 22 studies (4 newly identified) supporting concepts and outcomes identified were judged as being moderate mainly due to the plausibility of responder bias and potential lack of objectivity.
- There is some evidence to suggest CVD risk decreased due to NHS Health Check attendance.
- The same qualitative findings appeared in both reviews, with issues surrounding inequalities, cost-effectiveness, training and funding.

3.5 What are patients' experiences of having an NHS Health Check?

There were no newly identified quantitative studies reporting patients' experiences of having an NHS Health Check. Nine studies had been identified by the previous review detailing responses to patient satisfaction surveys. As such, evidence to date still identifies consistently high levels of satisfaction with NHS Health Checks (80% feel benefit from the process).[1] However, satisfaction is likely to be linked to temporal factors and should a patient survey be re-ran this finding may vary.

The previous review identified 15 qualitative studies reporting patients' experiences of having a NHS Health Check. The following analytical themes were identified: 'Unmet expectations', 'Limited understanding of the risk score', 'Quality of information', 'A potential trigger for behaviour change' and 'Confusion around follow up'. Two newly identified qualitative studies report patients' experiences of having an NHS Health Check (see Table 23). The two studies identified by the review update add adequacy including richness and thickness to the pre-existing thematic synthesis. However, plausibly due to a lack of data sufficiency, no new analytical themes were identified. [69 70 89]

<u>Understanding of the risk score</u>

Both studies reinforced findings of those included within the previous review, the depth and breadth of data informing findings from all included studies increased and more detail of research field experience and participant accounts could be included. New studies added further richness of data (conceptual details) revealing intricacies and complexities of the theme identified around patients limited understanding of the risk score (no recall of provision, no comprehension of score, false comprehension of score). [69 70 89]

Participants interviewed within the study completed by Alageel *et al* had no recall of being presented a specific risk but did recall a general discussion on heart health.[70] Those interviewed within the study completed by Hawking *et al* were more likely to recall and accept their risk score if they had had concerns about their cardiovascular health before attending the NHS Health Check.[89]

> Q5 *"[The risk score gave a] true reflection of their current state of health"*[89]

Patients were particularly satisfied when provided with a graphical "*risk report*" to take away. Researchers felt the graphic was easier for patients to understand than a risk score for people with low scientific literacy and as pictorial was okay when English was not patients first

language.[89]

Table 23 Features of studies providing data on patients' experiences of having an NHS Health Checks

Author, year	Type of report	Study period	Location of study	Setting of NHS Health Check	Data collection method	*n*	Method of recruitment to study	Participant characteristics
Hawking 2019 *et al*[89]*	Article	March 2016 – July 2017 (part of a wider trial March 2016 – December 2017)	Newham, East London	3 general practices (out of 6 in the wider feasibility study)	Interview	18	Not clear	11 male, 7 female. Age: 40 – 50 (4), 51 – 60 (9), 61 – 74 (5); QRISK2 score % <10 (11) 10 – 19 (7) >=20 (0); Ethnicity: White (2); Black (8); South Asian (6); Other (2)
Alageel *et al* 2020[70]*	Article	Not reported	Lewisham and Lambeth, South East London	General practices across Lambeth and Lewisham.	Face to face interview 13 Phone interview 9	22 Invited by general practitioner (14 letter, 7, opportunistic, 1 unknown)		12 male, 10 female; Age: 40 – 55 (3), 56 – 70 (18), Unknown (1); Smoking status: smoker (3), ex-smoker (5), non-smoker (14); Ethnicity: UK white (18), African-Caribbean (2), European(1), mixed ethnicity (1); IMD quintiles (1 most deprived): 1(4), 2 (10), 3 (4), 4 (3), 5 (0), Missing (1).; Employment: Employed (FT or PT): 12, Unemployed inc retired: 10
Alford *et al* 2010[76]	Evaluation report	Not given	Knowsley	Community	Interviews and focus groups	36	No details given	19 female, 17 male 13 high risk score, 23 low risk score
Baker *et al* 2014[71]	Journal article	2012	Gloucester	83 general practices	Content analysis of cross-	1,011 (43%)	Survey sent to all patients who had completed an NHS Health Check within a 2	55.2% female 19% 56-60 years

					sectional survey		month period	10.8% 40-45 years 96% white British
Chipchase *et al* 2011[77]	Report	2011	East and North Birmingham	2 general practices	Face-to-face semi-structured interviews	10	Attendees to NHS Health Checks in the first two weeks of February 2011 received a recruitment letter	8 female, 2 male
Corlett *et al* 2016[32]	Journal article	2013	London	4 pharmacies	Telephone interviews with sample of survey respondents	19	Invitation for a semi-structured telephone interview included with survey sent to all those who had attended an NHS Health Check within a 4 week period	Not given
Greenwich *et al* 2011[34]	Report	2011	Greenwich	Community	Open ended questionnaire, focus groups and in-depth phone interviews	612 survey 4 focus groups and 31 interviews	Recruited from community outreach services providing NHS Health Checks	Ethnic minority participants: 42% female
Ismail *et al* 2016[55]	Journal article	Not given	Not specified	General practices	Semi-structured interviews	45 baseline 38 follow-up	Purposive sampling from a list provided by 5 participating general practices	21 female, 24 male. Average age: 58. Ethnicity: 37 White, 5 South Asian and 3 African Caribbean
Jenkinson *et al* 2015[78]	Journal article	2013	Torbay	4 general practices	Telephone or face-to-face interviews	17	Letters of invitation sent to a random sample identified by general practices from lists stratified by age and gender of those who had not responded to an invitation to an NHS Health Check within 4 weeks.	12 females, 5 males 6 employed, 1 unemployed, 10 retired
Krska *et al* 2015	Journal article	2011	Sefton, an area of	16 general practices	Postal survey with	434 (23.4%)	All patients with estimated 10 year CVD risk > 20% from the 16 practices were	19% female 68.2% over 65 99.5% white

			North West England		free text responses		sent a postal survey regardless of whether they had attended an NHS Health Check or not	7.7% highest quintile of deprivation 13.7% lowest quintile
McNaughton *et al* 2015	Journal article	2009-12	North East of England (non-specific location)	5 general practices	Semi-structured interviews	29	Invitations to patients from five general practices who had received an NHS Health Check and had an estimated 10 year CVD risk >20%	10 females, 19 males 24 over 65 years 13 in least deprived quintile
Oswald *et al* 2010	Evaluation report	2009 - 2010	Teesside	General practices or pharmacies	Semi-structured interviews	8	Invited by general practices or pharmacies or from a list of patients who had attended an NHS Health Check and agreed to take part in the service evaluation	6 had attended general practices and 2 pharmacies
Perry *et al* 2014	Journal article	2010	Knowsley	Community	Interviews and focus groups	36	Letter or telephone invitation to all 38 people who were at high risk of CVD and had attended an NHS Health Check in the past 12-18 months were invited. The remaining attendees at low risk of CVD were purposively sampled for gender, age and risk score.	3 focus groups: 1 for high risk scores [6 males], 2 for low risk scores (17 females and 7 males) 6 semi-structured interviews (2 females and 4 males with high risk score)
Riley *et al* 2015	Journal article	2013	Bristol inner-city	Community	Semi-structured interviews	16	Participants were recruited via their attendance of community outreach events.	7 females, 9 males All from black and minority ethnic populations
Riley *et al* 2015	Journal article	2013-14	Bristol	General practices	Face-to-face and telephone semi-structured interviews	28	Purposive sampling from those identified through a search of patient records for patients who had undertaken an NHS Health Check within the previous 6 months	16 females, 12 males 23 White British 11 most deprived quintile 11 high (>20%) CVD risk

Shaw *et al* 2015	Journal article	2010-11	Birmingham and Black Country	General practices and community	Semi-structured interviews	23	Patients who had attended an NHS Health Check were invited by practice managers or lead clinicians	High black and minority ethnic population and high levels of deprivation
Strutt *et al* 2011	Masters thesis	2010	Darlington, Co. Durham, UK	2 general practices	Semi-structured face-to-face interviews	16	Invitation letters or telephone	7 females, 9 males White, South-Asian, and Middle Eastern

*and a bold border outside denotes new studies included from the review update

Quality of information (format, detail and personalisation)

A single study added some richness to the data on the quality of the NHS Health Check format. Within both studies most individuals reported positive experience of having a Health Check, however, some identified the format as creating a burden of completion:

> Q6 *"So that's what I found a bit off-putting. I didn't like that form filling"*.[89]

Potential Trigger for behaviour change/actual behaviour change

Both studies identified the NHS Health Check as a trigger for behaviour change due to a number of different motivating factors. There may have been an element of socially desirable responding causing individuals to suggest change had taken place after attendance at the NHS Health Check.[70 89]

There was a tendency to discuss and share the information with others, perhaps recommending attendance. Changes made such as eating more vegetables or adding less salt to food were done as households. This was felt to have re-motivated individuals who felt supported by close family members and friends joining in risk-reducing behaviours.[89]

Health professionals experienced the provision of the Health Check as a self-reminder to set an example for others.[89]

> Q7 *"You can't be telling people to do things if you yourself are not doing it"*.[70]

Of those who did not find the NHS Health Check a motivator for change, barriers identified were: pressure to change rather than facilitation from practitioners, perceived risk due to family history (genetic determinism – either through long-lived family members or heightened risk that they felt they could not change), practical issues in joining lifestyle change interventions.[70] Patients reported feeling pressured by their doctors to start statin therapy but not to start behavioural changes.[70]

> Q8 *"Many of those we interviewed were referred to lifestyle change interventions… However, there were often barriers to joining these interventions such as long waiting lists, distance from home and the timing of classes"*.[70]

The body of evidence which reported data relevant to the concept of patient experiences as an outcome of the NHS Health Checks intervention was rated as low-moderate, due to being rated as low, inconsistent or moderate across domains, with no 'strong' ratings (see Table 24).

Table 24 GRADE assessment for the evidence contributing to Objective 5

The outcome concept	Number of studies per design	Combined sample size	Importance of the outcome to the NHS Health Checks programme	Evidence supporting concept
Patient experiences as an outcome of the NHS Health Checks	Observational = 10 Qualitative = 9[32 34 35 38 55-58 69-71 75-78 80 81 89-95]	133,973	Important	Low/ moderate

3.5.1 Key findings

Findings from the original review

- Previously high levels of satisfaction with the programme were reported, however satisfaction is likely linked with temporal factors. New patient survey findings would plausibly differ from those completed historically.
- Understanding of the risk score and recall of scores was poor. Being reliant solely on the scores remains to be a barrier to triggering health behaviour change.
- The following barriers to change were also identified: 'Pressure to change' rather than facilitation from practitioners, 'Perceived genetic determinism (including of longevity)', 'Practical issues in joining change interventions', 'Environmental factors', 'Resources' such as access to services, cost and time to the individual which are not always controllable.

Findings informed by the updated review

- There were no newly identified quantitative studies reporting patients' experiences.
- Two newly identified qualitative studies report patients' experiences of having an NHS Health Check. No new first or second order constructs that lead to new analytical themes were identified within these studies. Extracted findings aligned with the analytical themes on 'Understanding of the risk score', 'Quality of information (format detail and personalisation)' and being 'A potential trigger for behaviour change'.
- A graphical communication tool was identified as being preferential to patients' in order to communicate their risk to them.

Overview of findings

- One quantitative study and 21 (two newly identified) qualitative studies provided data on patients experiences of NHS Health Checks.
- The body of evidence reporting data relevant to the concept of patient experiences as an outcome of the NHS Health Checks intervention was rated as low to moderate.
- The quantitative data presented from satisfaction surveys were based on questions that were perhaps too broad in focusing on general or overall satisfaction. However, negative aspects of patients' experiences were captured within the qualitative data.

- Evidence lacked due to an inadequate probing of findings in some studies. There was no exploration of the social and psychological mechanisms relating to issues that patients experienced. For example, the reasons why many attendees would struggle to interpret the risk score.
- Inferences and conclusions made by authors were reflected in the quantitative and qualitative data reported. For example, high levels of satisfaction were evident in the results from quantitative survey data, and participant quotes supported the themes derived by authors.

3.6 What is the effect of the NHS Health Check on disease detection, changing behaviours, referrals to local risk management services, reductions in individual risk factor prevalence, reducing cardiovascular disease risk and on statin and anti-hypertensive prescribing?

The previous review by Usher-Smith et al (2017) identified eighteen studies which assessed the impact of the NHS Health Check programme on health-related outcomes or referrals to risk management services.[1] In this review update a further thirteen studies with relevant data to address the research objective were located (Alageel et al 2017[96]; Alageel et al 2019[68]; Chang et al 2017[97 98]; Coghill et al 2018[11]; Collins et al 2017[105]; Collins et al 2020[99]; Gulliford et al 2017[48]; Hinde et al 2017[100]; Kennedy et al 2019[101]; Lang et al 2016[12]; Mytton et al 2018[102]; Palladino et al 2017[103]; Robson et al 2017[104]; see Table 25**).**
In five of the newly identified studies, the data were collected up to 2014 (Alageel *et al* 2017[96]; Chang *et al* 2017[97 98]; Coghill *et al* 2018[11]; Lang *et al* 2016[12]; Robson *et al* 2017[104]). In three economic studies, data were collected pre-2015, however these data were used to predict future trends up to 2031 (Collins *et al* 2017)**[105]** and 2014 (Collins *et al* 2020)[99] and until survey participants' who were aged 45 years at baseline, became 100 years old (Mytton *et al* 2018)[102]. In a different economic study, data used to inform the statistical model were from 2015 (Hinde *et al* 2017)[100]. In one study, data were from participants who completed an NHS Health Check between 2013 and 2015 (Gulliford *et al* 2017)[48]. Kennedy *et al* (2019) included data from a cohort of participants who were invited for an NHS Health Check in 2015. Palladino *et al* (2017)[103] reported data collected from 2009-16. Alageel *et al* (2019)[68] included some follow up data that were collected post-2014.

Five of the newly identified studies used a cohort design (Alageel *et al* 2017[96]; Alageel *et al* 2019[2]; Robson *et al* 2017[104]; Gulliford *et al* 2017[48]; Mytton *et al* 2018[102]). Alageel *et al* (2017) analysed data from 129,045 eligible participants who received a Health Check and 327,091 matched controls (matching criteria were not reported) using data from the 2010-13 CPRD.[96] This is a national dataset, providing access to anonymised medical records for approximately 6.9% (4.4 million) of the UK population and is representative of the age, sex and ethnicity constitution of the UK population. The CPRD has a broad population coverage, however contributing general practices are less representative of the UK in terms of geography and size.[106]

Also using CPRD data from individual patients, Alageel *et al* (2019) compared cardiovascular

outcomes between 127,891 Health Check participants who received NHS Health Checks between 1st April 2010 and 31st December 2013, and 322,910 controls who were matched based on age, sex and general practice. The follow-up period for this study was six years.[68]

Robson *et al* (2017) and Gulliford *et al* (2017) analysed patient electronic medical records. The former study used data from 143 general practices in east London from 2009-14, and the latter used data from 18 general practices in two London boroughs covering a period of two years (2013-15).[48 104]

Also using cohort data, Mytton *et al* (2018) performed a microsimulation study to estimate the health benefits and effect on inequalities of the current NHS Health Check programme and the impact of making feasible changes to its implementation.[102] Cardiovascular risk factor trajectories were generated for a representative (of age and gender) sample of 200,000 individuals aged 40-45 years from the Health Survey of England (HSE) (2009±2012), by matching individuals to persons based on cardiovascular risk profiles from the English Longitudinal Study of Aging (ELSA) (1998–2012).[102] Additionally, data measuring the uptake of NHS Health Checks and associated interventions and estimates of treatment efficacy and adherence based on the current NHS Health Checks programme was compared to a healthcare system without systematic Health Checks (provision of routine care).[102]

Kennedy *et al*. (2019) performed a quasi-randomised study in which risk factor detection and new interventions were compared between individuals who attended an NHS Health Check vs. non-attendees. The study included a sample of 366, 005 participants from 151 general practices who were invited to attend in one of 5 cohorts (based on birth year), from 2011-15. For each participant, attendance, demographic and outcome data were extracted from the Health Record Analytical Database (HRAD).[101]

Three of the newly identified studies used a cross-sectional design (Chang *et al* 2017).[97 98]; Coghill *et al* 2018[11]; Lang *et al* 2016[12]). Chang *et al* (2017) assessed the impact of the NHS Health Checks programme on early detection of hypertension, type-2 diabetes mellitus and chronic kidney disease between attendees and non-attendees (matching criteria not reported).[97 98] This study used CPRD data for 138,788 individuals (29,672 of these attended a Health Check) registered with 462 practices.[97 98] Coghill *et al* (2018) compared prescriptions of cardiovascular drugs and referrals to lifestyle services between NHS Health Check attendees with different social characteristics using data from 38/52 general practices in Bristol, England.[11] The data were from 13,733 completed NHS Health Checks. Lang *et al* (2016)

assessed cardiovascular risk factor status in relation to social characteristics amongst NHS Health Check attendees.[12] The population was 7,987 patients registered at nine general practices across West Midlands.[12]

The three remaining studies identified for this update (Collins 2017[105]; Collins 2020[99]; Hinde 2017[100]) assessed the cost-effectiveness of the NHS Health Checks programme.

In this section the effect of NHS Health Checks on the following are assessed:

1) Disease detection
2) Behaviour change
3) Referrals to local risk management services
4) Reductions in individual risk factors and cardiovascular disease risk, and
5) Prescribing.

We had specified a-priori that we would conduct meta-analysis for Objectives 3.1-3.6 if it was methodologically appropriate, however, the high heterogeneity and low number of high quality studies reporting on each domain in a consistent manner meant this was unfeasible.

Table 25 Features of studies reporting the impact of the NHS Health Check on health-related outcomes

Author (Year) Publication type	Study design / Data source	Setting Study time period	Sample	Population characteristics	Comparison	Method	Unit of analysis
Studies with comparison groups							
Alageel *et al* (2017)[96]* Conference abstract	Cohort CPRD data	Primary care; patients registered at general practices in the CPRD Jan 2010 to Dec 2013	129,045 eligible participants who received a Health Check; 327,091 matched controls	Mean age: not reported % male: not reported % white: not reported	Attendees compared with non-attendees	Matched cohort study. Matching criteria were not described.	Individual-level
Alageel *et al* (2019)[68]* Journal article	Cohort CPRD data	Primary care; patients registered at general practices in the CPRD Apr 2010 to Dec 2013	127,891 Health Check participants and 322,910 matched controls	% aged ≥65: 13.7 (intervention group), 9.7 (control group) % male: 49.4 (intervention group), 52.9 (control group) % white: not reported	Attendees compared with non-attendees	Matched cohort study. Matching criteria were age, sex and general practice.	Individual-level
Chang *et al* (2017)[97 98]* Conference abstract	Cross-sectional survey CPRD data	Primary care 2009-2013	The study population was 138,788 registered with 462 practices; 29,672 of these attended a Health Check	Not reported	Attendees compared to non-attendees Female attendees to male attendees Attendees living in most compared to least deprived areas	Matched study. Matching criteria were not reported.	Individual-level
Coghill *et al* (2018)[11]* Journal article	Cross-sectional survey routine general practice data	38 general practices Feb 2010 to Oct 2014	31,881 patients invited, and 13,733 NHS Health Checks completed	% aged <60: 65.3 (intervention group); 34.7 (control group) % male: 47 (intervention group), 55.7 (control group) % white: 84.6 (intervention group), 48.1 (control group)	Attendees vs. population; different population sub-groups of attendees	Logistic regression was used to test associations between invitation and attendance, with population characteristic	Individual-level
Collins *et al* (2017)[105]*	Cost effectiveness analysis	A subsample of Health Survey for England (HSE)	Not reported	Not reported	Programme implementation scenarios	Cost-effectiveness and equity analysis	Individual-level

Conference abstract	Health Survey for England data	participants living in Northwest England 2017 to 2031					
Collins *et al* (2020)[99]* Journal article	Cost effectiveness analysis Health Survey for England data	A subsample of Health Survey for England (HSE) participants living in Northwest England 2002 to 2040	Not reported	Not reported	Programme implementation scenarios	Cost-effectiveness and equity analysis	Individual level
Gulliford *et al* (2017)[48]* Journal article	Cohort Electronic health records	18 general practices in two London Boroughs July 2013 to June 2015	6,184 NHS Health Checks recorded (2,280 invited and 3,904 opportunistic)	% aged < 60: 87 (intervention group), 84 (control group) % male: 47 (intervention group), 46 (control group) % white: not reported	Opportunistic vs. invitation letter	Meta-analysis assessing the relative contribution of invited and opportunistic NHS Health Checks to overall Health Check uptake was estimated by general practice	General practice
Hinde *et al* (2017)[100]* Journal article	Cost-effectiveness publicly available economic evaluation toolkit	Data from two earlier studies: Forster et al (2015) and Chang et al (2016)	Not reported	Not reported	Health Check compared to no Health Check	Clinical and cost-effectiveness analysis	Individual-level
Kennedy *et al* (2019)[101]* Journal article	A quasi-randomised controlled trial Trial data	151 general practices in Hampshire, England, UK. April 2011 and March 2015	366,005 participants from 151 general practices	Mean age: Cohort 1:51 Cohort 2:50 Cohort 3: 49 Cohort 4: 48 Cohort 5:48 % male: Cohort 1: 47.5 Cohort 2:46.5 Cohort 3:47 Cohort 4: 47.4 Cohort 5: 47.2 % white: not reported	Attendance vs. non-attendance	Cohort study. Multivariable logistic regression models adjusted for age and gender	Individual-level
Lang *et al* (2016)[12]*	Cross-sectional survey	9 general practices across West Midlands	7,987 people	Mean age: 60 years % male:48.4 % white: 86.1	Comparison of NHS Health Check attendance	Logistic regression models adjusting for age,	Individual-level data

Journal article	primary care electronic health records	Screening completed between Jan 2009 and May 2010			between socioeconomic groups	gender and smoking status	
Mytton *et al* (2018) [102]* Journal article	Simulation using cohort data Health Survey of England (2009±2012) and the English Longitudinal Study of Aging (1998±2012) data were used	Health Survey for England dataset	200,000 individuals	Mean age: not reported % male: 50.4 %White: 86.1%	NHS Health Check programme compared to a healthcare system without systematic health checks	Microsimulation model	Individual-level
Palladino *et al* (2017)[103]* Abstract	Quasi experimental study Routine data	370,454 individuals aged 40–74 years registered with 455 general practices in England 2009-16	370,454 individuals	Not reported	High vs. medium and low programme coverage	Quasi-experimental propensity score adjusted study	Individual-level
Robson *et al* (2017)[104]* Journal article	Retrospective cohort General practice electronic health records	143 general practices in three clinical commissioning groups (CCGs) in east London April 2009-March 2014	252,259 adults from 139 general practices	%≥60 years: 11.5 (intervention group); 8.5 (control group) % male: 52.3 (intervention group); 59.5 (control group) % white: not reported	Attendance vs. non-attendance	Matched analysis. Matching criteria were CCG, NHS Health Check year, age, sex, and ethnic group	Individual-level
Caley *et al* (2014)[107] Journal Article	Non-randomised controlled study Electronic medical records	General practices in Warwickshire June 2010 – March 2013	79 General practices	Mean age: 41 years % male: 50.0%	Differences in population-level coverage	Multivariate regression models	Practice level
Chang *et al* (2016)[9] Journal Article	Matched cohort study CPRD data	England Baseline: April 2009 - March 2013 Follow-up: Median of 2 years	138,788 patients (a random sample drawn from the national CPRD dataset)	Mean age: 53.5 (attendees) 50.1 (comparison) % male: 47.4 (attendees) 50.0 (comparison) % white: 71.9 (attendees) 54.8 (comparison)	Attendees compared with non-attendees	Difference in differences with propensity score matching on age, gender, ethnicity, deprivation and region	Individual-level

Forster *et al* (2015)[108] Journal article	Matched cohort study CPRD data	England April 2009 - March 2013	75,123 patients (intervention) 182,245 patients (matched controls)	Mean age: 54 years %male: 48% % living in most deprived quintile: 15.2%	Attendees compared with non-attendees	Cohort study with matching on age, gender and general practice	Individual-level
Jamet *et al* (2014)[109] Working Paper	Observational study BNF (Large national prescriptions dataset)	England 2012	145 PCTs	N/A	Differences in population-level coverage	Multivariate regression models	PCT-level
Lambert *et al* (2016)[110] Journal article	Observational study	3 health districts in North East England	101 practices	Not reported	Differences in population-level coverage	Univariate regression models	Area-level
Before and after studies							
Artac *et al* (2013) [111]Journal article	Observational study Electronic medical records	Hammersmith and Fulham PCT July 2008 – March 2011 (pre-2008 data was also used)	1,886 high risk patients (baseline) 1,574 (follow-up)	% aged>65: 34.2% % male:78.4% % white:71.4%	Change over time	Significance testing	Individual-level
Chang *et al* (2015)[16]Journal Article	Observational study CPRD data	England April 2009 - March 2013	95,571 patients (a random sample drawn from the national CPRD dataset)	% aged>60:60.2% % male:20.2% % British:35.8%	Change over time	Descriptive statistics only	Individual-level
Cochrane *et al* (2012)[112] Journal article	Randomised triala Trial data	38 (of 57) general practices in Stoke on Trent Baseline: August 2009-January 2010 Follow-up: 1 year	365 patients in NHS Health Check arm of trial	Mean age:63.9 % male:90.1% %white:97%	Change over time	Significance testing	Individual-level
Dalton *et al* (2011)[26] Journal Article	Observational study Electronic practice records	29 (of 86) general practices in Ealing, London 2008-2009	5,294 high risk patients	Not reported	Change over time	Descriptive statistics only	Individual-level
Forster *et al* (2015)[17] Journal Article	Observational study CPRD data	England Baseline: 2010-2013 Follow-up: 15 months	140,356 patients	Not reported	Change over time	Descriptive statistics only	Individual-level

Krska *et al* (2015)[27] Journal Article	Observational study Electronic practice records	13 (of 55) general practices in Sefton, North West England Not reported (assumed first year of NHS Health Checks since high risk patients)	2,892 high risk patients	% aged >65:69.4% % male:78.3% % white:99.1%	Change over time	Univariate regression models	Individual-level
Robson *et al* (2016)[18]	Observational study QResearch data	England Baseline: April 2009 to March 2013 Follow-up: 12 months	214,295 patients (attended NHS Health Check) 1,464,729 patients (did not attend)	% aged >60:22.2% % male:49.6% % white:63.4%	Change over time	Descriptive statistics only	Individual-level
Studies without comparison							
Baker *et al* (2015)[21] Journal article	Cross-sectional review General practice feedback forms	83 of 85 general practices in Gloucestershire July 2011-July 2012	20,973	%aged 45-49: 17.3% % male: 45.2% % white: 94.8%	None	Descriptive statistics only	Individual-level
Carter *et al* (2015)[22] Journal Article	Observational cross sectional study Electronic medical records	65 general practices in Leicester City Clinical Commissioning Group April 2009-March 2014	53,799 patients	Not reported	None	Descriptive statistics only	Individual-level
Cochrane *et al* (2013)[23] Journal article	Observational cross sectional study Electronic practice records	37 (of 57) general practices in Stoke on Trent August 2009-January 2010	10,483 high risk patients	Not reported	None	Descriptive statistics only	Individual-level
Coffey *et al* (2014)[24] Journal article	Observation study Electronic database	40 general practices in Salford 2013-14	3,933	%male: 47.7%	None	Descriptive statistics only	Individual-level
Hooper *et al* (2014)[42] Short article	Observational study / NHS Health Checks data	40 general practices offering NHS Health Checks in Warwickshire April 2010 – March 2013	37,236 patients	Not reported	None	Descriptive statistics only	Individual-level
Robson *et al* (2015)[30] Journal Article	Observational study Electronic practice records	139 (of 143) general practices in North East London April 2009 to April 2012	144,451 patients	% aged >60:10.8% % male: Not reported % white:42.2%	None	Descriptive statistics only	Individual-level

*and bold outside border denotes new studies included in the updated review

3.6.1 The effect on disease detection

In the earlier review by Usher-Smith *et al* (2017), 12 studies reported data on disease detection.[113] Five new studies (Palladino *et al* (2017)[103]; Kennedy *et al* (2019)[101]; Robson *et al* (2017)[104]; Gulliford *et al* (2017)[48]; Lang *et al* (2016)[12]) were identified for this review update which reported disease detection data (See Table 26).

One of the newly identified studies (Palladino *et al* 2017) compared disease incidence rates between individuals without pre-existing type-2 diabetes who were registered between 2009-2016 at one of 455 general practices from across England, with high, medium or low NHS Health Check programme coverage.[103] The incidence rate of detected non-diabetic hyperglycaemia was 19% higher in the high coverage group than in the low coverage group (2781 vs. 2479 cases: hazard ratio (HR) 1·19, 95% confidence interval (CI) 1·01 to 1·41).[103] Also, rates of type 2 diabetes diagnosis (4,058, 4,657, and 3,827 cases in low, medium, and high coverage groups) were 10% higher in the medium coverage group (HR 1·10, 95% CI 1·03 to 1·18) and 11% higher in the high coverage group (HR 1·11, 95% CI 1·03 to 1·19).[103]

The other four studies reported data from specific regions of England.[12 48 101 104] Kennedy *et al* (2019) analysed data from 151 general practices in Hampshire from 2011-15.[101] Multivariate analyses adjusting for age and gender showed associations between NHS Health Check attendance vs. non-attendance and detection of the following: CVD risk >10% (OR 8.01, 95% CI 7.34 to 8.73) and >20% (5.86, 4.83 to 7.10), total cholesterol >5.5 mmol/L (3.72, 3.57 to 3.89) and >7.5 mmol/L (2.89, 2.46 to 3.38), and diagnoses of hypertension (1.33, 1.20 to 1.47) and diabetes (1.34, 1.12 to 1.61).[101]

Robson *et al* (2017) reported data from 143 general practices in east London.[104] Newly-diagnosed diseases occurred more in NHS Health Check attendees than non-attendees, with odds ratios for new diabetes 1.30 (95% confidence interval [CI] = 1.21 to 1.39), hypertension 1.50 (95% CI = 1.43 to 1.57), and chronic kidney disease 1.83 (95% CI = 1.52 to 2.21).[104]

Gulliford *et al* (2017) analysed data from 2013-15 from patients registered at 18 general practices in two London boroughs.[48] They reported that 22.2% of individuals who received opportunistic NHS Health Checks had a CVD risk score ≥10% compared to 17% of individuals who attended following invitation, a relative increment of 28% (95% CI 14–44%, P < 0.001).[48]

Lang *et al* (2016) analysed data from 2009-10 from patients who attended nine general practices across West Midlands.[12] Among those who attended NHS Health Checks screening, the most deprived were more likely to have CVD risk >20% (OR 1.09, 95% CI 1.03 to 1.15

per IMD decile, p=0.004).[12]

The results from studies included in the original review in addition to this review update are summarised in Table 26, Table 27 and Figure 9.

Table 26 Summary of results of studies reporting the impact of the NHS Health Check on disease detection

Author/ Year Publication type	Setting	Comparison	Disease detection
Gulliford *et al* (2017)[48]* Journal article	18 general practices in two London boroughs	Difference in CVD risk scores between opportunistic vs. invited Health Check attendees	17.0% of invited checks and 22.2% of opportunistic NHS Health Checks with CVD risk score ≥10%; a relative increment of 28% (95% confidence interval: 14–44%, P < 0.001)
Kennedy *et al* (2019)[101]* Journal article	151 general practices in Hampshire, England, UK. April 2011 and March 2015	Attendance vs. non-attendance	Multivariate analyses showed associations between Health Check invitation and detecting CVD risk >10% (OR 8.01, 95% CI 7.34 to 8.73) and >20% (5.86, 4.83 to 7.10), Total cholesterol >5.5 mmol/L (3.72, 3.57 to 3.89) and >7.5 mmol/L (2.89, 2.46 to 3.38), and diagnoses of hypertension (1.33, 1.20 to 1.47) and diabetes (1.34, 1.12 to 1.61).
Lang *et al* (2016)[12]* Journal article	9 general practices across West Midlands Screening completed between Jan 2009 and May 2010	Comparison of NHS Health Check attendance and risk factor detection between socioeconomic groups	Among those who attended screening, the most deprived were more likely to have CVD risk >20% (OR 1.09 (1.03 to 1.15) per IMD decile; p=0.004).
Palladino *et al* (2017)[103]* Journal article	370,454 individuals aged 40–74 years registered with 455 general practices in England 2009-16	High vs. medium and low programme coverage	The incidence rate of detected non-diabetic hyperglycaemia was 19% higher in the high coverage group than in the low coverage group (2,781 vs. 2,479 cases; hazard ratio 1·19, 95% CI 1·01 to 1·41), and rates of type 2 diabetes diagnosis (4,058, 4,657, and 3,827 cases in low, medium, and high coverage groups) were 10% higher in the medium coverage group (1·10, 1·03 to 1·18) and 11% higher in the high coverage group (1·11, 1·03 to 1·19). Individuals with detected non-diabetic hyperglycaemia in the high coverage group had a 1·1% larger reduction in cardiovascular risk than did those in the low coverage group (β=–1·12, 95% CI –1·61 to –0·63; mean follow-up 43·9 months), and those with detected type 2 diabetes a 0·4% larger reduction (–0·42, –0·78 to –0·06; 49·8 months).
Robson *et al* (2017)[104]* Journal article	143 general practices in three clinical commissioning groups (CCGs) in east London April 2009-March 2014	Attendance vs. non-attendance	Newly-diagnosed comorbidity was more likely in attendees than non-attendees, with odds ratios for new diabetes 1.30 (95% confidence interval [CI] = 1.21 to 1.39), hypertension 1.50 (95% CI = 1.43 to 1.57), and chronic kidney disease 1.83 (95% CI = 1.52 to 2.21).
Caley *et al* (2014)[107] Journal Article	79 general practices in Warwickshire	Association between % eligible completing an NHS Health Check	Change in prevalence of T2DM, hypertension, CHD, CKD, AF: Not statistically significant

Author/ Year Publication type	Setting	Comparison	Disease detection
		and change in prevalence of five conditions	
Chang *et al* (2016)[9] Journal Article	England	Differences between attendees and matched non-attendees	Change in AF: 0.02 (-0.02 to 0.06) Change in CKD: 0.17 (0.11 to 0.23)* Change in CAD: 0.02 (-0.04 to 0.08) Change in FH: 0.09 (0.07 to 0.11)* Change in heart failure: 0.01 (-0.01 to 0.03) Change in hypertension: 2.99 (2.77 to 3.21)* Change in PVD: 0.03 (0.01 to 0.05)* Change in stroke: -0.03 (-0.05 to -0.01)* Change in TIA: 0.008 (-0.01 to 0.03) Change in T2DM: 1.31 (1.17 to 1.45)*
Forster *et al* (2015) [108] Journal article	England	Differences between attendees and matched non-attendees	Hypertension: Men: +5%* Women: Not significant FH: Men: +33%* Women +32%*
Lambert *et al* (2016)[110] Journal article	3 health districts in North East England 30 months	Association between number of NHS Health Checks completed and outcomes	Association between NHS Health Check coverage and incident high risk cardiovascular disease and incident hypertension with the number of NHS Health Checks performed

*and bold outside border denotes new studies included in the updated review

Figure 9 Case detection rates amongst those attending NHS Health Checks

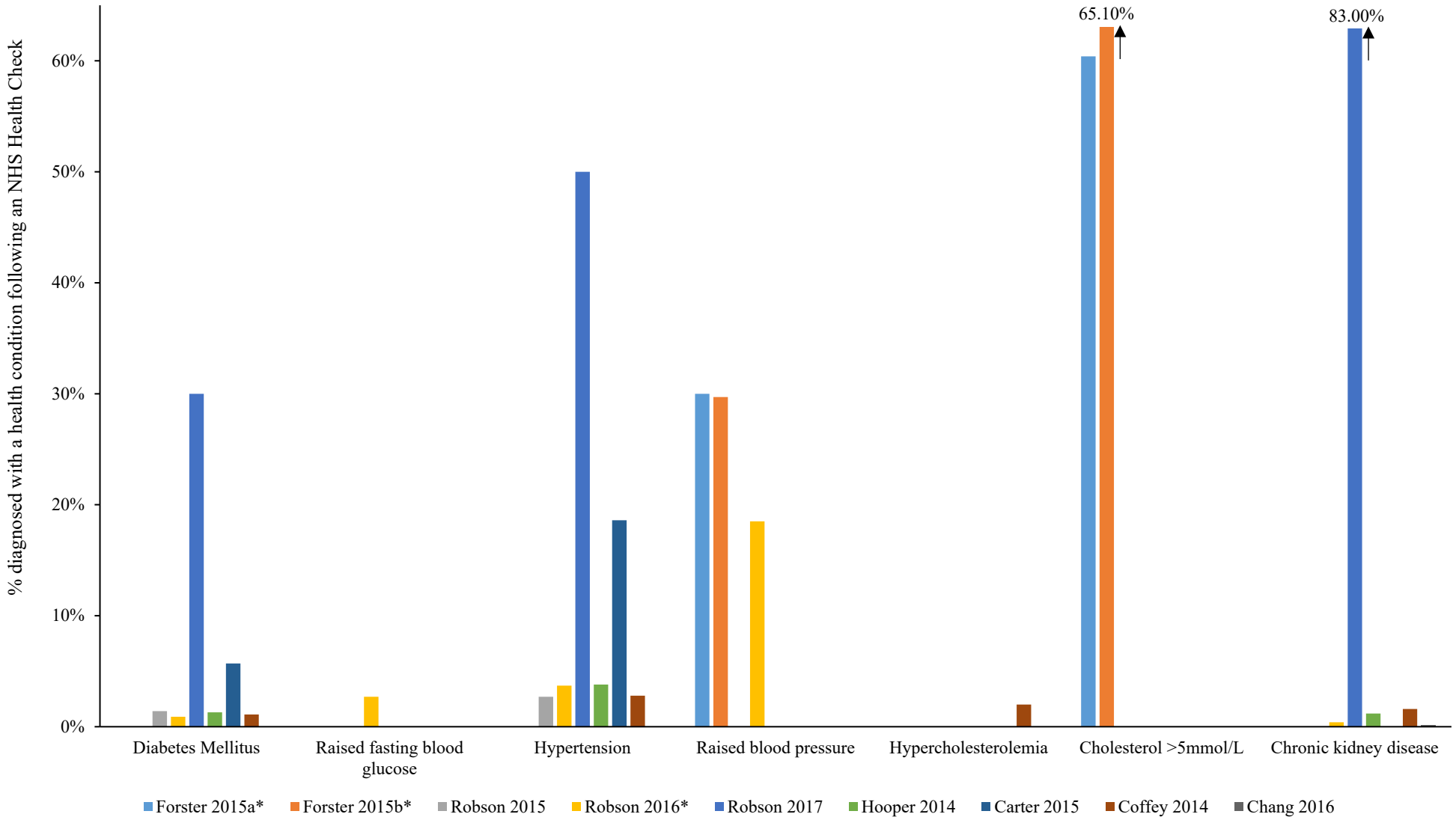


Table 27 Estimates of the number needed to screen (reported by included studies) to detect a new case of a disease or condition across different studies

Disease	Forster *et al* 2015[108a]	Forster *et al* 2015[17a]	Robson *et al* 2016[18b]	Robson *et al* 2015[30]	Kennedy *et al* 2019[101*a]	Hooper *et al* 2014[42]	Carter *et al* 2015[22]	Coffey *et al* 2014[24]
Diabetes		125-333 (60 days)	110 (12 months)	80 (6 months)	250 (12 months)	79	18 (not clear)	91 (up to 12 months)
Raised fasting blood glucose			37 (12 months)					
Hypertension			27 (12 months)	38 (6 months)	89 (12 months)	26	5 (not clear)	36 (up to 12 months)
Raised blood pressure (>140/90mmHg)	3	3	5		13 (12 months)			
Hypercholesterolaemia								50 (up to 12 months)
Total cholesterol >5mmol/l	2	2			5 (12 months)			
Chronic kidney disease			265 (12 months)	568 (6 months)	1,616 (12 months)	84	63 (not clear)	
CVD risk ≥ 20%		6	8	10	13 (12 months)		9	8

[a]National datasets

[b]Comparison between invited vs. opportunistic NHS Health Checks

Time periods in brackets are the time periods following the NHS Health Check in which the disease was detected. Where no time is given, data is up to and including only the NHS Health Check itself.

The GRADE approach was implemented to address Objective 6.1, namely the effect of NHS Health Checks vs. no NHS Health Check on disease detection, based on the nature of the comparisons (see Table 28). The overall GRADE assessment was 'very low' for the comparison between high and low population coverage of the NHS Health Checks programme, due to the observational nature of included studies and also indirectness (as the nature of the intervention group varied between studies). An overall GRADE assessment was not calculated for the comparison between invited vs. opportunistic NHS Health Checks as only one study fed into this table. An overall certainty rating of moderate was computed for the comparison of disease rates between attendance compared to NHS Health Check non-attendance, as the dose-response relationship was high (83% higher disease detection for chronic kidney disease between attendees and non-attendees in one study)

Table 28 GRADE assessment for the evidence contributing to Sub-objective 6.1-1/2/3

Comparison applied to	Certainty assessment							Certainty	Importance
	№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations		
High and low population coverage of NHS Health Checks programme	3[103 107 110]	observational studies[a]	not serious	not serious[b]	serious[c]	not serious[d]	none	⊕◯◯◯ VERY LOW	CRITICAL
Invited vs. opportunistic NHS Health Checks	1 [48]	observational studies	not serious[e]	[f]	not serious	serious[g]	none		CRITICAL
Attendance compared to non-attendance	4[9 18 101 108]	observational studies[h]	not serious[i]	not serious[j]	not serious	not serious[k]	strong association[l]	⊕⊕⊕◯ MODERATE	CRITICAL[m]

a. Study descriptions were: quasi-experimental study[103]; non-randomised controlled study[107] and an observational study.[110]
b. Palladino (2017) found that high NHS Health Checks programme coverage was associated with increased detection of diabetes[103] whereas Lambert (2015) found that increased population coverage of the NHS Health Checks programme was not associated with growth in general practice disease registers for diabetes[110]. Caley (2014) found no significant associations between % eligible completing an NHS Health Check and change in prevalence of five conditions including diabetes[107]. These variations could reflect ecological effects, attributable to differences in the geographical coverage of each study.[107]
c. The nature of the intervention group varied between studies. For example, Palladino (2017) compared general practices with high vs. medium or low coverage; Lambert (2016) assessed variation in detection rates in relation to number of NHS Health Checks performed across practices (therefore no binary intervention and control groups) and Calley (2014) compared practices that offered the intervention with control practices which did not.[103 107 110]
d. One of the studies (Palladino 2017) used data from a large sample and the confidence intervals did not cross the line of no effect.[103]
e. The study received one low overall rating, however this was in relation to the external rather than internal validity of the study.
f. Not applicable as only one study is included in this GRADE assessment.
g. The sample size was relatively small and the confidence intervals quite wide for >10% CVD risk in this study.
h. One study had a quasi-experimental design, three were cohort studies.
i. None of the studies received low ratings for domains relevant to internal validity/ risk of bias.
j. Overall, the intervention was associated with increased disease detection. Rates for individual diagnoses varied across studies however this is likely to reflect differences between samples, as some studies used national data whereas others used data from regions or smaller spatial units.
k. Some of the studies were small and potentially under-powered, however several studies used national data sets and therefore the overall sample size is large. Confidence intervals crossed the line of no effect in some cases however generally, confidence intervals were not large.
l. Robson (2017) reported the rate of chronic kidney disease diagnosis amongst attendees as 83%.
m. The purpose of the NHS Health Checks programme is to screen for chronic health conditions.

3.6.2 The effect on changing health-related behaviours

One additional study (Alageel *et al* 2019) was identified for this updated review which assessed the impact of the NHS Health Check attendance on a health behaviour (see Table 29).[68] Consistent with the earlier review by Usher-Smith *et al* (2017) the only behaviour assessed was smoking.[1] This new study had a cohort design and used national data from the CPRD dataset.[68] The study reported net reductions in smoking prevalence over a six-year period following the intervention amongst NHS Health Check attendees and amongst controls (matching criteria were not described). A greater net reduction in smoking prevalence was reported for the control group (NHS Health Check attendees 17% net reduction in smoking prevalence compared to baseline vs. 25% net reduction amongst controls; OR 0.90, 0.87 to 0.94, $P < 0.001$).[68] The reduction in smoking prevalence following NHS Health Check attendance was consistent with the overall findings from the earlier review.[1] However, unlike within the two studies included in the earlier review, the newly identified study by Alageel *et al* (2019) reported a larger reduction in smoking prevalence in the control group when comparing the magnitude of change between attendees and non-attendees.[68]

Table 29 Summary of results of studies reporting the impact of the NHS Health Check on health-related behaviours

Author / Year Publication type	Setting	Comparison	Behaviour
Alageel *et al* (2019)[68]* Journal Article	England	Differences between attendees and matched non-attendees	Health Check participants were less likely to be smokers than controls. After six years' follow-up the following net reductions in smoking were seen; NHS Health Check attendees 17% vs. controls 25% (OR 0.90, 0.87 to 0.94, P < 0.001).
Chang *et al* (2016)[9] Abstract	England	Differences between attendees and matched non-attendees	Change in smoking prevalence: -0.11 (-0.35 to 0.13)
Artac *et al* (2013)[111] Journal article	Hammersmith and Fulham PCT	Change over time amongst NHS Health Check attendees	No significant change in smoking status
Cochrane *et al* (2012)[112] Journal article	38 (of 57) general practices in Stoke-on-Trent	Change over time amongst NHS Health Check attendees	Significant reduction in smoking.
Forster *et al* (2015)[17] Journal Article	England	Change over time amongst NHS Health Check attendees	Significant reduction in the proportion of males (-16%) and females (-15%) who reported being smokers
Chang *et al* (2016)[9] Journal Article	England	Differences between attendees and matched non-attendees	Change in smoking prevalence following the intervention: -1.08 (-2.14, -0.02)

*and a bold outside border denotes new studies included in the updated review

Regarding the effect of NHS Health Checks vs. no NHS Health Checks on health-related behaviours the certainty in the evidence is very low (see Table 30). This is due to the mainly observational study type, the outcome data being opportunistically collated self-report data with high risk of bias, the inconsistency seen and the imprecision.

Table 30 GRADE assessment for the evidence contributing to Sub-objective 6.2

Certainty assessment							Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations		
5[9 17 68 111 112]	observational studies[a]	serious[b]	serious[c]	not serious	Not estimable[d]	none	⨁◯◯◯ VERY LOW	IMPORTANT[d]

a. One randomised study[112] and four observational studies.

b. Mode of collection of smoking data wasn't consistently reported, however it is likely to have been self-report and entered into routine medical records which relies on patients both attending the general practice and being asked about their smoking status within that time. Issues associated with self-report data and completeness could introduce biases in relation to the outcome measurement.

c. Although point estimates indicated a reduction in smoking across studies, there were inconsistencies regarding the statistical significance of these effects between studies.

d. Imprecision is not estimable due to differences in effect calculations between studies.

3.6.3 The effect on referrals to local risk management services

Four additional studies were located for the review update which reported data for the association between NHS Health Check attendance and being referred to lifestyle services. [11 68 96 101]

Based on an analysis of national CPRD data, Alageel *et al* (2017) identified that smoking cessation interventions were offered to a higher proportion of NHS Health Check recipients in the first year following the intervention compared to controls who did not receive an NHS Health Check (difference 24.1%, 95% CI 23.85-24.62%, p<0.001).[96] Using the same dataset Alageel *et al* (2019) reported that Health Check participants were more likely to receive weight management advice (adjusted hazard ratio [HR] 5.03, 4.98 to 5.08, P<0.001), smoking cessation interventions (HR 3.20, 3.13 to 3.27, P<0.001) compared to control participants who were matched for age, sex, and general practice, and did not receive an NHS Health Check.[68] Kennedy *et al* (2019) analysed data from 151 general practices in Hampshire, England.[101] Across 5 patient cohorts, NHS Health Check attendance resulted in an increase in the provision of stop smoking advice (OR 1.65, 95% CI 1.51 to 1.79) and weight advice/referrals (OR 8.36, 95% CI 7.89 to 8.86).[101] Coghill *et al* (2018) found that 1.8% of NHS Health Check attendees were referred to a smoking cessation service, 0.02% to a dietician, 0.3% to a physical activity service and 0.01% to an alcohol service, amongst from 13,733 NHS Health Checks completed at 38 general practices in Bristol.[11] As with the previous review, the data summarised in Table 31 illustrate wide variations in referrals between different areas of the country.[1]

Table 31 Summary of results of studies reporting the impact of the NHS Health Check on referrals to lifestyle services

Author/year	Setting	Data	Smoking cessation amongst smokers (%)	Diet/weight loss amongst those with BMI ≥30 (%)	Exercise amongst those with low physical activity or BMI ≥30 (%)	Alcohol amongst those with increased alcohol consumption(%)
Participants with cardiovascular risk ≥ 20%						
Alageel *et al* (2017)[96]*	England CPRD data	Offered a smoking cessation intervention	81			
Alageel *et al* (2019)[68]*	England CPRD data	Advice or referrals	90	73 (weight management)	Not reported	
Coghill *et al* (2018)[11]*	38 general practices in Bristol	Referral	1.8	0.02	0.3	0.01
Kennedy *et al* (2019)[101]*	151 general practices in Hampshire, England	Advice or referrals	23.5-26.8 across 5 cohorts	63.2-57.7 across cohorts (weight advice/ referral)	Not reported	
Krska *et al* (2015)[27]	13 (of 55) general practices in Sefton, North West England	Referrals	7.9	3.7	6.9	1.6
Robson *et al* (2016)[18]	England QResearch database	Referrals	5.7	40.0	42.4	33.1
Cochrane *et al* (2013)[23]	38 (of 57) general practices in Stoke on Trent	Referrals	---------- 9.7 referred to enhanced lifestyle support ----------			
Forster *et al* (2015)[17]	England CPRD data	Advice or referrals	74.5	---------- 70.7 ----------		
Participants with any cardiovascular risk						
Robson *et al* (2016)[18]	England QResearch database	Referrals	6.8	38.7	41.4	33.9
Baker *et al* (2015)[21]	83 of 85 general practices in Gloucestershire	Advice or referrals	66.9	40.8	44.2	0.7
Coffey *et al* (2014)[24]	40 general practices in Salford	Referrals	0.5			

*and a bold outside border denotes new studies included in the updated review

An overall certainty rating of 'very low' was identified for the GRADE assessment of the effect of NHS Health Checks vs. no NHS Health Checks on referrals to local risk management services (see Table 32). This was due to the observational nature of the studies completed,

concerns regarding confounding, risk of bias, inconsistency in the outcome measurement, poor internal validity and large heterogeneity of effects.

Table 32 GRADE assessment for the evidence contributing to Sub-objective 6.3

Certainty assessment							Certainty	Importance
№ of studies	**Study design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**		
11	observational studies[a]	serious[b]	serious[c]	not serious	not serious[d]	none	⨁◯◯◯ VERY LOW	IMPORTANT

a. One quasi-randomised controlled trial(Kennedy *et al* 2019)[101]; the remaining studies had an observational design.

b. Two studies (Krska *et al* 2015[27] and Baker *et al* 2015[21]) were rated low on confounding; one study (Foster 2015[17]) was rated low on outcome measurement. These are issues relevant to the internal validity of a study.

c. Large variations existed in the proportions of patients being referred to lifestyle services between studies. This heterogeneity is likely reflective of geographical variations in referrals.

d. The 11 studies which reported relevant data to address the research question were mixed in their coverage; some used national datasets with large sample sizes other studies used regional data. Overall however, the sample size was large. Confidence intervals were not presented for several studies and it is likely that the confidence intervals were large for the regional studies, however in several of the larger studies for which CIs were presented, these were narrow.

3.6.4 The effect on reductions in individual risk factors and cardiovascular disease risk

In the original review, four studies were identified that included data on the effect of the NHS Health Check on risk factor prevalence and cardiovascular disease risk. One additional study (Alageel *et al* 2019[68]) was identified in this review update which assessed change in risk factor values following the NHS Health Check.[68] At six years following the Health Check, adjusted mean differences (95% CI, P value) in cardiovascular risk factor scores between cases and control participants were as follows: body mass index (Kg/m2) -0.30 (-0.39 to -0.20, <0.001); systolic blood pressure (mean, mm Hg) -1.43 (-1.70 to – 1.16, <0.001); diastolic blood pressure (mean, mm Hg) -0.93 (-1.11 to -0.75, <0.001) total cholesterol (mean, mmol/L) – 0.05 (-0.07 to – 0.03, <0.001), high density lipoprotein cholesterol (mean, mmol/L) 0.01 (0.002 to 0.02, 0.21 a statistically non-significant reduction).[68] This was broadly consistent with findings from the earlier review (see Table 34). Overall, the evidence indicates a general reduction in cardiovascular risk factors in relation to NHS Health Checks. The direction of effect was inconsistent across studies in relation to systolic blood pressure (two studies reported a reduction and three studies reported no reduction following the intervention, see Table 33) and BMI/ obesity (four studies reported a reduction and one study reported no reduction following the intervention). However none of the studies indicated an increase in cardiovascular risk factor values following the intervention.

Table 33 Changes in individual risk factors and cardiovascular disease risk in studies reporting changes over time amongst people who had attended NHS Health Checks

Risk Factor	Artac 2013[111]	Cochrane 2012[112]	Forster 2015[17]	Chang 2016[114]	Alageel 2019[68]
Cardiovascular disease risk score	↓	↓	↔	↓	Not reported
Systolic blood pressure	↔	↔	↔	↓	↓
Diastolic blood pressure	↓	↓	↓	↓	↓
Cholesterol	↓	↓	↓	↓	↓
BMI / obesity	↔	↓	↓	↓	↓

↓ represents a decrease in individual risk factors and cardiovascular disease risk, ↔ represents maintenance in individual risk factors and cardiovascular disease risk

Table 34 Summary of results of studies reporting the impact of the NHS Health Check on reductions in individual risk factors and cardiovascular disease risk

Author / Year Publication type	Setting	Comparison	Individual risk factor or cardiovascular risk reductions
Alageel *et al* (2019)[68]* Journal article	England	Differences between attendees and matched non-attendees	At six years following the Health Check, adjusted mean differences (95% CI, P value) in cardiovascular risk factor scores between cases and control participants were as follows: body mass index (Kg/m2) -0.30 (-0.39 to -0.20, <0.001); systolic blood pressure (mean, mm Hg) -1.43 (-1.70 to – 1.16, <0.001); diastolic blood pressure (mean, mm Hg) -0.93 (-1.11 to -0.75, <0.001) total cholesterol (mean, mmol/L) – 0.05 (-0.07 to – 0.03, <0.001), high density lipoprotein cholesterol (mean, mmol/L) 0.01 (0.002 to 0.02, 0.21).
Chang *et al* (2016)[9] Journal Article	England	Differences between attendees and matched non-attendees	Change in QRISK2 CVD risk: -0.21% (-0.24 to -0.19)* Change in SBP: -2.51mmHg (-2.77 to -2.25)* Change in DBP: -1.46mmHg (-1.62 to -1.29)* Change in BMI: -0.27 (-0.34 to -0.20)* Change in Cholesterol: -0.15mmol/L (-0.18 to -0.13)*
Artac *et al* (2013)[111] Journal article	Hammersmith and Fulham PCT	Change over time among NHS Health Check attendees	Significant reduction in: CVD risk score (JBS) (from 28.2% to 26.2%), DBP (but not SBP), Cholesterol, Lipid ratios. No significant change in: BMI or obesity
Cochrane *et al* (2012)[112] Journal article	38 (of 57) general practices in Stoke on Trent	Change over time among NHS Health Check attendees	Significant reduction in CVD risk, DBP and SBP, cholesterol and obesity.
Forster *et al* (2015)[17] Journal Article	England	Change over time among NHS Health Check attendees	Significant reduction in: SBP (-5.53mmHg in males and -2.33mmHg in females), DBP (-3.84mmHg in males and -1.94mmHg in females) Cholesterol (-0.39mmol/l in males and -0.28 in females) BMI (-0.28 kg/m2 in males, -0.19 kg/m2 in females). No significant reduction in CVD risk score.

The body of evidence assessing the effect of NHS Health Checks vs. no NHS Health Checks on reductions in individual risk factors and cardiovascular disease risk was rated as ‘very low’ due to concerns in relation to the outcome assessment in the largest study included in this analysis (Table 35).

Table 35 GRADE assessment for the evidence contributing to Sub-objective 6.4

Certainty assessment							Certainty	Importance
№ of studies	**Study design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**		
5[9 17 68 111 112]	observational studies b	serious c	not serious d	not serious	not serious e	none	⊕◯◯◯ VERY LOW	CRITICAL

a. One study was a randomised trial[112], the other four were observational studies.
b. One study had a domain with a low rating - Forster (2015)[17], for outcome measurement. This could affect the internal validity for assessment of the association between NHS Health Checks and CVD risk. Although the other four studies were rated as medium or high for this domain, the study by Forster (2015) was the largest study in the analysis and could have impacted significantly on the overall results.
c. Results were generally consistent across studies
d. Decision based on confidence intervals which were reasonably narrow and did not cross the line of no effect. Also, only one of the studies did not use a national data set with a large sample size.[112]

3.6.5 The effect on prescribing

Twelve studies in the original report by Usher-Smith *et al* (2017)[1] reported data on prescribing after the NHS Health Check. Four additional studies were identified for this review update which contain data quantifying the effect of NHS Health Checks on prescribing (Alageel *et al* 2019[68]; Coghill *et al* 2018[11]; Kennedy *et al* 2019[101]; Robson *et al* 2017[11 68 101 104]). A summary of results from the studies is presented in Table 36.

3.6.5.a Prescribing of statins

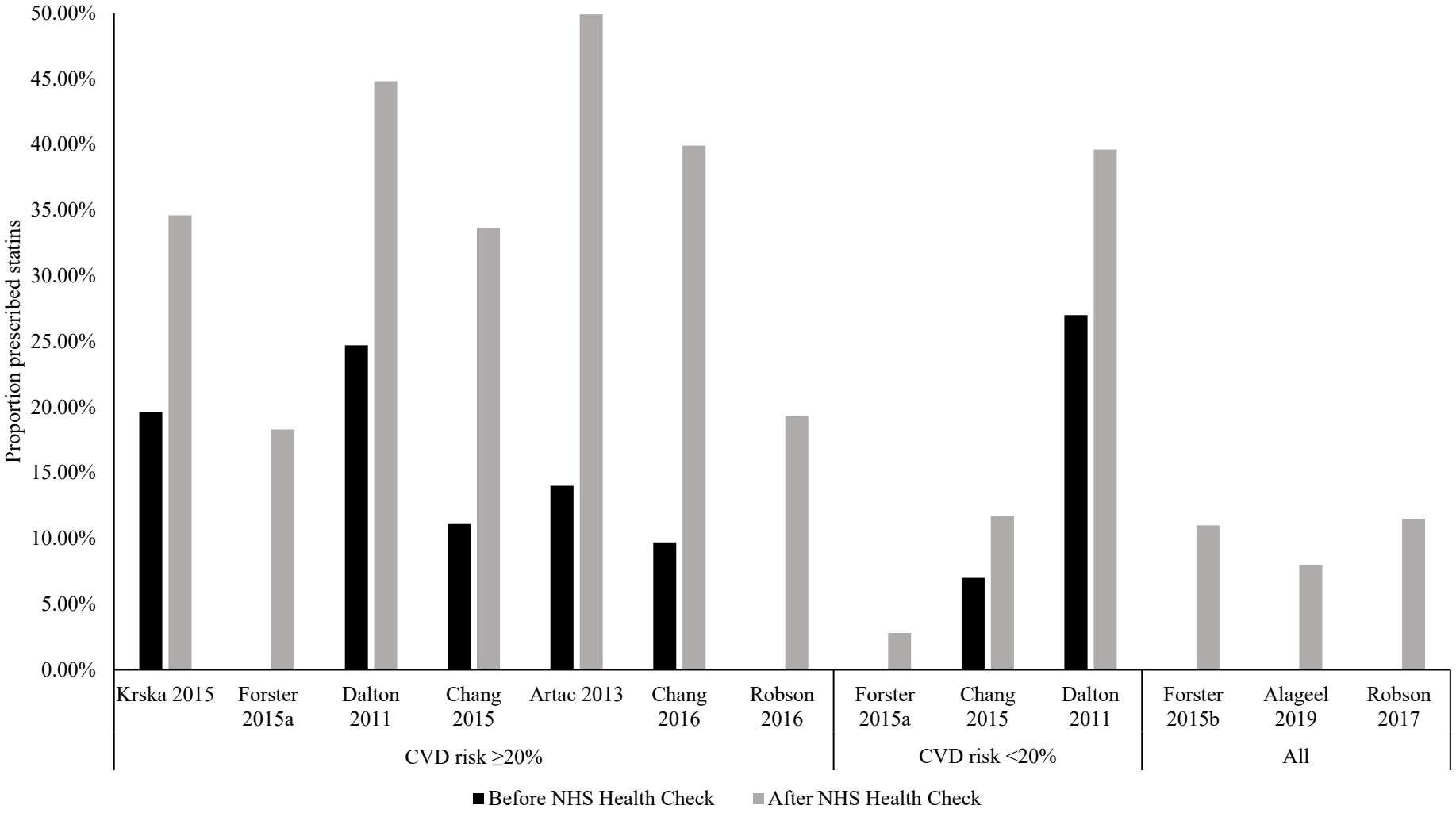
All studies in the initial review reported an increase in statin prescribing amongst those who attended an NHS Health Check, based on intra-individual comparisons before and after attendance and prescribing amongst NHS Health Check attendees comparative to non-attenders. The data from the newly identified studies in this review update provided findings consistent with those from the earlier review, NHS Health Checks increased statin prescribing.

A cohort study by Alageel *et al* (2019) reported that NHS Health Check attendees were more likely to receive statins compared to non-attenders (HR 1.24, 1.21 to 1.27, P<0.001) who were matched based on age, sex and general practice.[68] The data analysed in this study were from NHS Health Checks conducted from 2010-13, with annual follow-ups over a 6 year period.

A quasi- randomised controlled trial by Kennedy *et al* (2019) reported that NHS Health Checks led to an increase in the prescription of statins (OR 1.54, 95% CI 1.39 to 1.71) compared to age and sex-matched control participants.[101] The ORs of having CVD risk >10% plus being prescribed a statin or >20% plus statin, respectively, were 2.90 (95% CI 2.36 to 3.57) and 2.60 (95% CI 1.92 to 3.52).[101] The data analysed in this study were collected from April 2011 to March 2015.

A retrospective cohort study Robson *et al* (2017) also reported that new statin prescriptions were higher in attendees than in non-attendees (11.5% compared to 8.2%, respectively), where intervention and control participants were matched based on clinical commissioning group, NHS Health Check year, age, sex, and ethnic group.[104] The data in this study were collected from 2009-14.

Figure 10 Change in the percentage of people being prescribed statins before and after attending an NHS Health Check



3.6.5.b Prescribing of anti-hypertensives

In the cohort study by Alageel *et al* (2019), NHS Health Check attendees were less likely to receive anti-hypertensive drugs compared to non-attendees (HR 0.86, 95% CI 0.85 to 0.88, <0.001).[68] Overall this study was rated as being of high quality and adjusted for age, sex and deprivation level. The narrow confidence interval indicates a precise effect estimate and the highly significant result indicates that the difference between intervention and control groups in this study were unlikely to have occurred by chance. However, the finding of the study by Alageel *et al* (2019) is inconsistent with the findings from the studies reported in the earlier review, all of which reported increased prescription of anti-hypertensive medication in relation to NHS Health Check attendance.[68]

In contrast, Kennedy *et al* (2019) reported that anti-hypertensives were more likely to be prescribed to NHS Health Check attendees compared to age and sex-matched control participants who did not attend one (OR 1.15, 95% CI 1.06 to 1.24).[101] The OR of receiving a hypertension diagnosis in addition to anti-hypertensive treatment was 1.33 (95% CI 1.18 to 1.50).[101]

Table 36 Summary of results of studies reporting the impact of the NHS Health Check on prescribing

Author / Year Publication type	Setting	Comparison	Outcome: prescribing
Alageel *et al* (2019)[68]*	England	Differences between attendees and matched non-attendees	Health Check participants were more likely to receive statins (HR 1.24, 1.21 to 1.27, P<0.001) and were less likely to receive anti-hypertensive drugs 0.86 (0.85 to 0.88, <0.001)
Coghill *et al* (2018)[11]*	38 general practices in Bristol	Difference between population sub-groups of attendees	Compared to men, women were most likely to be prescribed a cardiovascular drug, (OR 1.18, 95% CI 1.03 to 1.35) as were patients aged ≥ 70 years compared to aged ≤70 years (OR 1.64, 95% CI 1.14 to 2.35). Those classified as being at high risk of CVD were most likely to be prescribed cardiovascular medication (OR 6.16, 95% CI 4.51 to 8.40). There was no evidence of any association between prescribing of CVD drugs and socioeconomic status or ethnicity
Kennedy *et al* (2019)[101]*	151 general practices in Hampshire, England, UK.	Attendance vs. non-attendance	NHS Health Checks led to increases in statins (OR 1.54, 95% CI 1.39 to 1.71) and anti-hypertensives (OR 1.15, 95% CI 1.06 to 1.24). The ORs of CVD risk >10% plus statin or >20% plus statin, respectively, were 2.90 (95% CI 2.36 to 3.57) and 2.60 (95% CI 1.92 to 3.52). The OR of hypertension diagnosis plus anti-hypertensive treatment was 1.33 (95% CI 1.18 to 1.50). There were no significant differences in prescriptions of NRT (OR 0.92, 95% CI 0.71 to 1.20), anti-glycaemics (OR 1.18, 95% CI 0.97 to 1.44) or anti-obesity medications (OR 1.00, 95% CI 0.68 to 1.48).
Robson *et al* (2017)[104]*	143 general practices in three clinical commissioning groups (CCGs) in east London	Attendance vs. non-attendance	New statin prescriptions were higher in attendees (11.5%, 9,802/85,122) than in non-attendees (8.2%, 13,741/167,137).
Chang *et al* (2016)[9]	England	Differences between attendees and matched non-attendees	Increase in statin prescribing: attendees: 9.7% to 15.3% (difference 5.6 (95%CI 5.29 - 5.90) Non-attendees: 3.1% to 4.3% (difference 1.2 (95%CI 1.11 – 1.28) Difference in difference matching estimate: 3.83 (3.52 to 4.14)* Increase in anti-hypertensive prescribing: Attendees: 4.8% to 9.9% (difference 5.05 (95%CI 4.76 – 5.33) Non-attendees: 1.8% to 4.4% (difference 2.59 (95%CI 2.59 – 2.70) Difference in difference matching estimate: 1.37 (1.08 to 1.66)*
Forster *et al* (2015)[108]	England	Differences between attendees and matched non-attendees	New statin prescribing: HR 1.58 (1.52- 1.63)* New anti-hypertensive drug prescribing: HR 1.06 (1.03 to 1.10)*
Jamet *et al* (2014)[109]	England	Association between number of NHS Health Checks completed and statin prescribing	Prescriptions of high dose statins: regression coefficient for NHS Health Checks 0.094* Prescriptions of low dose statins: Not significant

Author / Year Publication type	Setting	Comparison	Outcome: prescribing
Robson *et al* (2016)[18]	England April 2009 to March 2013 (4 years)	New prescriptions amongst Health Check attendees and descriptive comparisons with non-attendees	New statin prescription: Attendees: 5.1% Non-attendees: 1.0%; Attendees ≥20% risk: 19.3% New anti-hypertensive prescription: Attendees: 3.9% Non-attendees: 1.8%; Attendees ≥20% risk: 8.8%
Artac *et al* (2013)[111]	Hammersmith and Fulham PCT	Change amongst NHS Health Check attendees	Increase in statin prescribing: ≥20% risk: Male 13.8% to 51.3% Female 15.0% to 42.2% All 14% to 49.9%
Chang *et al* (2015)[16]	England	Change amongst NHS Health Check attendees	Increase in statin prescribing: ≥20% risk: Male 11.7% to 34.6% Female 7.8% to 27.8% All 11.1% to 33.6% <20% risk: Male 7.8% to 13.6% Female 6.4% to 10.3% All 7.0% to 11.7%
Dalton *et al* (2011)[26]	29 (of 86) general practices in Ealing, London	Change amongst NHS Health Check attendees	Increase in statin prescribing: High risk: 24.7% to 44.8% Low risk: 27.0% to 39.6%
Forster *et al* (2015)[17]	England	New prescriptions amongst NHS Health Check attendees	New statin prescription ≥20% risk: Male 17.6% Female 21.4% All: 18.3% <20% risk: Male 2.9% Female 2.7% All: 2.8% New anti-hypertensive prescription: ≥20% risk: Male 11.1% Female 16.3% All: 12.1% <20% risk: Male 3.4% Female 3.4% All: 3.4%
Krska *et al* (2015)[27]	13 (of 55) general practices in North West England	Change amongst NHS Health Check attendees	Increase in statin prescribing ≥20% risk: 19.6% to 34.6%
Cater *et al* (2016)[22]	65 general practices in Leicester	Prescriptions following NHS Health Check	Statin prescribing after NHS Health Check: ≥20% risk: Male 63% Female 67.8%
Cochrane *et al* (2013)[23]	37 (of 57) general practices in Stoke on Trent	Prescriptions following NHS Health Check	Statin prescribing after NHS Health Check: ≥20% risk: 17.1%
Coffey *et al* (2014)[24]	40 (of 47) general practices in Salford	Prescriptions following NHS Health Check	Statin prescribing after NHS Health Check: ≥20% risk: all 11%

*and a bold outside border denotes new studies included in the updated review

Table 37 GRADE assessment for the evidence contributing to Sub-objective 6.5

Certainty assessment							Certainty	Importance
№ of studies	**Study design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**		
16[9 11 16-18 22-24 27 68 101 104 108 109 111]	observational studies[a]	not serious[b]	not serious[c]	not serious	not serious[d]	none	⊕⊕◯◯ LOW	IMPORTANT

a. One study was a randomised trial[101], the remaining 15 had an observational design

b. The only study that received a low rating for a domain relevant to risk of bias was Krska 2016[27] which scored low for confounding. As other studies scored medium or high on this domain, it was deemed that risk of bias overall would not be significantly affected.

c. Most studies show an increase in prescribing following the NHS Health Check. The exception is Alageel 2019[68] in relation to prescribing of anti-hypertensive medication.

d. Although variations in effect estimates are present between studies, this heterogeneity may be attributable to factors including different sample sizes and differences in study designs. The confidence intervals reported appear reasonably small and do not cross the line of no effect.

3.6.6 Modelling studies

In the earlier review by Usher-Smith *et al* (2017)[1], three microsimulation studies were identified which assessed the cost-effectiveness of the NHS Health Checks programme based on different approaches to implementation. A further three studies economic modelling studies with relevant data were identified in the review update reported here (Collins, 2017[105]; Collins, 2020[99]; Hinde, 2017[100]).

Collins (2017) modelled data on Liverpool demographics, risk factor exposures, and CVD epidemiology to assess whether the city could redesign its NHS Health Checks to enhance its cost effectiveness and equity over a period of 15 years (from 2017-31).[105] The following three scenarios were modelled: i) current implementation of the NHS Health Checks programme; ii) optimal implementation of NHS Health Checks, which assuming optimal coverage, uptake, treatment and lifestyle changes; iii) combining the current implementation of the NHS Health Check programme with structural policies targeting dietary consumption of salt, sugar, fruit and vegetables.[105]

Over the 15-year period, the numbers of CVD cases prevented or postponed would be approximately 310 (40–734) for Scenario A, 870 (327–1,397) for Scenario B, and 1,740 (815–2,939) for Scenario C.[105] The cumulative discounted net costs and quality-adjusted life years (QALYs) gained for the three scenarios respectively were estimated to be +£2.1 m (£1.5 m – +£4.8 m) and +90 QALYs (-124 –+376) for A; +£1.4 m (£6.1 m – +£6.6 m) and +434 QALYs (-76 –+1,133) for B; or £16.9 m (£33.2 m – £5.9 m) and +2,871 QALYs (+1,355 –+4,830) for C. The estimated probabilities of Scenarios A and B being cost-effective by 2031 were 25% and 74% respectively, valuing each QALY at £20 000, whereas Scenario C was estimated to become cost-effective by 2030. Scenario A was predicted to increase existing health inequalities; Scenario B was predicted to be neutral, while it was considered that Scenario C would substantially decrease inequalities.[105]

Collins (2020) undertook a follow up to their 2017 study reported above by assessing the cost-effectiveness of re-designing the NHS Health Checks programme.[99] Using data from a subsample of Health Survey for England, the authors of this study simulated four scenarios for participants from Liverpool from 2002-2040 : a) no CVD screening, b) 'current' basic universal CVD screening as currently implemented, c) enhanced universal CVD screening with 'increased' population-wide delivery, and d) 'universal plus targeted' with top-up delivery to the most deprived fifth of the population.[99] The gross health benefits (total QALYs gained per

100,000 person years only, irrespective of costs) were 2.4 QALYs (95% Uncertainty Interval −4.5 to 11.1) for the current scenario, 3.9 (−6.2 to 16.5) for the 'increased' scenario and 5.6 (−4.2 to 18.7) for the 'universal plus targeted' scenario.[99]

Hinde *et al* (2017) assessed whether the impact of the Checks on BMI alone was sufficient to justify its cost using data from a patient cohort.[100] The NHS Health Checks programme was associated with a reduction in mean BMI of 0.27(95%CI 0.20 to 0.34) compared to no intervention.[100] Also, a small positive QALY gain of 0.05 per participant was identified, coupled with a reduction in disease-related care costs of £170 ($210 USD).[100] Based on the estimated cost per NHS Health Check of £179 the estimated incremental cost-effectiveness ratio was £900/QALY.[100]

3.6.7 Key findings and interpretation

Findings from the original review

- NHS Health Checks detect raised risk factors and morbidities amongst those who attend. One in four attendees are identified as having raised blood pressure, one in 30-40 are diagnosed with hypertension, one in every six to ten as having CVD risk ≥ 20% and one in every 80-200 are diagnosed with Diabetes Mellitus.
- Chronic kidney disease, familial hypercholesterolaemia, peripheral vascular disease are detected at an increased rate after an NHS Health Check.
- Smoking cessation rates in attendees compared with non-attendees show no difference. Further research is needed to explore the impact of attending an NHS Health Check on physical activity, diet, and alcohol consumption.
- Referrals to smoking cessation, weight loss, exercise, and alcohol cessation services varies widely and all are below the estimated uptake rates used in the initial modelling for the NHS Health Check programme.
- The overall percentage of people at high risk (≥20% modelled cardiovascular risk) prescribed statins following NHS Health Checks is increased by3-4%.
- Similar trends have been observed for anti-hypertensive prescribing.
- Modelling showed population-wide interventions were more cost-effective than individual level interventions.

Findings informed by the updated review

- Overall, findings were consistent between the earlier review and review update in relation to the direction of the effects of the NHS Health Checks programme on CVD risk (which decreased), risk management referrals (which increased), and health behaviours (specifically smoking status, which generally decreased) and prescription of statins (which increased).
- An inconsistency was reported between studies in the earlier review and the update on the effect of NHS Health Check attendance on prescribing of anti-hypertensive medications. A newly identified study reported reduced prescribing of anti-hypertensive medications amongst programme attendees compared to a control group.
- The only intended behaviour change assessed again was smoking, the findings in the new study aligned with the four others reporting that NHS Health Check participants

were less likely to be smokers compared to controls.

- Studies identified in this review update found that NHS Health Check attendance vs. non-attendance was associated with detection of high total cholesterol.
- General practices with high NHS Health Check coverage had increased detection of non-diabetic hyperglycaemia compared to practices with low programme coverage.
- A further three economic modelling studies were identified, two of which are allied with one another assessing implementation and re-design scenarios using demographic data from Liverpool's population, risk factor exposures and CVD epidemiology to assess health benefits, equity and cost effectiveness. The third assessed whether the impact of the Checks on BMI were sufficient to justify its costs.

Overview of findings

- There were 17 studies (5 newly identified) reporting data on disease detection.
- The certainty in the body of evidence on disease detection was judged to be very low due to large variations in effect (likely due to ecological effects) and indirectness.
- NHS Health Checks led to an overall increase in the detection of raised risk factors and morbidities (raised hyperglycemia, pre-diabetes, diabetes mellitus, cholesterol, hypertension, Chronic Kidney Disease). Results for other risk factors were inconsistent across studies although none saw an increase in risk.
- Effects seen varied between morbidities and in relation to gender and deprivation level.
- There was consistent evidence across the studies that amongst those attendees of an NHS Health Check compared to non-attendees stop smoking advice and weight management advice were more commonly given. As well as evidence of increases in referrals to smoking cessation, dietician support, a physical activity service or an alcohol service.
- All studies report an increase in statin prescribing amongst those who attend an NHS Health Check. Four of five studies report an increase in anti-hypertensive prescribing; a single cohort study reports a decrease in anti-hypertensive prescribing.

4. Discussion

Body of evidence

Although the number of published studies have increased by 43% since the last evidence review and a breadth of evidence exists, there remains to be research gaps on the NHS Health Checks programme. The certainty and confidence in the evidence informing Objectives one, two and six has been judged to range from low to very low. Meaning it is likely that any new, large, well reported studies at low risk of bias could potentially change our understanding of the data informing these objectives. Sub-objectives with a sparsity of data informing them are as follows: impact of setting on NHS Health Checks (eight studies); impact of NHS Health Checks on changing behaviours (six studies); impact on reduction in individual risk factors and cardiovascular disease risk (five studies); modelling the cost-effectiveness of the NHS Health Check programme (six studies). There remains to be a lack of randomised controlled trials addressing the research questions posed.

Strengths and limitations

The majority of the key findings from the original review remain unchanged. Evidence supporting these findings has strengthened, in the main, due to a consistent and increasing quantity of informing data.

The methods utilised to review the evidence available on the NHS Health Checks programme were comprehensive. In this updated evidence review, duplicate blinded screening of citations and full texts was undertaken. Duplicate data extraction was completed for all data types. Risk of bias assessments were carried and a summary of certainty in the overall body of evidence for each objective and sub-objective was completed. Methods used to synthesise the new data with the existing body of evidence were appropriate given the quantity and types of new studies identified.

Coverage and uptake of the NHS Health Checks remains below that originally idealized. With evidence on who is and who is not having an NHS Health Check still limited. Poor reporting regarding the variation in implementation remains as does the inconsistency across studies in what is meant when the term coverage and uptake are used. In particular, there is a lack of large scale, national level studies reporting characteristics of those who do and do not take-up an invitation to an NHS Health Check.

Reporting within studies also remains to be an issue, with data granularity only being given for

the standard socio-demographic factors. Additionally, when this granularity of data is given, it is often not being done across studies in a consistent fashion (e.g. with incomparable cut-points). This makes it difficult to draw conclusions across the body of evidence. Looking at how data collation and reporting could be standardised would still be of benefit.

Potential Further Research

High-quality studies comparing matched attendees and non-attendees, including follow-up would allow the impact of health check attendance on lifestyle factors to be further quantified. There is a need to understand more fully the effect of the programme on lifestyle behaviours, disease detection and prevention across divergent sociodemographic groups. Routine collection of data on those invited and those attending across a range of socio-demographic groups could also improve our knowledge on coverage and uptake. There is limited evidence on how an increase in lifestyle advice, onward referral and prescription after an NHS Health Check effects relevant health outcomes within the context of the programme. Systematic evaluation of referral patterns and lifestyle service provision alongside data on patient engagement with those services and their subsequent health outcomes would be of particular value.

Barriers to uptake of an NHS Health Check need to be explored in more depth as they could inform improvement of recruitment to the programme. Resource barriers at an individual and structural level may hinder onward referral. Identification of such barriers, facilitators and plausibly adverse events from the NHS Health Check programme could allow for service and outcome improvement.

Further work could be completed to assess the viability and cost-effectiveness of opportunistic invitation across differing settings. Opportunistic invites in community settings improved uptake amongst some of those most at risk. Changing the most used invitation method for the NHS Health Checks programme could improve uptake substantially. Research into the most cost effective delivery model could inform how and where the programme is run.

A review of interventions for cardiovascular disease (e.g. physical activity or diet change), outside of the NHS Health Check Programme may be informative. Looking at opportune moments, such as the retirement window, for delivery as well as how to maximize impact by leveraging potential for change at the household level and across social networks could improve outcomes.

In one of the newly identified studies, ‘graphical aids’ to notify patients about their cardiovascular disease risk were identified as being more informative, effective and preferable.

Further research in to alternative presentations of individual risk and how they are understood within the context of the programme is needed.

Further research informed by the qualitative findings of the review could be of benefit.

There has been no exploration of the social and psychological mechanisms relating to issues that patients' experience. For example, the reasons as to why many attendees would struggle to interpret the risk score. Nor has there been exploration of the social, psychological and service delivery mechanisms relating to Healthcare professionals views towards NHS Health Checks and their delivery. Understanding which staff are best placed to deliver NHS Health Checks and reviewing training offered to aid delivery of an NHS Health Checks may be useful.

Modelling studies have re-indicated that targeting people at greatest risk of CVD is cost-effective. However, models as a best representation of reality may not provide a true reflection of the NHS Health Check Programme as it runs. They do not consider all components of the programme and as such provide an incomplete picture of its impact. A cost effectiveness model of the NHS Health Check Programme considering all components would allow for a considered judgement on the extent of the NHS Health Check programme's effectiveness and cost-effectiveness.

5. Acknowledgements

We are thankful for the input of the advisory members of the review team Professor Dawn Craig and Professor Jonathan Ling. Also, Dr Niina Kolehmainen who gave her input into the implementation of her developed GRADE method for rating the certainty of mixed-methods evidence informing a research question.

The work was commissioned and funded by PHE following a competitive bidding process in November 2019. Views and opinions presented are those of the authors and do not necessarily reflect those of PHE or the Department of Health.

6. Contribution of Authors

Dr L Tanner is a Research Associate who screened articles for inclusion, extracted and synthesised quantitative data, interpreted the findings, drafted the report, and gave critical feedback on other reviewer's work.

Dr R Kenny is a Research Associate who screened articles for inclusion, extracted and synthesised quantitative data, interpreted the findings, drafted the report, and gave critical feedback on other reviewer's work.

Ms M Still is a Research Assistant who extracted and synthesised the qualitative data.

Dr F Pearson is a Senior Research Associate and co-PI on the project who co-developed the funding bid and led the protocol development, screened articles for inclusion, extracted and synthesised the qualitative data, interpreted the findings, drafted the report and gave critical feedback on other reviewer's work and the report.

Dr R Bhardwaj-Gosling is a Clinical Senior Lecturer and lead investigator on the project who led the funding bid, co-developed the protocol, led the project operationally, extracted qualitative data, drafted the report and gave critical feedback on other reviewer's work and the report.

7. References

1. Usher-Smith J, Mant J, Martin A, et al. NHS Health Check Programme rapid evidence synthesis *University of Cambridge and RAND Europe* 2017
2. Critical Appraisal Skills Programme Checklist. [Available from: https://casp-uk.net/casp-tools-checklists/ accessed November 2019.
3. Schünemann H, Brożek J, Guyatt G, et al. GRADE handbook for grading quality of evidence and strength of recommendations. *The GRADE Working Group, 2013* Updated October 2013.;Available from gradepro.org/handbook
4. Lewin S, Booth, A., Glenton, C. et al. . Applying GRADE-CERQual to qualitative evidence synthesis findings: introduction to the series. *Implementation Sci* 2018;13(2) doi: https://doi.org/10.1186/s13012-017-0688-3
5. Department of Health Economic modelling for vascular checks - NHS Health Check [updated 2018. Available from: www.healthcheck.nhs.uk%2fseecmsfile%2F%3Fid%3D1172&usg=AOvVaw3dSxJVchGA59ce3njYAyDH accessed Nov 2019.
6. *NHS Health Checks: Applying All Our Health* 2018
7. Digital N. NHS Health Check programme, Patients Recorded as Attending and Not Attending, 2012-13 to 2017-18 Experimental statistics (Resources Section CSV). 2020 [Available from: https://digital.nhs.uk/data-and-information/publications/statistical/nhs-health-check-programme/2012-13-to-2017-18 accessed March 2020.
8. NHS Digital. NHS Health Check programme, Patients Recorded as Attending and Not Attending, 2012-13 to 2017-18. 2019
9. Chang KC, Lee JT, Vamos EP, et al. Impact of the National Health Service Health Check on cardiovascular disease risk: a difference-in-differences matching analysis. *CMAJ* 2016;188(10):E228-E38. doi: 10.1503/cmaj.151201 [published Online First: 2016/05/04]
10. Chattopadhyay K, Biswas M, Moore R. NHS Health Check and healthy lifestyle in Leicester, England: analysis of a survey dataset. *Perspect Public Health* 2020;140(1):27-37. doi: 10.1177/1757913919834584 [published Online First: 2019/05/10]
11. Coghill N, Garside L, Montgomery AA, et al. NHS health checks: a cross- sectional observational study on equity of uptake and outcomes. *BMC health services research* 2018;18(1):238. doi: 10.1186/s12913-018-3027-8 [published Online First: 2018/04/05]
12. Lang SJ, Abel GA, Mant J, et al. Impact of socioeconomic deprivation on screening for cardiovascular disease risk in a primary prevention population: a cross-sectional study. *BMJ Open* 2016;6(3):e009984. doi: 10.1136/bmjopen-2015-009984 [published Online First: 2016/03/24]
13. Woringer M, Cecil E, Watt H, et al. Evaluation of community provision of a preventive cardiovascular programme - the National Health Service Health Check in reaching the under-served groups by primary care in England: cross sectional observational study. *BMC health services research* 2017;17(1):405. doi: 10.1186/s12913-017-2346-5 [published Online First: 2017/06/16]
14. Iacobucci G. Fewer people are attending NHS health checks, show figures. *Bmj* 2019;367:l6098. doi: 10.1136/bmj.l6098 [published Online First: 2019/10/20]
15. Artac M, Dalton AR, Babu H, et al. Primary care and population factors associated with NHS Health Check coverage: a national cross-sectional study. *Journal of public*

health (Oxford, England) 2013;35(3):431-9. doi: 10.1093/pubmed/fdt069 [published Online First: 2013/07/25]
16. Chang KC, Soljak M, Lee JT, et al. Coverage of a national cardiovascular risk assessment and management programme (NHS Health Check): Retrospective database study. *Prev Med* 2015;78:1-8. doi: 10.1016/j.ypmed.2015.05.022 [published Online First: 2015/06/09]
17. Forster AS, Dodhia H, Booth H, et al. Estimating the yield of NHS Health Checks in England: a population-based cohort study. *Journal of public health (Oxford, England)* 2015;37(2):234-40. doi: 10.1093/pubmed/fdu079 [published Online First: 2014/10/19]
18. Robson J, Dostal I, Sheikh A, et al. The NHS Health Check in England: an evaluation of the first 4 years. *BMJ Open* 2016;6(1):e008840. doi: 10.1136/bmjopen-2015-008840 [published Online First: 2016/01/15]
19. Artac M, Dalton AR, Majeed A, et al. Uptake of the NHS Health Check programme in an urban setting. *Fam Pract* 2013;30(4):426-35. doi: 10.1093/fampra/cmt002 [published Online First: 2013/02/05]
20. Attwood S, Morton K, Sutton S. Exploring equity in uptake of the NHS Health Check and a nested physical activity intervention trial. *Journal of public health (Oxford, England)* 2016;38(3):560-68. doi: 10.1093/pubmed/fdv070 [published Online First: 2016/10/30]
21. Baker C, Loughren EA, Crone D, et al. A process evaluation of the NHS Health Check care pathway in a primary care setting. *Journal of public health (Oxford, England)* 2015;37(2):202-9. doi: 10.1093/pubmed/fdv053 [published Online First: 2015/04/30]
22. Carter P, Bodicoat DH, Davies MJ, et al. A retrospective evaluation of the NHS Health Check Programme in a multi-ethnic population. *Journal of public health (Oxford, England)* 2016;38(3):534-42. doi: 10.1093/pubmed/fdv115 [published Online First: 2016/10/30]
23. Cochrane T, Gidlow CJ, Kumar J, et al. Cross-sectional review of the response and treatment uptake from the NHS Health Checks programme in Stoke on Trent. *Journal of public health (Oxford, England)* 2013;35(1):92-8. doi: 10.1093/pubmed/fds088 [published Online First: 2012/10/30]
24. Coffey M, Cooper AM, Brown TM. *Vascular Health Checks in Salford: An Exploration Using FARSITE Data, Commissioned by Salford City Council* 2014
25. Cook EJ, Sharp C, Randhawa G, et al. Who uses NHS health checks? Investigating the impact of ethnicity and gender and method of invitation on uptake of NHS health checks. *Int J Equity Health* 2016;15:13. doi: 10.1186/s12939-016-0303-2 [published Online First: 2016/01/23]
26. Dalton AR, Bottle A, Okoro C, et al. Uptake of the NHS Health Checks programme in a deprived, culturally diverse setting: cross-sectional study. *Journal of public health (Oxford, England)* 2011;33(3):422-9. doi: 10.1093/pubmed/fdr034 [published Online First: 2011/05/07]
27. Krska J, du Plessis R, Chellaswamy H. Implementation of NHS Health Checks in general practice: variation in delivery between practices and practitioners. *Prim Health Care Res Dev* 2016;17(4):385-92. doi: 10.1017/S1463423615000493 [published Online First: 2015/11/03]
28. Kumar J, Chambers R, Mawby Y, et al. Delivering more with less? Making the NHS Health Check work in financially hard times: real time learning from Stoke-on-Trent. *Qual Prim Care* 2011;19(3):193-9. [published Online First: 2011/07/26]
29. Roberts DJ, de Souza VC. A venue-based analysis of the reach of a targeted outreach service to deliver opportunistic community NHS Health Checks to 'hard-to-reach'

groups. *Public Health* 2016;137:176-81. doi: 10.1016/j.puhe.2016.03.004 [published Online First: 2016/04/12]
30. Robson J, Dostal I, Madurasinghe V, et al. The NHS Health Check programme: implementation in east London 2009-2011. *BMJ Open* 2015;5(4):e007578. doi: 10.1136/bmjopen-2015-007578 [published Online First: 2015/04/15]
31. Usher-Smith JA, Pritchard J, Poole S, et al. Offering statins to a population attending health checks with a 10-year cardiovascular disease risk between 10% and 20. *Int J Clin Pract* 2015;69(12):1457-64. doi: 10.1111/ijcp.12742 [published Online First: 2015/10/01]
32. Corlett SA, Krska J. Evaluation of NHS Health Checks provided by community pharmacies. *Journal of public health (Oxford, England)* 2016;38(4):e516-e23. doi: 10.1093/pubmed/fdv153 [published Online First: 2017/02/06]
33. Local Goverment Authority. Checking the health of the nation: Implementing the NHS Health Check Programme Studies - Buckinghamshire, 2015.
34. Greenwich N. Evaluation of NHS Health Checks and Community Outreach Programme in Greenwich. 2011:1-61.
35. Trivedy C, Vlaev I, Seymour R, et al. An evaluation of opportunistic health checks at cricket matches: the Boundaries for Life initiative. *Sport in Society* 2017;20(2):226-34. doi: 10.1080/17430437.2016.1173919
36. Visram S, Carr S, Geddes L. Can lay health trainers increase uptake of NHS Health Checks in hard to reach populations? A mixed method pilot evaluation. *J Public Health (Bangkok)* 2015;36:226-33.
37. Worringer M, Cecil E, Watt H. Community providers of the NHS health Check CVD prevention Programme target younger and more deprived people. *Int J Integr Care* 2015;15 doi: 10.5334/ijic.2185
38. Krska J, du Plessis R, Chellaswamy H. Views and experiences of the NHS Health Check provided by general medical practices: cross-sectional survey in high-risk patients. *Journal of public health (Oxford, England)* 2015;37(2):210-7. doi: 10.1093/pubmed/fdu054 [published Online First: 2014/08/15]
39. McDermott L, Cornelius V, Wright AJ, et al. Enhanced Invitations Using the Question-Behavior Effect and Financial Incentives to Promote Health Check Uptake in Primary Care. *Ann Behav Med* 2018;52(7):594-605. doi: 10.1093/abm/kax048 [published Online First: 2018/06/04]
40. Coffee S. *Engaging Mental Health Service Users in Solihull with the NHS Health Check Programme: A Community Pilot Project* 2015
41. Coghill N, Garside L, Chappell A. A Quantitative Quasi-experimental Approach to the Evaluation of a Telephone Outreach Service. *University of Bath* 2016
42. Hooper J, Chohan P, Caley M. Case detection of disease by NHS Health Checks in Warwickshire, England and comparison with predicted performance. *Public Health* 2014;128(5):475-7. doi: 10.1016/j.puhe.2014.01.013 [published Online First: 2014/05/27]
43. Sallis A, Bunten A, Bonus A, et al. The effectiveness of an enhanced invitation letter on uptake of National Health Service Health Checks in primary care: a pragmatic quasi-randomised controlled trial. *BMC Fam Pract* 2016;17:35. doi: 10.1186/s12875-016-0426-y [published Online First: 2016/03/25]
44. Coghill N, Garside L, Chappell A. Improving the uptake of NHS Health Checks in more deprived communities using 'outreach telephone calls' made by specialist health advocates from the same communities: A quantitative service evaluation. A conference abstract. *Public Health England NHS Health Check National Conference 2016: Getting Serious about Prevention* 2016

45. Cornelius VR, McDermott L, Forster AS, et al. Automated recruitment and randomisation for an efficient randomised controlled trial in primary care. *Trials* 2018;19(1):341. doi: 10.1186/s13063-018-2723-3 [published Online First: 2018/06/28]
46. Gidlow CJ, Ellis NJ, Cowap L, et al. A qualitative study of cardiovascular disease risk communication in NHS Health Check using different risk calculators: protocol for the RIsk COmmunication in NHS Health Check (RICO) study. *BMC Fam Pract* 2019;20(1):11. doi: 10.1186/s12875-018-0897-0 [published Online First: 2019/01/16]
47. Gold N, Durlik C, Sanders JG, et al. Applying behavioural science to increase uptake of the NHS Health Check: a randomised controlled trial of gain- and loss-framed messaging in the national patient information leaflet. *BMC Public Health* 2019;19(1):1519. doi: 10.1186/s12889-019-7754-5 [published Online First: 2019/11/16]
48. Gulliford MC, Khoshaba B, McDermott L, et al. Cardiovascular risk at health checks performed opportunistically or following an invitation letter. Cohort study. *Journal of public health (Oxford, England)* 2018;40(2):e151-e56. doi: 10.1093/pubmed/fdx068 [published Online First: 2017/06/22]
49. Sallis A, Sherlock J, Bonus A, et al. Pre-notification and reminder SMS text messages with behaviourally informed invitation letters to improve uptake of NHS Health Checks: a factorial randomised controlled trial. *BMC Public Health* 2019;19(1):1162. doi: 10.1186/s12889-019-7476-8 [published Online First: 2019/08/24]
50. McDermott L, Wright A, Cornelius V. Enhanced invitation methods and uptake of health checks in primary care. Rapid randomised controlled trial using electronic health records. *Health Technology Assessment* 2017;20(84)
51. Alpsten BT. Saving lives through effective patient engagement around NHS health checks. *Clin Gov* 2015;20:108-12.
52. Local Government Association. Checking the health of the nation : Implementing the NHS Health Check Programme studies - Stoke-on-Trent. 2015
53. Gidlow CJ, Ellis NJ, Riley V, et al. Randomised controlled trial comparing uptake of NHS Health Check in response to standard letters, risk-personalised letters and telephone invitations. *BMC Public Health* 2019;19(1):224. doi: 10.1186/s12889-019-6540-8 [published Online First: 2019/02/23]
54. Stone TJ, Brangan E, Chappell A, et al. Telephone outreach by community workers to improve uptake of NHS Health Checks in more deprived localities and minority ethnic groups: a qualitative investigation of implementation. *Journal of public health (Oxford, England)* 2019;12:12. doi: 10.1093/pubmed/fdz063 [published Online First: 2019/06/13]
55. Ismail H, Atkin K. The NHS Health Check programme: insights from a qualitative study of patients. *Health Expect* 2016;19(2):345-55. doi: 10.1111/hex.12358 [published Online First: 2015/03/04]
56. Perry C, Thurston M, Alford S. The NHS health check programme in England: a qualitative study. *Health Promot Int* 2014;31:106-15.
57. Riley R, Coghill N, Montgomery A, et al. The provision of NHS health checks in a community setting: an ethnographic account. *BMC health services research* 2015;15:546. doi: 10.1186/s12913-015-1209-1 [published Online First: 2015/12/15]
58. Strutt E. Patient-centred care: patients' experiences of and responses to the National Health Service (NHS) Health Check programme in general practice. *http://ethesesduracuk/3246* 2011
59. Cerruti M, Biondi R. Timely insertion of electronic wheelchair in overall rehabilitation plan for cerebral palsy in young children: investigation on the opinion of parents. *Scienza Riabilitativa* 2010;12:14-23.

60. Cronin S. Exploring the lived experiences of children with specialised wheelchair and seating needs from a family perspective. University of Limerick, 2012.
61. Feldner H. Impacts of early powered mobility provision on disability identity: A case study. *Rehabil Psychol* 2019;64(2):130.
62. Feldner HA, Logan SW, Galloway JC. Mobility in pictures: a participatory photovoice narrative study exploring powered mobility provision for children and families. *Disabil Rehabil Assist Technol* 2019;14(3):301-11. doi: 10.1080/17483107.2018.1447606
63. Kenyon LK, Mortenson WB, Miller WC. 'Power in Mobility': parent and therapist perspectives of the experiences of children learning to use powered mobility. *Dev Med Child Neurol* 2018;60(10):1012-7.
64. McGarry S, Moir L, Girdler S. The Smart Wheelchair: is it an appropriate mobility training tool for children with physical disabilities? *Disabil Rehabil Assist Technol* 2012;7(5):372-80.
65. Pituch E, Rushton PW, Ngo M, et al. Powerful or powerless? Children's, parents', and occupational therapists' perceptions of powered mobility. *Phys Occup Ther Pediatr* 2018:1-16.
66. Wiart L, Darrah J, Hollis V, et al. Mothers' perceptions of their children's use of powered mobility. *Phys Occup Ther Pediatr* 2004;24(4):3-21.
67. Whittaker PJ. Uptake of cardiovascular health checks in community pharmacy versus general practice. *Journal of Fluid Mechanics* 2020;884:6. doi: 10.1002/jppr.1568
68. Alageel S, Gulliford MC. Health checks and cardiovascular risk factor values over six years' follow-up: Matched cohort study using electronic health records in England. *PLoS Med* 2019;16(7):e1002863. doi: 10.1371/journal.pmed.1002863 [published Online First: 2019/07/31]
69. Alageel S, Gulliford MC, McDermott L, et al. Implementing multiple health behaviour change interventions for cardiovascular risk reduction in primary care: a qualitative study. *BMC Fam Pract* 2018;19(1):171. doi: 10.1186/s12875-018-0860-0 [published Online First: 2018/11/01]
70. Alageel S, Gulliford MC, Wright A, et al. Engagement with advice to reduce cardiovascular risk following a health check programme: A qualitative study. *Health Expect* 2020;23(1):193-201. doi: 10.1111/hex.12991 [published Online First: 2019/10/28]
71. Baker C, Loughren EA, Crone D, et al. Patients' perceptions of a NHS Health Check in the primary care setting. *Qual Prim Care* 2014;22(5):232-7. [published Online First: 2015/04/22]
72. Graley CE, May KF, McCoy DC. Postcode lotteries in public health--the NHS Health Checks Programme in North West London. *BMC Public Health* 2011;11:738. doi: 10.1186/1471-2458-11-738 [published Online First: 2011/10/01]
73. Ismail H, Kelly S. Lessons learned from England's Health Checks Programme: using qualitative research to identify and share best practice. *BMC Fam Pract* 2015;16:144.
74. Nicholas JM, Burgess C, Dodhia H. Variations in the organization and delivery of the 'NHS Health Check' in primary care. *J Public Heal* 2013;35:85-91.
75. Oswald N, Mcnaughton R, Watson P. Tees Vascular Assessment Programme Evaluation. 2010
76. Alford S, Catherine P. Knowsley at Heart community NHS health checks : Behaviour change evaluation. 2010
77. Chipchase L, Hill P, Waterall J. An insight into the NHS Health Check Programme in Birmingham; Summar report. 2011

78. Jenkinson CE, Asprey A, Clark CE, et al. Patients' willingness to attend the NHS cardiovascular health checks in primary care: a qualitative interview study. *BMC Fam Pract* 2015;16:33. doi: 10.1186/s12875-015-0244-7 [published Online First: 2015/04/17]
79. McNaughton RJ, Oswald NT, Shucksmith JS, et al. Making a success of providing NHS Health Checks in community pharmacies across the Tees Valley: a qualitative study. *BMC health services research* 2011;11:222. doi: 10.1186/1472-6963-11-222 [published Online First: 2011/09/21]
80. Research Works. Public Health England Understanding the implementation of NHS Health Checks. 2013
81. Riley R, Coghill N, Montgomery A, et al. Experiences of patients and healthcare professionals of NHS cardiovascular health checks: a qualitative study. *Journal of public health (Oxford, England)* 2016;38(3):543-51. doi: 10.1093/pubmed/fdv121 [published Online First: 2016/10/30]
82. Shaw RL, Pattison HM, Holland C. Be SMART: examining the experience of implementing the NHS Health Check in UK primary care. *BMC Fam Pract* 2015;16:1.
83. Shaw RL, Lowe H, Holland C, et al. GPs' perspectives on managing the NHS Health Check in primary care: a qualitative evaluation of implementation in one area of England. *BMJ Open* 2016;6(7):e010951. doi: 10.1136/bmjopen-2015-010951 [published Online First: 2016/07/09]
84. Baker C, Loughren E, Crone D. Perceptions of health professionals involved in a NHS Health Check care pathway. *Pract Nurs* 2015;26:608–12.
85. Crabtree V, Hall J, Gandecha M. NHS Health Checks: The views of community pharmacists and support staff. *Int J Pharm Pract 2010* 2010;18:35-6.
86. Graley CEM, May KF, DC. M. Postcode lotteries in public health - the NHS Health Checks Programme in North West London. *BMC Public Health* 2011;11:738.
87. Krska J, du Plessis R, Chellaswamy H. Views of practice managers and general practitioners on implementing NHS Health Checks. *Prim Health Care Res Dev* 2016;17(2):198-205. doi: 10.1017/S1463423615000262 [published Online First: 2015/05/21]
88. Loo RL, Diaper C, Salami OT. The NHS Health Check: The views of community pharmacists. *Int J Pharm Pract* 2011;19:13.
89. Hawking MKD, Timmis A, Wilkins F, et al. Improving cardiovascular disease risk communication in NHS Health Checks: a qualitative study. *BMJ Open* 2019;9(8):e026058. doi: 10.1136/bmjopen-2018-026058 [published Online First: 2019/09/05]
90. Alageel S, Gulliford MC. Effect of the NHS Health Check programme on cardiovascular disease risk factors during 6 years' follow-up: matched cohort study. *Lancet* 2018;392:17-17. doi: 10.1016/S0140-6736(18)32869-1
91. Cowper. The NHS Health Check Leadership Forum : Summary and Findings. NHS Heal Check Leadersh Forum 2013. *NHS Heal Check Leadersh Forum* 2013
92. Riding L-E. Public health transformation twenty months on: adding value to tackle local health needs. *http://wwwlocalgovuk/documents/10180/6869714/L15_15+Public+health+transformation+twenty+months+on_WEB_39693pdf/7bb8060e-9a7b-4b85-8099e854be74cfb5* 2015
93. Taylor J, Krska J, Mackridge A. A community pharmacy-based cardiovascular screening service: views of service users and the public. *Int J Pharm Pract* 2012;20(5):277-84. doi: 10.1111/j.2042-7174.2012.00190.x [published Online First: 2012/09/08]

94. McNaughton RJ, Shucksmith J. Reasons for (non)compliance with intervention following identification of 'high-risk' status in the NHS Health Check programme. *Journal of public health (Oxford, England)* 2015;37(2):218-25. doi: 10.1093/pubmed/fdu066 [published Online First: 2014/09/23]
95. Shaw RL, Pattison HM, Holland C, et al. Be SMART: examining the experience of implementing the NHS Health Check in UK primary care. *BMC Fam Pract* 2015;16:1. doi: 10.1186/s12875-014-0212-7 [published Online First: 2015/01/23]
96. Alageel S, Wright A, Gulliford M. Impact of the Health Check programme on the provision of smoking cessation interventions in England. *European Journal of Public Health* 2017;27(suppl_3):71-71.
97. Chang K, Lee JT, Vamos E, et al. Socio-demographic inequalities in the effectiveness of England's NHS Health Check. *European Journal of Public Health* 2017;27:2.
98. Chang K, Lee JT, Vamos E, et al. Socio-Demographic Inequalities in Cardiovascular Risk Management and Early Detection of Vascular Conditions by the Nhs Health Check: A Difference-in-Differences Matching Analysis. *Journal of Epidemiology and Community Health* 2017;71:A4-A4. doi: 10.1136/jech-2017-SSMAbstracts.6
99. Collins B, Kypridemos C, Cookson R, et al. Universal or targeted cardiovascular screening? Modelling study using a sector-specific distributional cost effectiveness analysis. *Prev Med* 2020;130:105879. doi: 10.1016/j.ypmed.2019.105879 [published Online First: 2019/11/05]
100. Hinde S, Bojke L, Richardson G, et al. The cost-effectiveness of population Health Checks: have the NHS Health Checks been unfairly maligned? *Journal of Public Health* 2017:1-7.
101. Kennedy O, Su F, Pears R, et al. Evaluating the effectiveness of the NHS Health Check programme in South England: a quasi-randomised controlled trial. *BMJ Open* 2019;9(9):e029420. doi: 10.1136/bmjopen-2019-029420 [published Online First: 2019/09/23]
102. Mytton OT, Jackson C, Steinacher A, et al. The current and potential health benefits of the National Health Service Health Check cardiovascular disease prevention programme in England: A microsimulation study. *PLoS Med* 2018;15(3):e1002517. doi: 10.1371/journal.pmed.1002517 [published Online First: 2018/03/07]
103. Palladino R, Vamos E, Chang KCM, et al. Impact of a national diabetes risk assessment and screening programme in England: a quasi-experimental study. *Lancet* 2017;390:S65-S65. doi: Doi 10.1016/S0140-6736(17)33000-3
104. Robson J, Dostal I, Madurasinghe V, et al. NHS Health Check comorbidity and management: an observational matched study in primary care. *Br J Gen Pract* 2017;67(655):e86-e93. doi: 10.3399/bjgp16X688837 [published Online First: 2016/12/21]
105. Collins B, Kypridemos C, Parvulescu P, et al. The Cost-Effectiveness and Equity of the Nhs Health Checks Cardiovascular Disease Prevention Programme: A Microsimulation Using Real-World Data from a Deprived Northern City. *Journal of Epidemiology and Community Health* 2017;71(Suppl 1):A50-A50. doi: 10.1136/jech-2017-SSMAbstracts.99
106. Herrett E, Gallagher AM, Bhaskaran K, et al. Data resource profile: clinical practice research datalink (CPRD). *International Journal of Epidemiology* 2015;1(44(3)):827-36.
107. Caley M, Chohan P, Hooper J, et al. The impact of NHS Health Checks on the prevalence of disease in general practices: a controlled study. *Br J Gen Pract* 2014;64(625):e516-21. doi: 10.3399/bjgp14X681013 [published Online First: 2014/07/30]

108. Forster AS, Burgess C, Dodhia H, et al. Do health checks improve risk factor detection in primary care? Matched cohort study using electronic health records. *Journal of Public Health* 2015;38(3):552-59.
109. Jamet N, Bourguignon S, Marque S. Cost Effectiveness Analysis Of Mitraclip In Mitral Regurgitation For High Risk Patients. *Value Health* 2014;17(7):A481. doi: 10.1016/j.jval.2014.08.1392 [published Online First: 2014/11/01]
110. Lambert MF. Assessing potential local routine monitoring indicators of reach for the NHS health checks programme. *Public Health* 2016;131:92-8. doi: 10.1016/j.puhe.2015.10.019 [published Online First: 2015/12/31]
111. Artac M, Dalton AR, Majeed A, et al. Effectiveness of a national cardiovascular disease risk assessment program (NHS Health Check): results after one year. *Prev Med* 2013;57(2):129-34. doi: 10.1016/j.ypmed.2013.05.002 [published Online First: 2013/05/25]
112. Cochrane T, Davey R, Iqbal Z, et al. NHS health checks through general practice: randomised trial of population cardiovascular risk reduction. *BMC Public Health* 2012;12(1):944. doi: 10.1186/1471-2458-12-944 [published Online First: 2012/11/03]
113. Usher-Smith JA, Harte E, MacLure C, et al. Patient experience of NHS health checks: a systematic review and qualitative synthesis. *BMJ Open* 2017;7(8):e017169. doi: 10.1136/bmjopen-2017-017169 [published Online First: 2017/08/13]
114. Chang KC, Vamos EP, Palladino R, et al. Impact of the NHS Health Check on inequalities in cardiovascular disease risk: a difference-in-differences matching analysis. *J Epidemiol Community Health* 2019;73(1):11-18. doi: 10.1136/jech-2018-210961 [published Online First: 2018/10/05]

8. Appendices

Table A1 Inclusion and exclusion criteria used for each objective in the original NHS Health Check rapid review.

	Inclusion Criteria			**Exclusion Criteria**		
Overarching Criteria	NHS Health Check major topic. Format: Guidelines, RCT or cluster RCT, Quasi RCT or cluster quasi RCT, Controlled and uncontrolled pre- post-studies with appropriate comparator groups, Interrupted time series, Cohort studies (prospective and retrospective), Case-control studies, Qualitative studies from any discipline or theoretical tradition using recognised qualitative methods of data collection and analysis, Economic and health outcome modelling			Editorials, commentaries and opinion pieces		
Objective number	**One**	**Two**	**Three**	**Four**	**Five**	**Six**
Research type	Quantitative	Qualitative/Quantitative	Qualitative	Qualitative/Quantitative	Qualitative	Quantitative
Included participants	UK population eligible for NHS Health Checks (aged 40-74yrs)	UK population invited for NHS Health Checks	UK population eligible but not attending NHS Health Checks	Primary care services across the UK providing NHS Health Checks	UK population attending NHS Health Checks	UK population eligible for NHS Health Checks
Included measurements for extraction	Demographics, patient condition characteristics (e.g. BMI, smoking status, CVD risk factors, etc)	Patient characteristics (subgroups, protected characteristics), setting characteristics (any healthcare), mode of delivery, booking system, cell/recall methods, take up rates, use of point of care testing, etc	Patient opinions, attitudes and experiences of NHS Health Checks, choices made and why, reasons and beliefs underlying decisions.	Provider management protocols, recall methods, provider experiences of programme provision, referrals to lifestyle services, prescribing statins or anti-hypertensives, further investigations, adherence to guidelines etc	Patient opinions and experiences of NHS Health Checks	Disease and condition detection rates, including hypertension, diabetes, chronic kidney disease, AF, familial hypercholesterolemia, peripheral vascular disease etc, behaviour change, referrals to local risk management services, reductions in individual risk factor prevalence or CVD risk, statin and anti-hypertensive prescribing, any other physical or mental health outcomes, cost effectiveness

Exclusions	Participants not eligible for NHS Health Checks or receiving other forms of Health Check or screening services	Patients not eligible for NHS Health Checks or taking up other forms of Health Check or screening services	Patients not eligible for Health Check or choosing not to take up other forms of Health Check or screening services	Primary care services not offering NHS Health Checks or people identified as at risk for CVD outside NHS Health Checks	Patients who have not had an NHS Health Check	Patients not eligible for an NHS Health Check