Office for Health Improvement & Disparities

Review of the NHS Health Check

Annex E: health economic modelling

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Contents

1. Summary

This annex to the report ‘Preventing illness and improving health for all: A review of the NHS Health Check programme and recommendations’ describes findings from modelling the health economic and equity impact of:

- the current NHS Health Check (NHSHC) programme, compared to no NHSHC, in order to inform review issue 1 on the benefits and limitations of the current service
- further investment to extend the check when compared to the current NHSHC if:
    - 30 to 39 year olds were included within the eligible population (to inform review issue 2, on the eligible population)
    - uptake among the first and second most deprived quintile was increased (to inform review issue 6 on improving uptake)
    - overall uptake was increased to 60%, 75% or 90% (to inform review issue 6 on improving take-up)
    - the effectiveness of follow-up behavioural interventions was improved (to inform review issue 7 on improving follow-up)

workHORSE, (2, 3, 4) an economic microsimulation modelling tool, funded by the National Institute of Health Research (NIHR) and developed by the University of Liverpool (building on their IMPACT NCD model), was used in this study.

workHORSE models the impact of external risk factors (family history, acquired diseases), alongside those considered at an NHSHC (obesity, high blood pressure and so on). The model takes these into account in terms of impact on a wide variety of health outcomes (stroke, CHD, diabetes, dementia, lung, colon and breast cancer), plus healthcare, social care, informal care and productivity to produce health, economic and equity outcomes. The model itself and the costs it assigns to delivery of the NHSHC is detailed elsewhere (1, 2, 3).

The model was used to assess return on investment, cost-effectiveness and equity impacts of scenarios specific to objectives a and b. The main findings from the modelling are:

Issue 1. The benefits and limitations of the current NHSHC

By 2040 the current NHSHC is likely to reduce absolute health inequalities and is estimated to achieve a return on investment (ROI) of £2.93 for every £1 spent from a societal perspective, compared to no programme. From a health and social care perspective the incremental cost effectiveness ratio (ICER) is unlikely to fall below the National Institute for Health and Care Excellence (NICE) upper threshold of £30,000 for cost-effectiveness (4). This may be explained in part by the conservative impact estimates used for physical activity, alcohol and weight management interventions within the model. Increasing the effectiveness or the size of the population benefiting from behavioural interventions is likely to improve the effectiveness of the current NHSHC.

Issue 2. The eligible population

Further investment to extend the eligible population to people from the age of 30 is unlikely to produce a ROI greater than £1 (per £1 spent) or fall below the NICE upper threshold of £30,000 for cost-effectiveness by 2040, compared to the current NHSHC programme. It is likely to have a positive impact on reducing absolute health inequalities.

The high level of uncertainty in the ROI and ICER estimates may be explained by the combination of offering NHSHC to younger people (from age of 30) and that the model predicts impacts over 20 years, a period in which a cardiovascular disease (CVD) event is much less likely to occur for the younger people in this cohort.

Issue 6. Improving take-up

Further investment to increase uptake among the most deprived or to increase overall uptake to 60% is unlikely to: reduce health inequalities; or for the ICER to fall within or below the NICE cost-effectiveness threshold of £30,000 per quality adjusted life year (QALY); or for the ROI to exceed £1 (per £1 spent) by 2040, compared to the current NHSHC programme. The uncertainty in these findings may be explained by the small overall increase in participants compared to the current NHSHC.

Further investment to increase uptake to 75% or 90% are estimated to achieve an ROI of £2.95 or £3.27 respectively for every £1 spent by 2040 from a societal perspective. At a 90% uptake, results indicate that it is likely to achieve additional reductions in absolute health inequalities. These incremental gains in uptake suggest that there is an opportunity to achieve additional health economic gains and reductions in absolute health inequality through the current programme by driving up participation. However, the additional investment required to improve uptake may negate these estimated ROI gains.

Issue 7. Improving follow-up

Further investment to improve follow-up by increasing the impact and engagement among attendees of alcohol reduction, increased physical activity and weight loss interventions, is estimated to achieve an additional ROI of £5.18 for every £1 spent from a societal perspective, compared to the current NHSHC programme. From a health and social care perspective it is estimated to achieve an ICER of £12,820 per QALY which is likely to fall below the upper NICE £30,000 per QALY cost-effectiveness threshold based on the uncertainty of the results. However, this scenario is unlikely to achieve additional reductions in absolute health inequality by 2040.

2. Background

NHS Health Checks are an important component of locally led public health prevention services. They are offered to people without pre-existing disease aged between 40 and 74, free of charge, every 5 years. The results are used to raise awareness and support individuals to make behaviour changes and, where appropriate, access clinical management to help them reduce their risk of a heart attack, diabetes, stroke, respiratory disease and some forms of dementia and cancer in the next 10 years.

The government's prevention green paper 'Advancing our Health: Prevention in the 2020s' (5) recognised that the NHS Health Check programme, originally introduced in April 2009, has achieved a lot and continues to do so. A national evaluation of the programme estimates that at current statin prescribing levels, over 5 years, 2,500 people will have avoided a major cardiovascular event, such as heart attack or stroke (6).

In their current form, checks also underpin important NHS Long Term Plan (7) commitments to prevent 150,000 heart attacks, strokes and cases of dementia, and are the major conduit for recruitment to the Diabetes Prevention Programme.

However, the green paper also recognised significant variation in uptake and follow-up of health risks identified by the programme, along with the potential that people could benefit from a more tailored service or a particular focus at pivotal changes in the life course. The government therefore announced its intention, building on the gains made over the past 10 years, to consider whether changes to the NHS Health Check programme could help it deliver even greater benefits.

To achieve this, the Department of Health and Social Care (DHSC) commissioned Public Health England (PHE) to undertake an evidence-based review of how NHS Health Checks can evolve in the next decade to maximise the future benefits of the programme. Professor John Deanfield, was appointed to chair the PHE review of the programme.

This annex to the report 'Preventing illness and improving health for all: A review of the NHS Health Check programme and recommendations' describes findings from modelling the health economic and equity impact of:

- the current NHS Health Check (NHSHC) programme, compared to no NHSHC, in order to inform review issue 1 on the benefits and limitations of the current service

- further investment to extend the check when compared to the current NHSHC if:

    - 30 to 39 year olds were included within the eligible population (to inform review issue 2, on the eligible population)

- uptake among the first and second most deprived quintile was increased (to inform review issue 6 on improving uptake)

- overall uptake was increased to 60%, 75% or 90% (to inform review issue 6 on improving take-up)

- the effectiveness of follow-up behavioural interventions was improved (to inform review issue 7 on improving follow-up)

3. Method

3.1 Model

To model the health economic and equity impact of the NHSHC we used workHORSE (1, 2, 3) an economic modelling tool developed by the University of Liverpool.

The workHORSE tool models the impact of external risk factors (family history, acquired diseases), alongside those considered at an NHSHC (obesity, high blood pressure and so on). The model takes these into account in terms of impact on a wide variety of health outcomes (stroke, CHD, diabetes, dementia, lung, colon and breast cancer), plus healthcare, social care, informal care and productivity to produce health, economic and equity outcomes. The model itself and the costs it assigns to delivery of the NHSHC are detailed elsewhere (1, 2, 3).

We assessed ROI, cost-effectiveness and equity of different scenarios from 2 perspectives: (i) a health and social care perspective taking into account intervention costs, health care costs, social care costs and QALYs, and (ii) a societal perspective taking into account the same elements as the health and social care perspective with the addition of informal care costs and production as defined in the model (3).

3.2 Scenarios

To understand the potential future health economic and equity impact of the current NHSHC programme we compared the current NHSHC (scenario B) to scenario A where no one is eligible.

Scenario A – nobody eligible: no delivery of the NHSHC programme.

Scenario B – current NHSHC: delivery of the NHSHC programme with eligibility, uptake, content and frequency as defined in the current NHSHC. Of the attendees with a relevant risk, 1% were assumed to achieve a 1% decrease in alcohol consumption or weight, or an increase of 1 active day a week (table 1, Appendix A).

To understand the potential additional health economic and equity impact of further investment to extend eligibility, attendee socio-demographics, participation and follow-up we compared each of the scenarios C to F to the current NHSHC programme (scenario B).

Scenario C – invite from age 30: delivery of the NHSHC programme with uptake, content, follow-up and frequency as defined for the current NHSHC scenario (B). With the variation of extending eligibility to the age of 30 (Table 1).

Scenario D – most deprived: delivery of the NHSHC programme with eligibility, content, follow-up and frequency as defined in the current NHSHC scenario. With the variation of a relative increase in take-up of 5% among the first quintile of the index of multiple deprivation (QIMD) and a 2.5% relative increase in the second QIMD (table 1).

Scenario E – increased uptake: delivery of the NHSHC programme with eligibility, content, follow-up and frequency as defined in the current NHSHC scenario. With the variation of achieving an uptake of 60%, 75% or 90% (table 1).

Scenario F – improving follow-up: delivery of the NHSHC programme with eligibility, content, frequency and uptake as defined in the current NHSHC scenario. With the variation of 10% of obese or overweight attendees losing 5% about of their weight, 10% of attendees heavy drinkers achieving a 10% decrease in alcohol consumption, and 10% of attendees increasing of their physical activity by 1 active day a week (table 1).

All the *scenarios were* run over a 20-year time frame (2020 to 2040) and based on the content, eligibility, uptake and frequency of the current NHSHC programme with the exception of the behavioural follow-up (for which data was not available) and inputs that were varied with each scenario, as shown in table 1.

Table 1. Inputs that varied by scenario (changes compared to current NHSHC in blue)

Scenario name	Age eligibility	Uptake of offers	Behavioural follow-up
A: No NHSHC	N/A	N/A	N/A
B: Current NHSHC	40 to 74	52.5%	1% of those who are obese and overweight would lose about 1% of their weight 1% of participants increase their physical activity by 1 active day per week 1% of the participants who are heavy drinkers reduce their alcohol intake by 1%.
C: Invite people from age 30	30 to 74	52.5%	
D: Increase in most deprived uptake (method 1)	40 to 74	53.2%*	
Ei: Increase uptake (to 60%)	40 to 74	60%	
Eii: Increase uptake (to 75%)	40 to 74	75%	
Eiii: Increase uptake (to 90%)	40 to 74	90%	
F: Improved follow-up	40 to 74	52.5%	10% of obese and overweight participants would lose about 5% of their weight 10% of participants would increase their physical activity by 1 active day per week

Scenario name	Age eligibility	Uptake of offers	Behavioural follow-up
			10% of the participants who are heavy drinkers would reduce their alcohol intake by 10%

* Uptake of QIMD1 was increased by 5% and of QIMD2 by 2.5%.

3.3 Model parameters

For each scenario the interactive workHORSE tool was used to input distributions of attendees by sociodemographic and QRISK scores (QRISK category by QIMD by sex and by age). These values were derived from the NHSHC primary care dataset 2012 to 2017 (8). Due to a lack of data for 30 to 39 year olds (in scenario C), the distribution for this age group was assumed to be equivalent to the 40 to 49 year olds. Estimated values for the NHSHC invitation, completed check and smoking cessation costs were provided by the corresponding PHE policy teams, other behavioural intervention costs were taken from publications (Appendix A).

Estimates of smoking cessation among NHSHC attendees were based on PHE primary care datasets. As data was not available to estimate the impact of referral to other lifestyle services (weight management, physical activity and alcohol services) a minimum impact of 1% was assumed, as per Liverpool University published case studies (chapter 5 NIHR report). For the remaining parameters where data was not available workHORSE default values were used as described in the original model (3).

3.4 Outputs

The workHORSE model was used to calculate the following outputs for the comparison between scenario A and B and the comparison of each scenario from C to F with B:

- ROI, where a QALY was monetised at a cost of £60,000 (9)
- ICER
- probability of the scenario having a ROI greater than £1 per £1 spent
- probability of the scenario having an ICER below the NICE upper cost-effectiveness threshold of £30,000 (4)
- probability of the scenario reducing inequality, where the change in slope index of inequality (SII) has been calculated to provide an estimate of the changes in absolute health inequalities in terms of QALYs across QIMDs

These outputs were produced from the different perspectives (if relevant) as shown in Table 2.

Table 2. Outputs and perspectives used for each scenario

Output/perspective	Health and social care	Societal
ROI	No	Yes
ICER	Yes	No
Probability ROI is greater than £1 per £1 spent	No	Yes
Probability ICER is below £30,000 per QALY	Yes	No
Probability that the scenario reduces health inequality: independent of perspective	Yes	Yes

For each output, the median value from 100 Monte Carlo iterations, each with a population size of 200,000, was calculated.

Probability estimates were calculated and a threshold of 80% used to determine the likelihood, over the next 20 years, of each scenario satisfying the outcome criteria of interest.

4. Results

4.1 Current NHSHC compared to no programme

Table 3 shows that over 20 years and from the societal perspective the current programme (scenario B) showed a ROI of £2.93 for every £1 spent when compared to no programme (scenario A). There is a high level of certainty that this scenario would achieve reductions in absolute health inequality by 2040 (table 4).

From a health and social care perspective it is unlikely that an ICER of less than £30,000 per QALY would be reached by 2040 and therefore this scenario is unlikely to be within or below the NICE cost-effectiveness threshold (table 4).

Table 3. Current NHSHC ROI by 2040

Scenario	Comparator	ROI societal perspective	Likely (80%) that a ROI>£1 will be reached by 2040
B: Current NHSHC	A	£2.93	Yes

Table 4. Current NHSHC ICER and likelihood of reducing absolute health inequality by 2040

Scenario	Comparator	ICER per QALY health and social care perspective	Likely (80%) that an ICER of <£30,000/ QALY will be reached by 2040	Likely (80%) that it reduces absolute health inequalities (SII) by 2040
B: Current NHSHC	A	£29,042	No	Yes

4.2 Further investment in the NHSHC

4.2.1 Invite people from age 30

Over 20 years and from the societal perspective, it is unlikely that inviting individuals from age 30 (scenario C), compared to the current NHSHC programme (scenario B), will achieve an ROI greater than £1 per £1 spent (table 5).

From a health and social care perspective it is unlikely that an ICER less than £30,000 per QALY would be achieved by 2040 (table 6). However, there is a high level of certainty that this scenario achieves additional reductions in absolute health inequality (table 6).

4.2.2 Increase in most deprived uptake

Over 20 years and from the societal perspective increasing the uptake of the most deprived (scenario D: QIMD 1 was increased by 5% and QIMD 2 by 2.5%; overall uptake increased from 52.5% to 53.2%), compared to the current NHSHC (scenario B), is unlikely to achieve a ROI greater than £1 per £1 spent (table 5).

From a health and social care perspective it is unlikely that an ICER of less than £30,000 per QALY would be reached or that this scenario would achieve any additional reductions in absolute health inequality by 2040.

4.2.3 Increase uptake to 60%

Over 20 years and from the societal perspective increasing the overall uptake of the NHSHC programme from 52% to 60% (scenario Ei), compared to the current NHSHC programme (scenario B), is unlikely to achieve a ROI greater than £1 per £1 spent (table 5).

From a health and social care perspective it is unlikely that an ICER of less than £30,000 per QALY would be reached by 2040 or that this scenario would achieve additional reductions in absolute health inequality by 2040 (table 6).

4.2.4 Increase overall uptake to 75%

Over 20 years and from the societal perspective, increasing the overall uptake of the NHSHC programme from 52% to 75% (scenario Eii) compared to the current NHSHC programme (scenario B) showed a ROI of £2.95 for every £1 spent (table 5).

From a health and social care perspective it is unlikely that an ICER of less than £30,000 per QALY would be reached by 2040 or that this scenario achieves additional reductions in absolute health inequality (table 6).

4.2.5 Increase overall uptake to 90%

Over 20 years and from the societal perspective, increasing the overall uptake of the NHSHC programme from 52% to 90% (scenario Eiii) compared to the existing programme resulted in a ROI of £3.27 for every £1 spent (table 5).

From a health and social care perspective it is unlikely that an ICER of less than £30,000 per QALY would be reached by 2040 but a high level of certainty that this scenario reduces health inequality (table 6).

4.2.6 Improved follow-up

Over 20 years and from the societal perspective, increasing the proportion of attendees achieving a favourable behavioural outcome for alcohol, physical activity and weight (scenario F), resulted in an additional estimated ROI of £5.18 for every £1 spent (table 5).

From a health and social care perspective it is estimated to achieve an ICER of £12,820 per QALY, which is likely to fall below the upper NICE £30,000 per QALY cost-effectiveness threshold. However, it is unlikely that this scenario would achieve additional reductions in absolute health inequality by 2040 (table 6).

Table 5. Further investment scenario ROIs by 2040

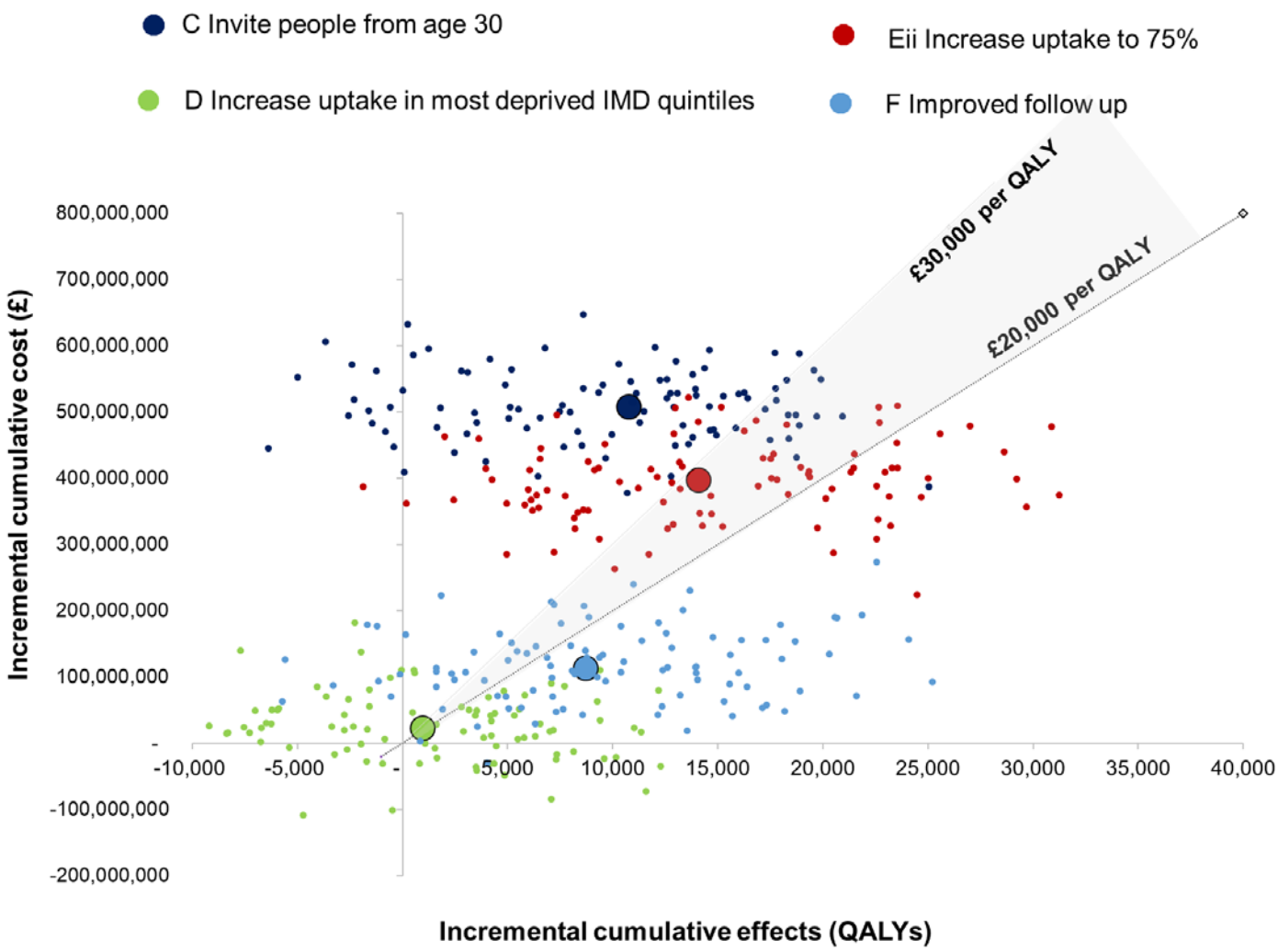
Scenario	Comparator	ROI societal perspective	Likely (80%) that a ROI>1 will be reached by 2040
C: Invite people from age 30	B	£1.96	No
D: Increase in most deprived uptake	B	£5.81	No
Ei: Increase uptake (to 60%)	B	£3.55	No
Eii: Increase uptake (to 75%)	B	£2.95	Yes
Eiii: Increase uptake (to 90%)	B	£3.27	Yes
F: Improved follow-up	B	£5.18	Yes

Table 6. Further investment scenarios ICER and reduction in absolute health inequality by 2040

Scenario	Comparator	ICER per QALY Health and social care perspective £	Likely (80%) that an ICER of <£30,000/ QALY will be reached by 2040	Likely (80%) that it reduces absolute health inequalities (SII) by 2040
C: Invite people from age 30	B	£46,976	No	Yes
D: Increase in most deprived uptake	B	£22,021	No	No
Ei: Increase uptake (to 60%)	B	£24,812	No	No
Eii: Increase uptake (to 75%)	B	£28,058	No	No
Eiii: Increase uptake (to 90%)	B	£27,102	No	Yes
F: Improved follow-up	B	£12,820	Yes	No

Figure 1 shows the median value and the 100 iterations for scenarios C, D, Eii and F against the current NHSHC programme from a health and social care perspective using the lower and upper NICE cost-effectiveness thresholds of £20,000 and £30,000 per QALY respectively.

Figure 1. Cost-effectiveness plane from a health and social care perspective for scenarios C, D, Eii and F



5. Conclusion

We used the workHORSE tool to estimate the health economic and equity impacts of the current NHSHC programme over a 20-year period. This shows that by 2040 the current NHSHC (scenario B) is likely to reduce health inequalities and achieve a return on investment of £2.93 for every £1 spent from a societal perspective, compared to no programme.

The model suggests that the ICER estimated for the current NHSHC (scenario B) is unlikely to fall below the NICE upper threshold of £30,000 for cost-effectiveness by 2040. This may be explained in part by the conservative impact estimates used for physical activity, alcohol and weight management. Increasing these effectiveness estimates or the size of the population benefiting from behavioural interventions may improve the overall effectiveness of the NHSHC and subsequently the ICER estimates for the programme.

The workHORSE model was also used to estimate the potential additional health economic and equity impacts of further investment over a 20-year period. This shows that extending the eligible population to people from the age of 30 (scenario C) compared to the current NHSHC programme (scenario B), is unlikely to: achieve a ROI greater than £1 (per £1 spent) or be cost effective by 2040. This high level of uncertainty may be explained by the combination of offering NHSHCs to younger people and that the model looks at results over the next 20 years, a period in which a CVD event is much less likely to occur for the younger individuals within the cohort.

The results indicate that scenario C is likely to have an additional impact on reducing absolute health inequality. This may in-part be explained by our use of the same QRISK category by QIMD and sex distribution for 30 to 39 year olds as is currently seen for 40 to 49-year olds. The QRISK value is heavily driven by age, so the assumption that the distribution is the same may overestimate CVD risk in this cohort. Additionally, the higher levels of eligible young people in the most deprived quintiles and that these more deprived groups are more likely to experience an earlier onset of CVD illness may contribute to the finding.

Compared to the current NHSHC programme (scenario B), further investment to increase uptake among the most deprived (scenario D) is unlikely to reduce health inequalities; or for the ICER to fall within or below NICE cost-effectiveness upper threshold of £30,000 per QALY; or for the ROI to exceed £1 (per £1 spent) by 2040. The uncertainty in the equity, ROI and ICER findings may be explained by the relatively small overall increase in participants in scenario D compared to scenario B.

Further investment to increase uptake to 60% (scenario Ei) compared to the current NHSHC (scenario B) is unlikely to reduce health inequalities; or for the ICER to fall within or below NICE cost-effectiveness upper threshold of £30,000 per QALY; or for the ROI to exceed £1 (per £1 spent) by 2040. The high level of uncertainty may be explained by the relatively small difference in uptake – only 7.5% – between the two scenarios.

Increasing uptake to 75% or 90% (scenarios Eii and Eiii) are estimated to achieve a ROI of £2.95 and £3.27 respectively for every £1 spent by 2040 based on a societal perspective. At a 90% uptake results indicate that it is likely to achieve additional reductions in health inequalities. However, these scenarios are unlikely to fall below the NICE cost-effectiveness upper threshold of £30,000 per QALY by 2040 when considering a health and social care perspective. These incremental gains with increasing uptake suggest that there is an opportunity to achieve a greater ROI and reductions in health inequalities through the current programme by driving up participation. However, the additional investment required to improve uptake may negate these estimated ROI gains.

Compared to the existing programme (scenario B), further investment to improve follow-up by increasing the impact and engagement among attendees of alcohol reduction, increased physical activity and weight loss (scenario F) is estimated to achieve an additional ROI of £5.18 for every £1 spent. The estimated ICER of £12,820 is likely to fall below the upper NICE cost-effectiveness threshold of £30,000 per QALY. There is a low level of certainty that this scenario would reduce absolute health inequality by 2040.

Interestingly, only scenario F reached 80% probability of staying below the upper NICE cost-effectiveness threshold of £30,000 per QALY (Figure 1).

The high levels of uncertainty reported across a number of the scenarios and outputs may be explained by the small differences in the uptake of offers (Table 1). Due to the model being stochastic, this is likely to result in large variations in costs and utilities among the few additional individuals between iterations resulting in large variations in ROIs and ICERs. The randomness within the model and small sample sizes are also likely to have a role to play in the high levels of uncertainty.

Limitations

A number of limitations arose with the use of this model:

- it includes the costs and effectiveness of risk factor specific programmes such as weight management – attaching the cost and health impacts to the NHSHC could lead to an over-estimation of the direct costs and utilities associated with the NHSHC programme

- the synthetic individuals in the model who are not eligible for, or do not take-up the NHSHC offer, cannot be prescribed a behavioural intervention such as alcohol, physical activity or weight management – although most of the related costs and benefits would cancel out between the scenarios, some would not.

- a lack of data on the effectiveness of behavioural interventions by socio economic status has meant that the model assumes no gradient on the impact of the NHSHC between different socio economic groups

- the model does not consider the impacts from COVID-19 and the mitigation measures put in place

- the analysis does not consider the impact of changes to other programmes that are delivered as part of a system of population-level interventions and may impact on the delivery of the NHSHC programme

- the model assumes every eligible individual is invited for a NHS Health Check

- the model produces results over a 20-year period and so does not indicate cost-effectiveness over a person's lifetime.

Future work in this area could benefit from exploring:

- the costs and benefits of combining multiple scenarios, such as extending the age of eligibility to 30 to individuals from the more deprived communities

- the health economic and health inequality impact of delivering these scenarios over a time frame greater than 20 years

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Appendix A. Input values

Table A1. Costs of the NHS Health Check

Parameter	Value	Comments
Cost £ per invitation	£1.34	Provided by CVD prevention team, commissioner survey
Cost £ per completed HC (excluding cost of invite)	£37.7	Provided by CVD prevention team, commissioner survey

Table A2. Costs of follow-up interventions

Parameter	Value	Comments
Smoking cessation cost/ successful quit	£490	Provided by review team
Weight management annual cost per participant losing weight	£62	Model DH 2008, Multi-component weight loss programmes NICE clinical guideline CG43 “Obesity”, December 2006 inflated to 2020
Physical activity annual cost per more active participant	£65	NICE Physical activity: brief advice for adults in primary care. Public Health Guideline PH44. May 2013. Cost per patient inflated to 2020.
Alcohol service annual cost per participant cutting down	£8	PHE Local Health and Care Planning: Menu of preventative interventions inflated to 2020
Cost of statins	£0	Not included in workHORSE model as cost was deemed as negligible

workHORSE only models the lifestyle interventions resulting from NHSHC participation (through referrals or because participants decide to change their lifestyle after being told about their risk). In a cost-effectiveness analysis, all the lifestyle interventions that would have happened anyway, even without NHSHC, are cancelled out in the ICER formula.

Table A3. Parameters applied to current NHSHC

Parameter	Value	Comments
Time period for the simulation	2020 to 2040	20 years
Minimum time between checks	5 years	Current NHSHC programme
Age eligibility	40 to 74	Current NHSHC programme
Invite people already diagnosed with hypertension	No	Current NHSHC programme
Cost £ per invitation	£1.34	Provided by CVD prevention team, commissioner survey
Cost £ per completed HC (excluding cost of invite)	£37.7	Provided by CVD prevention team, commissioner survey
Uptake of offers	52.5%	% provided by QRISK X IMD quintiles X sex X age group categories based on NHSHC 2012 to 2017 primary care dataset
% of all attendees prescribed statins	8%	% provided by QRISK X IMD quintiles categories based on NHSHC primary care dataset
% of all attendees prescribed anti-hypertensives	11%	% provided by QRISK X IMD quintiles categories based on NHSHC primary care dataset
% of smoking cessation due to programme	12.9%	Derived from NHSHC primary care dataset, adjusted using England Survey data
Smoking cessation cost / successful quit	£490	Provided by Review team
% of obese and overweight participants losing weight due to programme	1%	Liverpool University published case studies (chapter 5 NIHR report)

Parameter	Value	Comments
Average % weight loss due to programme	1%	Liverpool University published case studies (chapter 5 NIHR report)
Weight management annual cost per participant losing weight	£62	Model DH 2008, Multi-component weight loss programmes NICE clinical guideline CG43 “Obesity”, December 2006 inflated to 2020
% of participants increasing physical activity due to programme	1%	Liverpool University published case studies (Chapter 5 NIHR report)
Average increase in activity due to programme (number of active days per week)	1 day	Liverpool University published case studies (Chapter 5 NIHR report)
Physical activity annual cost per more active participant	£65	NICE Physical activity: brief advice for adults in primary care. Public Health Guideline PH44. May 2013. Cost per patient inflated to 2020.
% of participants at high-risk alcohol consumption cutting down due to programme	1%	Liverpool University published case studies (Chapter 5 NIHR report)
Average % alcohol intake reduction due to programme	1%	Liverpool University published case studies (Chapter 5 NIHR report)
Alcohol service annual cost per participant cutting down	£8	PHE Local Health and Care Planning: Menu of preventative interventions inflated to 2020
Percentage of participants reverting to pre health check lifestyle every year	20%	Default value. Definition: % that revert to previous lifestyle every year, after successfully improving lifestyle due to HC. Eg, 20% attrition rate pa means that after 5 yrs only (1-0.2)^5 = 33% of those who successfully improved their lifestyle initially are still observing the lifestyle change. Same attrition rate applies to all risk factors except smoking.

Parameter	Value	Comments
Annual discount rate for costs	3.5%	Default value (The Green Book 2020, Appendix 1)
Annual discount for QALYs	1.5%	Default value (The Green Book 2020, Appendix 1)
Willingness to pay	Cost per QALY	£30,000 (for health and social care perspective) NICE recommended threshold for cost per QALY gained or £60,000 (for societal perspective) Default value (The Green Book 2020, Appendix 1)
Number of Monte Carlo iterations for the interactive exploration (GUI)	100	Advanced options, default value
Number of Monte Carlo iterations for the final results (GUI)	Not done	Advanced options, default value
Number of cores to be used for explicit parallelisation	20	Advanced options, default value
Number of cores to be used for implicit parallelisation	1	Advanced options, default value
Size of synthetic population	200,000	Advanced options, default value
Number of synthetic population files to combine together	2	Advanced options, default value
Number of synthetic population primer files to be produced. Better be a multiple of the setting above.	10	Advanced options, default value
Number of synthetic population files to combine together	2	Advanced options, default value

Parameter	Value	Comments
Median lag between exposure and CVD incidence	4	Advanced options, default value
Median lag between exposure and COPD incidence	5	Advanced options, default value
Median lag between exposure and cancer incidence	9	Advanced options, default value
Median lag between exposure and death from causes not explicitly modelled	5	Advanced options, default value
Number of years after which a prevalent cancer case is considered cured	10	Advanced options, default value
Increase for more erratic jumps in trajectories	1	Advanced options, default value
Statin adherence. The mean of a beta distribution with shape2 = 0.2	0.9	Advanced options, default value
BP medication adherence. The mean of a beta distribution with shape2 = 0.2	0.9	Advanced options, default value
Adjust the decision aid line used in some of the graphs =0.8	0.8	Advanced options, default value

Appendix B

This appendix presents a series of charts which show results described in the main report for the cost effectiveness, probability of achieving cost effectiveness and probability of reducing absolute health inequality for each of the scenarios.

Figure 1 for scenario B, C, D, Ei, Eii, Eiii and F show a chart which plots the incremental cumulative effect (ranges from -60,000 to 60,000 QALYs) against the incremental cumulative cost (ranges from -£1.5 billion to £1.5 billion) for each of the 100 iterations. Figure 2 for each scenario uses the same chart but only shows the median result. On both charts a solid line at the 0 value for both the effect and cost divides the chart into quadrants. There is an intersecting dashed diagonal line which represents the NICE upper cost-effectiveness threshold of £30,000 per QALY. The quadrants, intersecting line and the following colour coding is used to indicate whether the scenario results are likely to be cost-effective:

- top left quadrant, red area: intervention is more costly (£millions) and less effective (for example,10,000 fewer QALYs over the duration modelled)

- bottom left quadrant, red area: intervention is cost-saving, but is less effective (i.e. reduces QALYs), in either case the intervention yields worse health outcomes and so these red shaded regions indicate that these interventions would not be considered

- bottom right quadrant, green area: the intervention is optimal in that the intervention is both cost-saving and more effective (i.e. increases QALYs)

- top right quadrant, blue area: the intervention is more effective (i.e. increases QALYs), and falls below a cost-effectiveness threshold (e.g. NICE use a threshold of between £20,000 and £30,000 per QALY) meaning that while the intervention incurs costs, this is within the willingness to pay threshold

- top right quadrant, white area: the intervention is more effective (i.e. increases QALYs), but exceeds the cost-effectiveness threshold for cost-benefit and so would D not generally be recommended or approved as it exceeds the willingness to pay threshold

Figure 3 for scenario B, C, D, Ei, Eii, Eiii and F shows the probability that the scenario is likely to be cost effective over a 20-year period, from 2020 to 2040. A dot represents the probability for each year. A dotted horizontal line at the 80% probability denotes the threshold that the result needs to cross in order to be considered likely that the scenario will be cost-effective.

Figure 4 for scenario B, C, D, Ei, Eii, Eiii and F shows the probability that the scenario is likely to reduce absolute health inequality over a 20-year period, from 2020 to 2040. A dot represents the probability for each year. A dotted horizontal line at the 80% probability denotes the threshold that the result needs to cross in order to be considered likely that the scenario reduces absolute health inequality.

Current NHSHC compared to no programme

Overall ICER and ROI median values were estimated by calculating the ROI/ICER for each of the 100 iterations and then taking the median. Whereas the median ROI/ICER values displayed on the graphs below were estimated by calculating the median of the different components of the costs and utilities over the 100 iterations and then calculating the ROI/ICER from those medians; therefore, small differences between the medians and the graphs are expected due to rounding.

Figure B1 shows the results of the 100 iterations and Figure B2 shows the median value from scenario B using a health and social care perspective.

Figure B1. Cost-effectiveness plane showing the 100 iteration results for scenario B

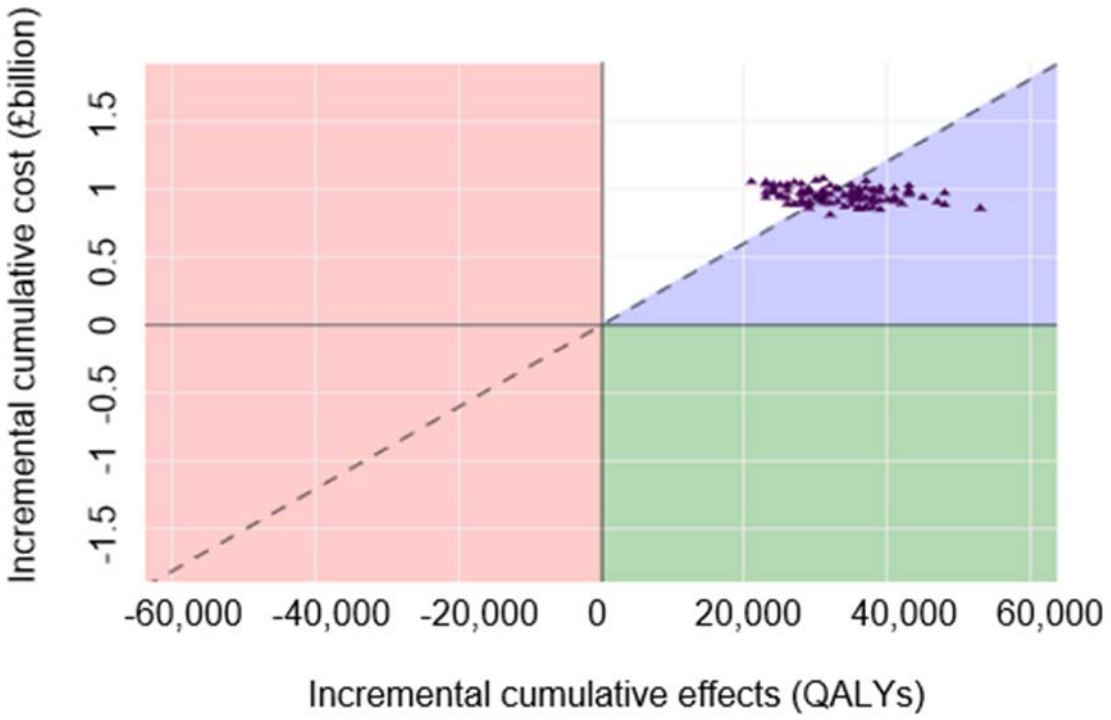


Figure B2. Cost-effectiveness plane showing the median value for scenario B

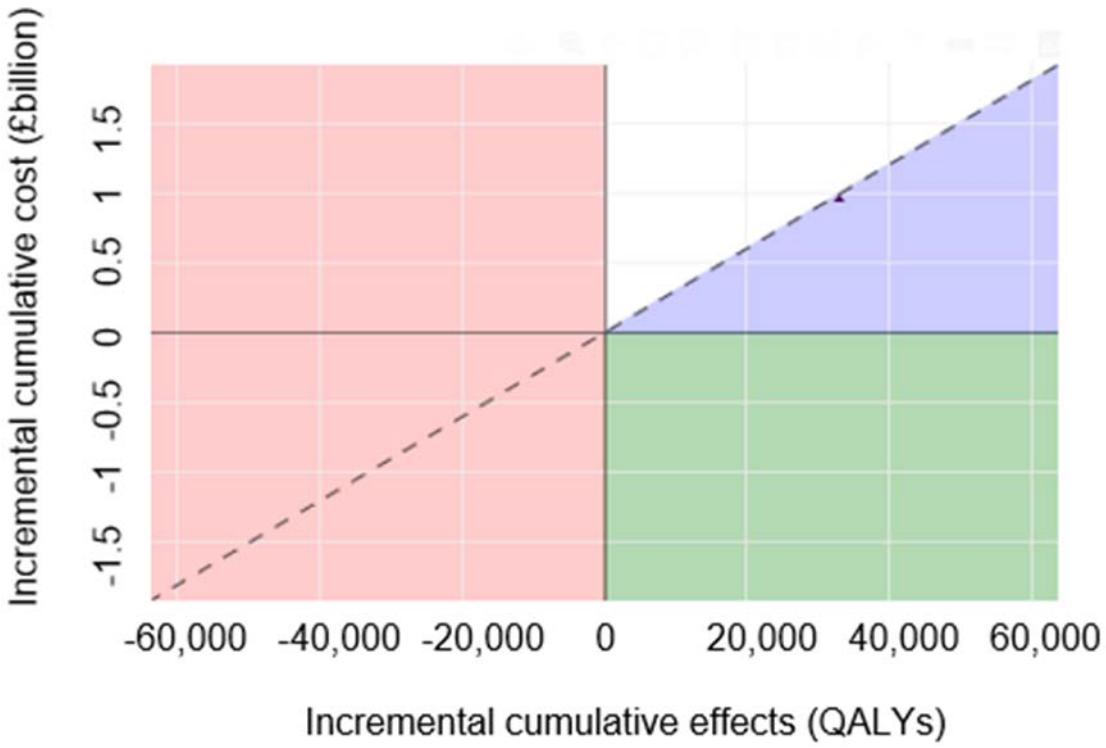


Figure B3 shows the probability that scenario B is likely to be cost effective by 2040 from a health and social care perspective using NICE upper cost-effectiveness threshold of £30,000 per QALY

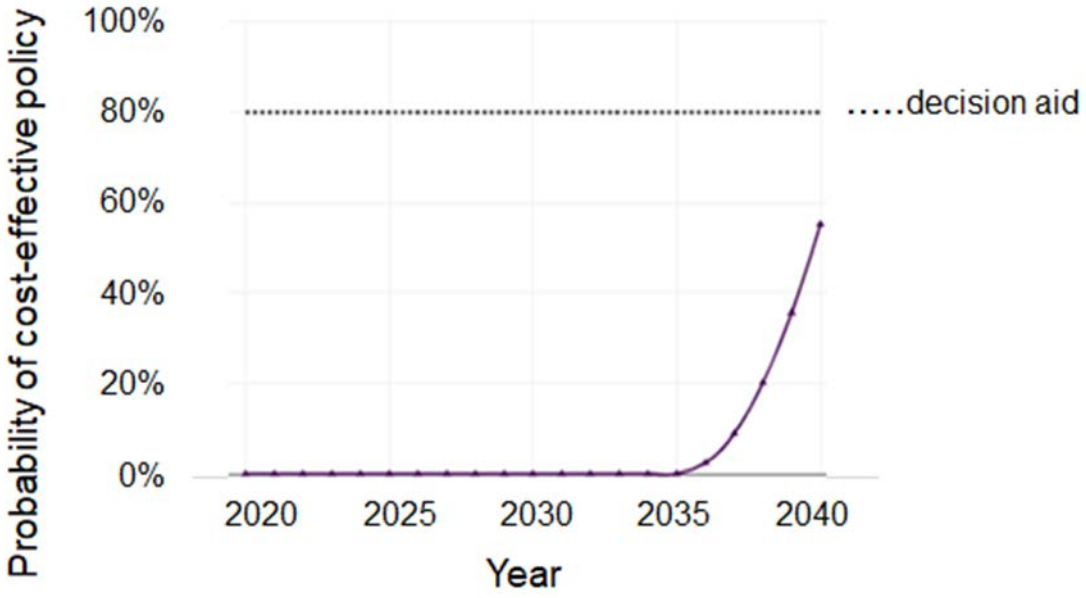
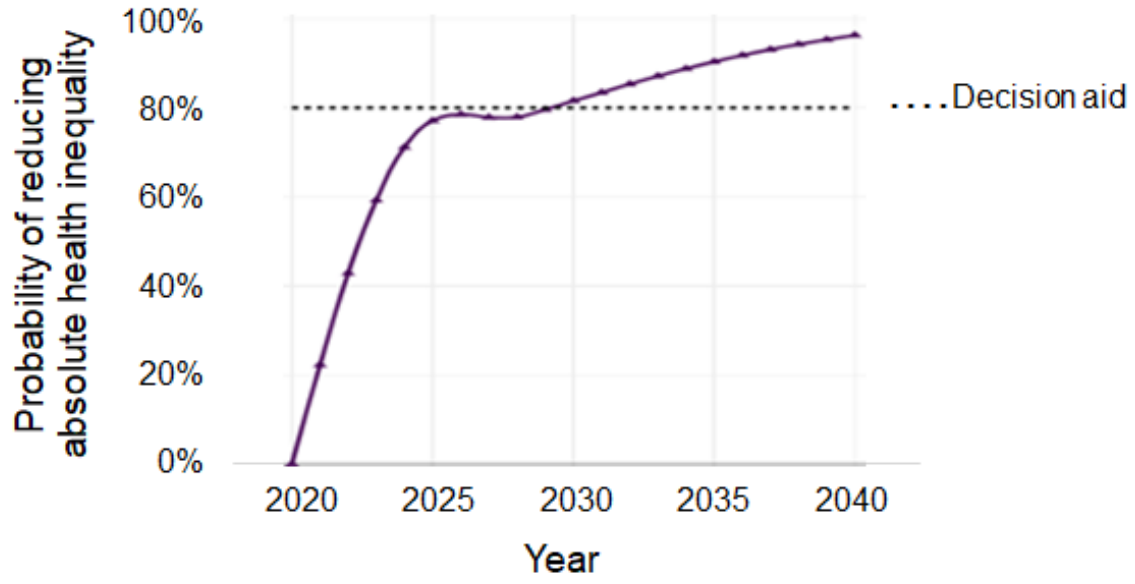


Figure B4 shows the probability that scenario B will reduce absolute health inequality by 2040.

Figure B4 Probability of reducing absolute health inequality for scenario B



Invite people from age 30

Figure C1 shows the results of the 100 iterations and Figure C2 shows the median value from scenario C using a health and social care perspective. Figure C1. Cost-effectiveness plane showing the 100 iteration results for scenario C

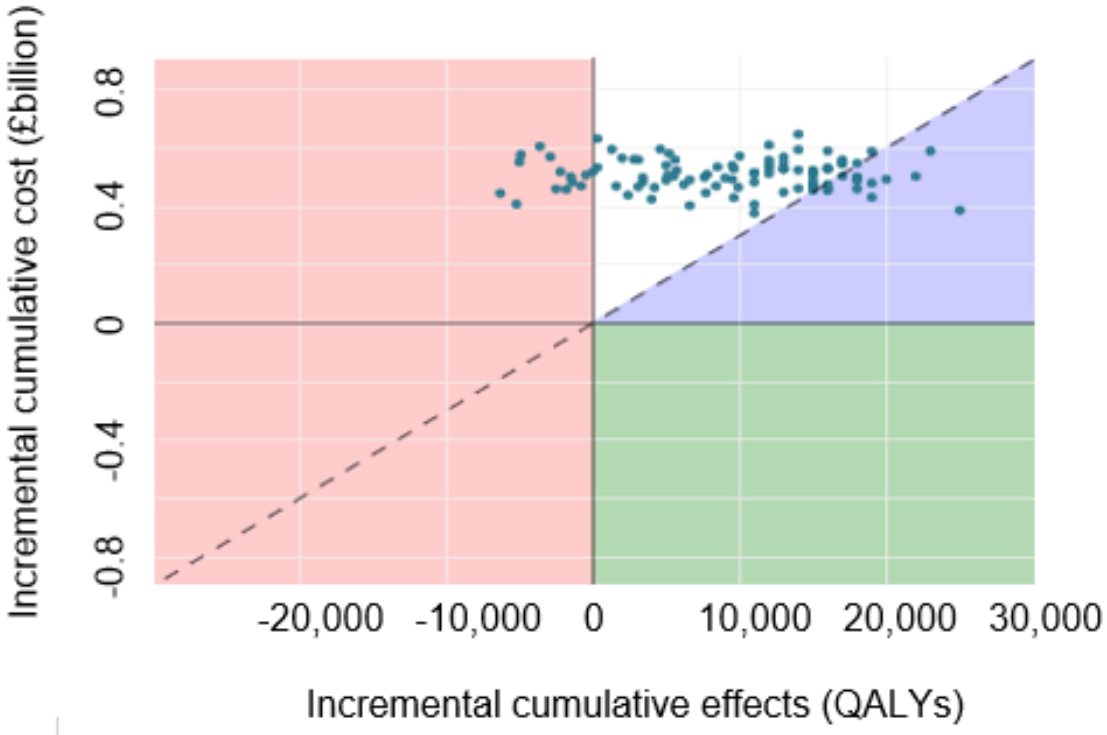


Figure C2. Cost-effectiveness plane showing the median value for scenario C

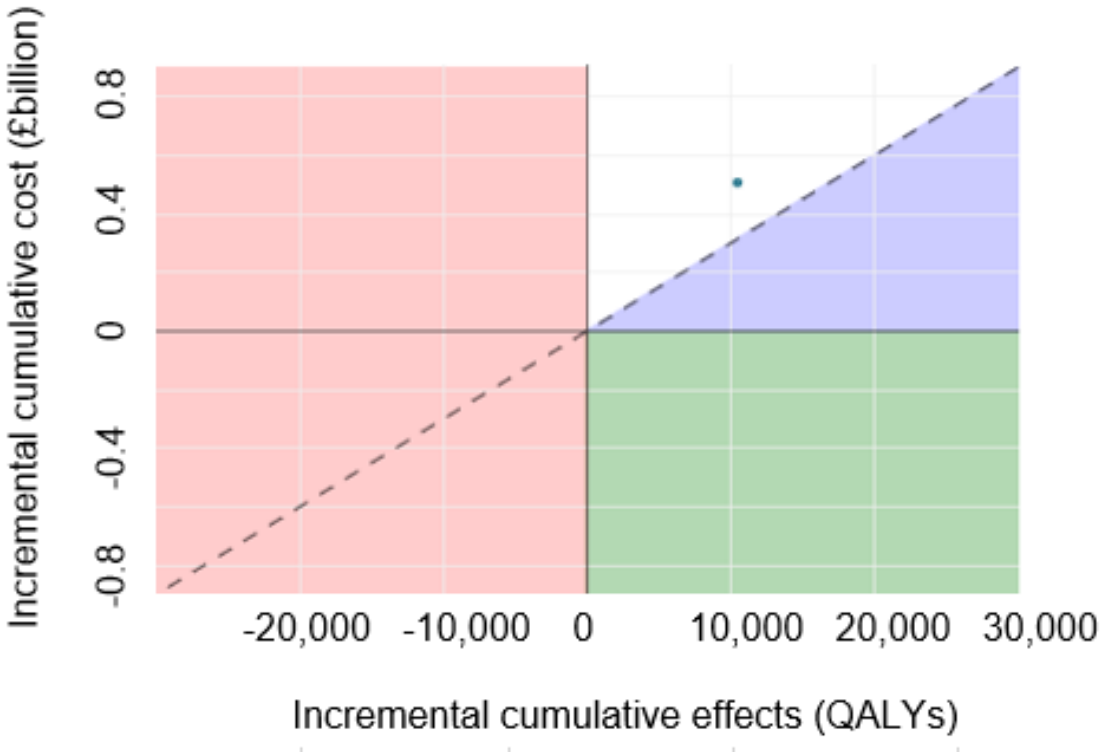


Figure C3 shows the probability that scenario C is likely to be cost effective by 2040 from a health and social care perspective using NICE upper cost-effectiveness threshold of £30,000 per QALY.

Figure C3. Probability of cost-effective policy for scenario C

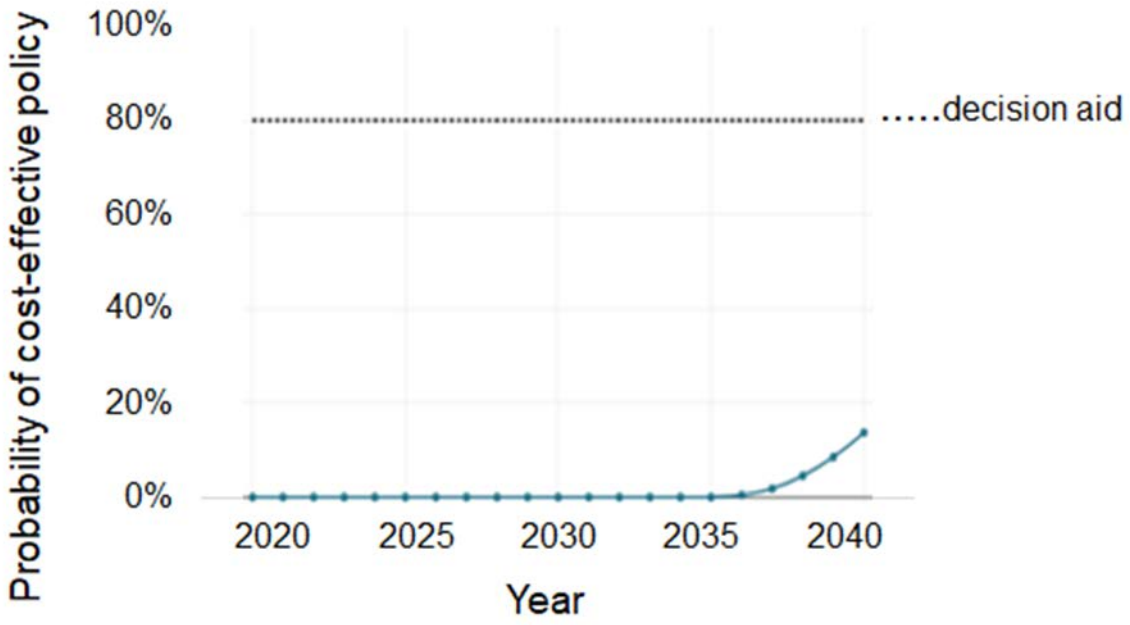
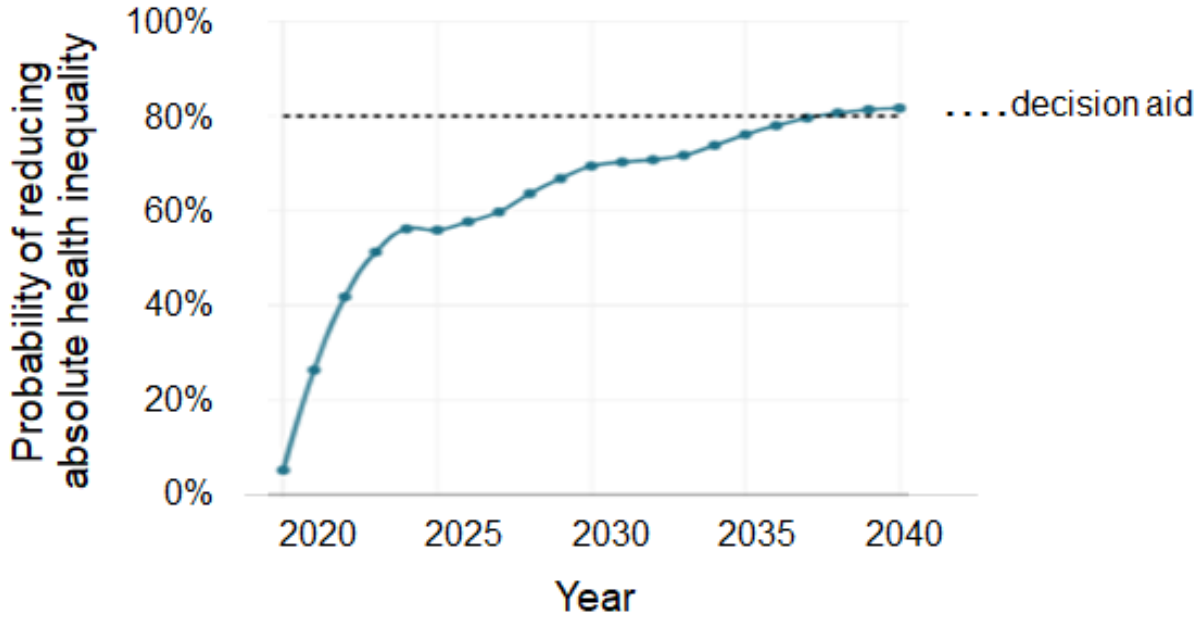


Figure C4 shows the probability that scenario C will reduce absolute health inequality by 2040.

Figure C4. Probability of reducing absolute health inequality for scenario C



Increase take-up in the most deprived uptake

Figure D1 shows the results of the 100 iterations and Figure D2 shows the median value from scenario D using a health and social care perspective .

Figure D1. Cost-effectiveness plane showing the 100 iteration results for scenario D

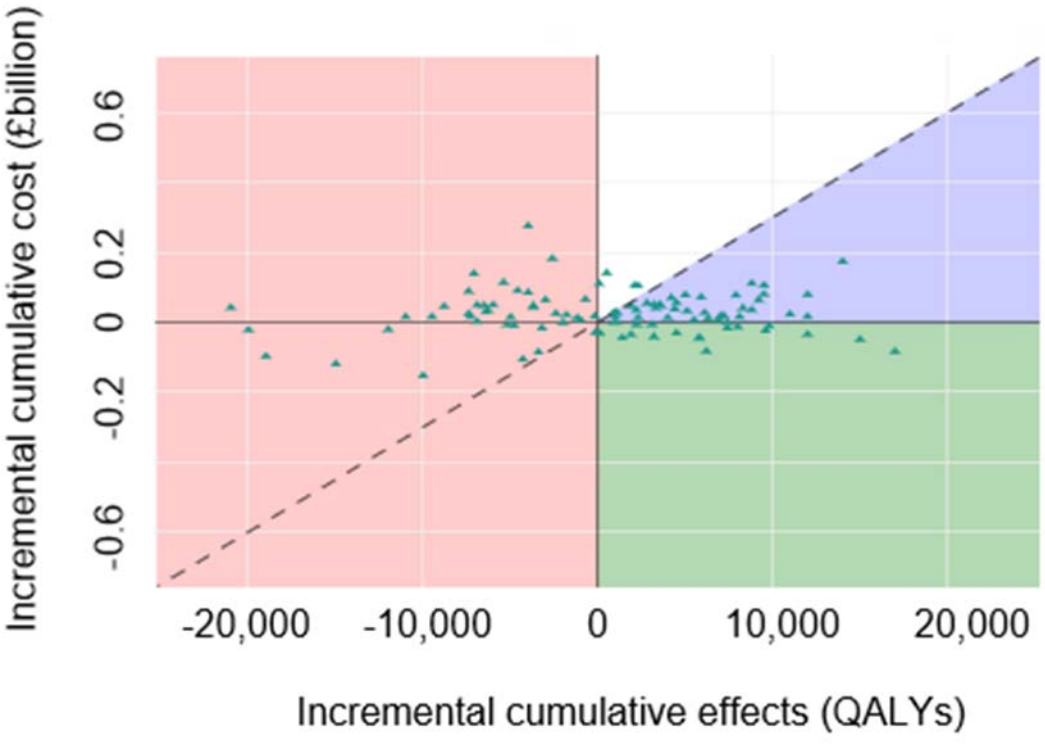


Figure D2. Cost-effectiveness plane showing the median value for scenario

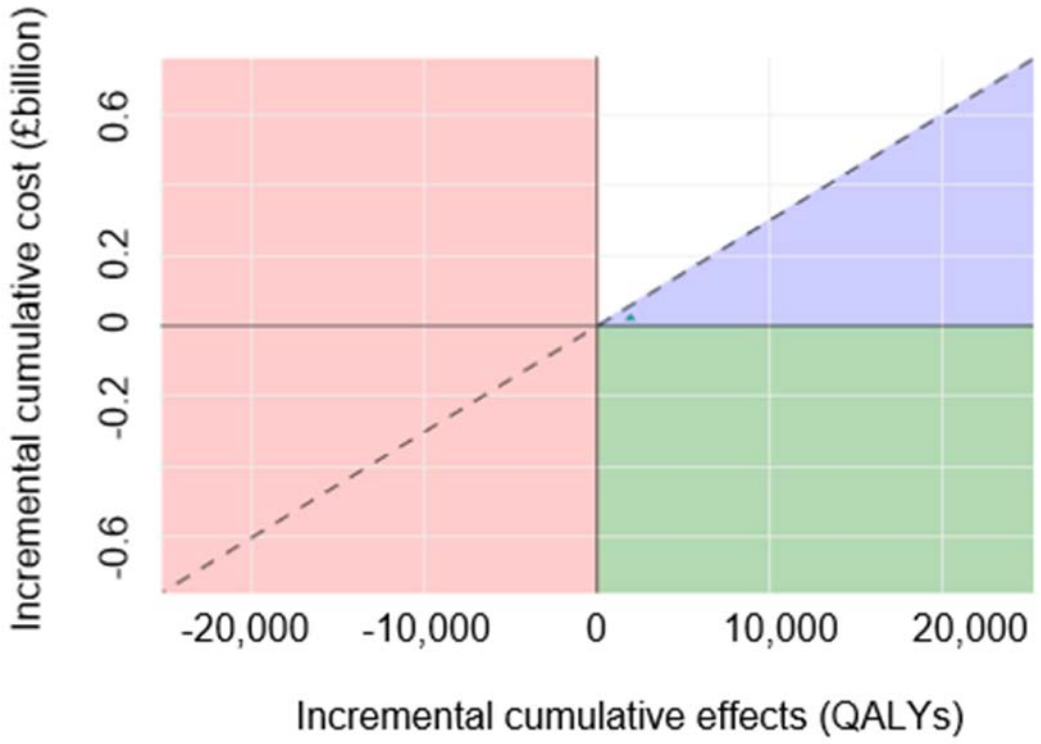


Figure D3 shows the probability that scenario D is likely to be cost effective by 2040 from a health and social care perspective using NICE upper cost-effectiveness threshold of £30,000 per QALY.

Figure D3. Probability of cost-effective policy for scenario D

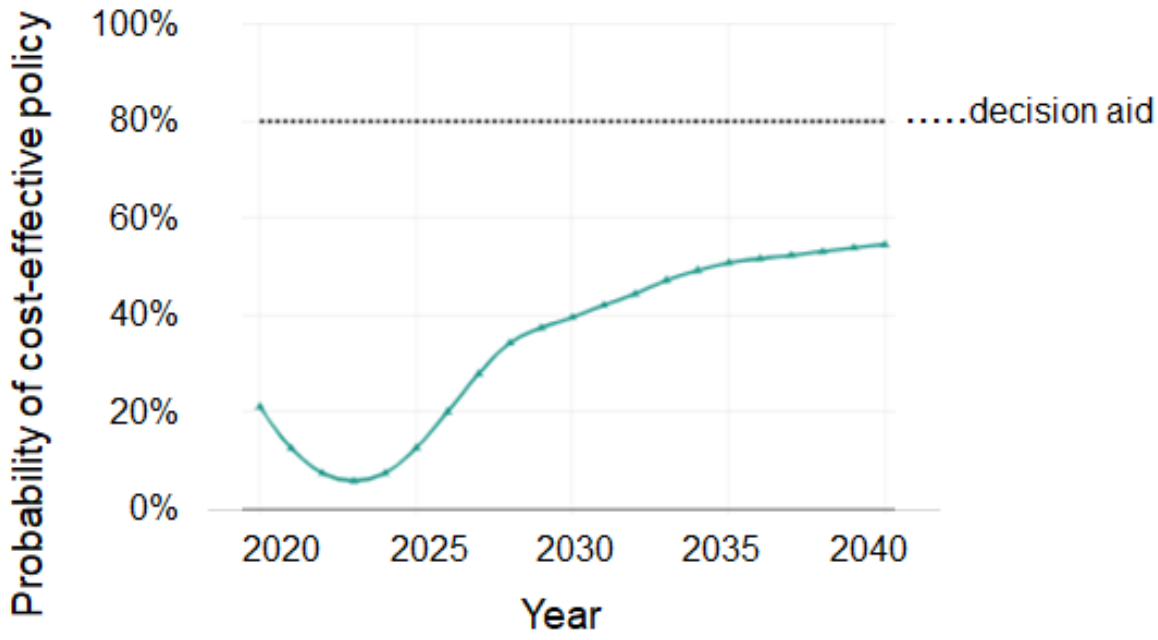
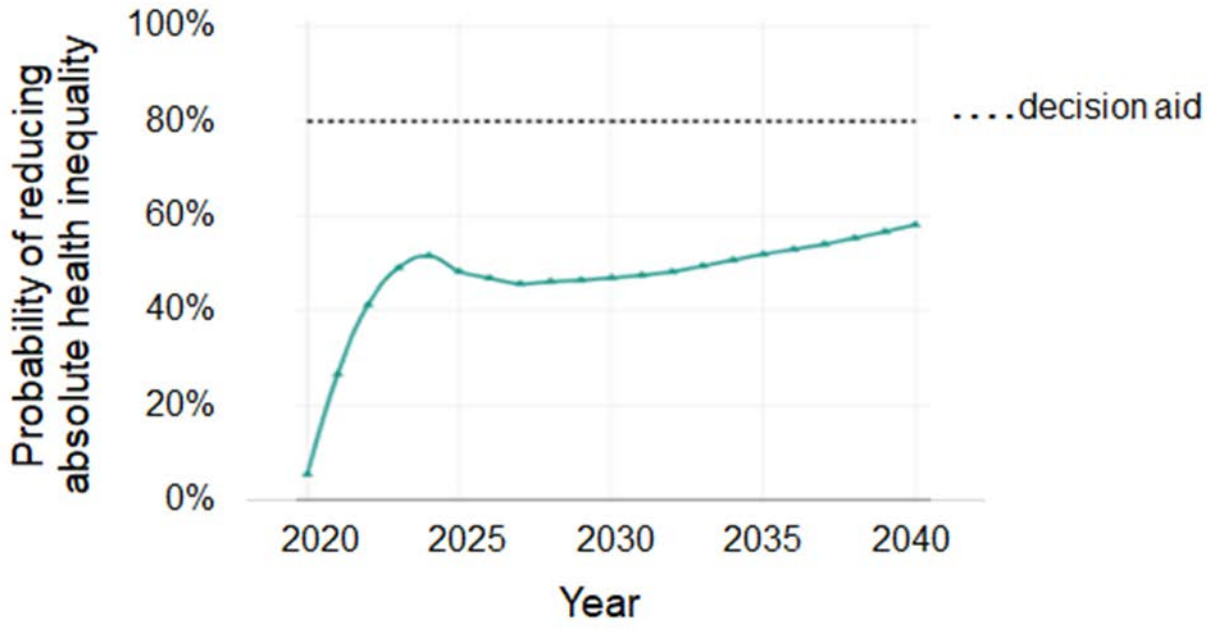


Figure D4 shows the probability that scenario D will reduce absolute health inequality by 2040.

Figure D4. Probability of reducing absolute health inequality for scenario D



Increase uptake to 60%

Figure Ei1 shows the results of the 100 iterations and Figure Ei2 shows the median value from scenario E using a health and social care perspective .

Figure Ei1. Cost-effectiveness plane for scenario Ei

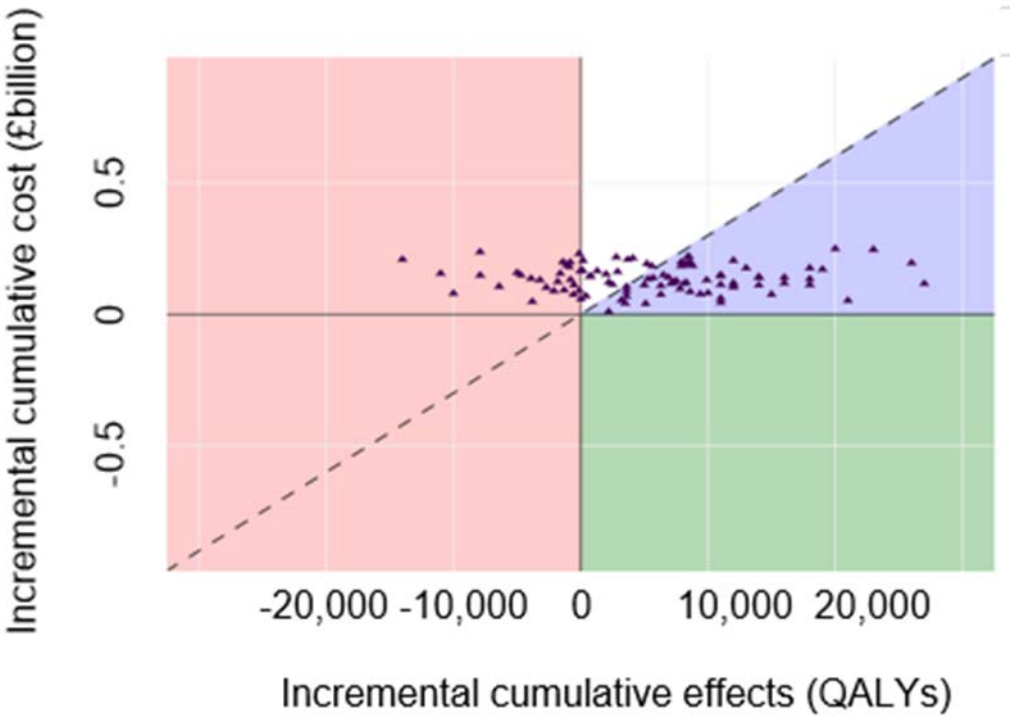


Figure Ei2 Cost-effectiveness plane showing the median value for scenario Ei

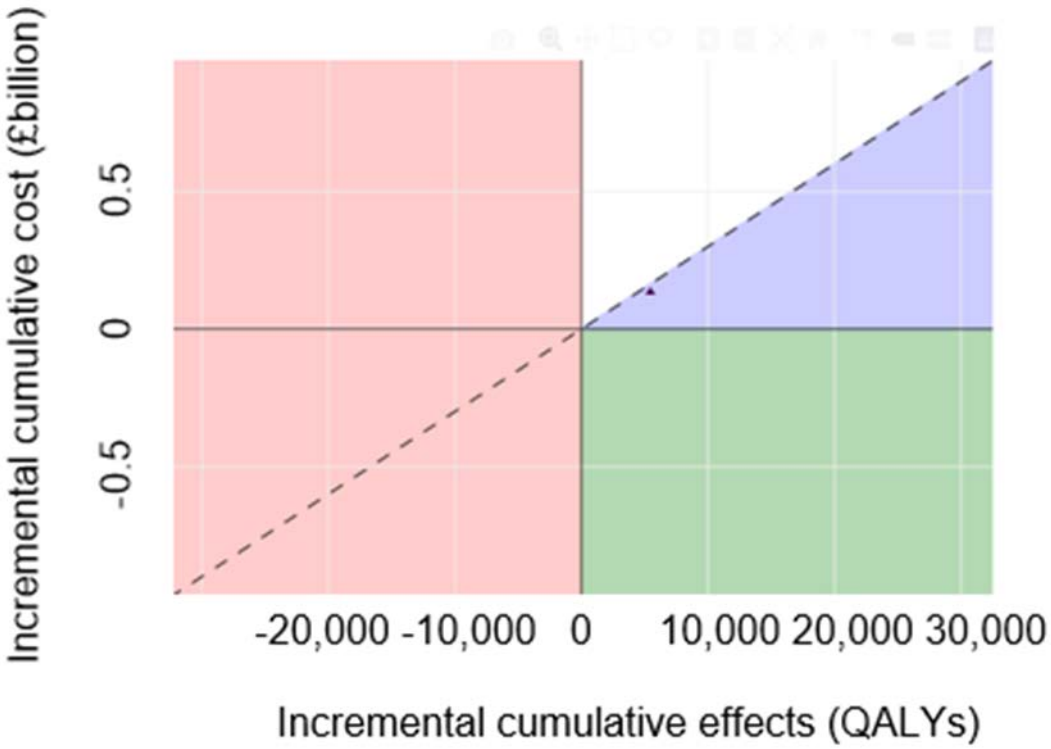


Figure Ei3 shows the probability that scenario Ei is likely to be cost effective by 2040 from a health and social care perspective using NICE upper cost-effectiveness threshold of £30,000 per QALY.

Figure Ei3. Probability of cost-effective policy for scenario Ei

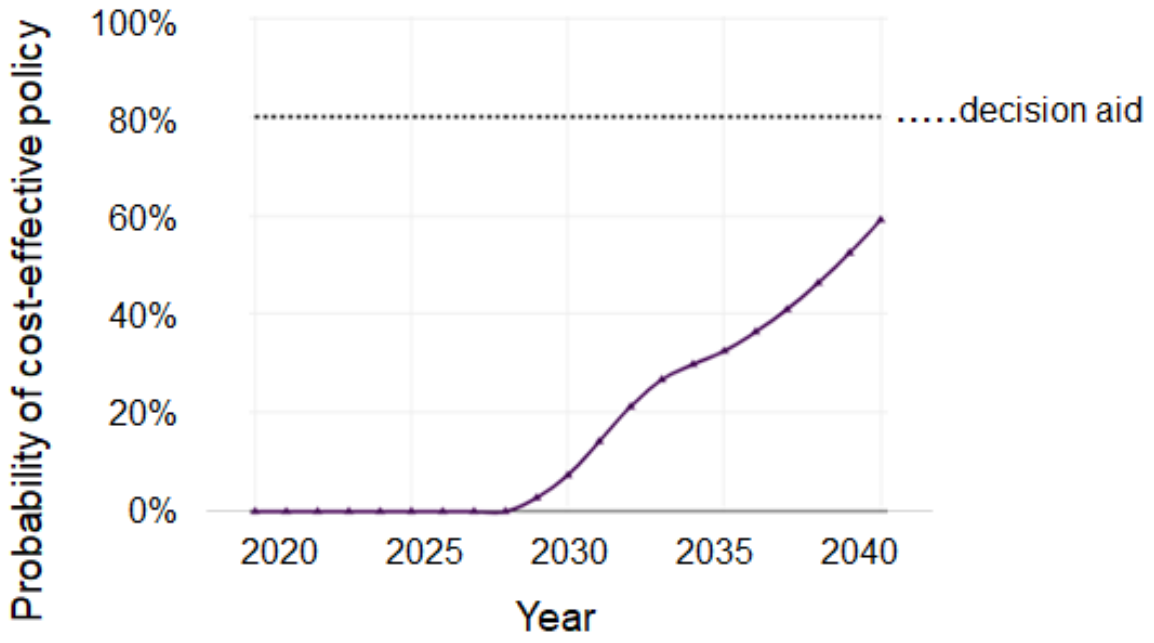
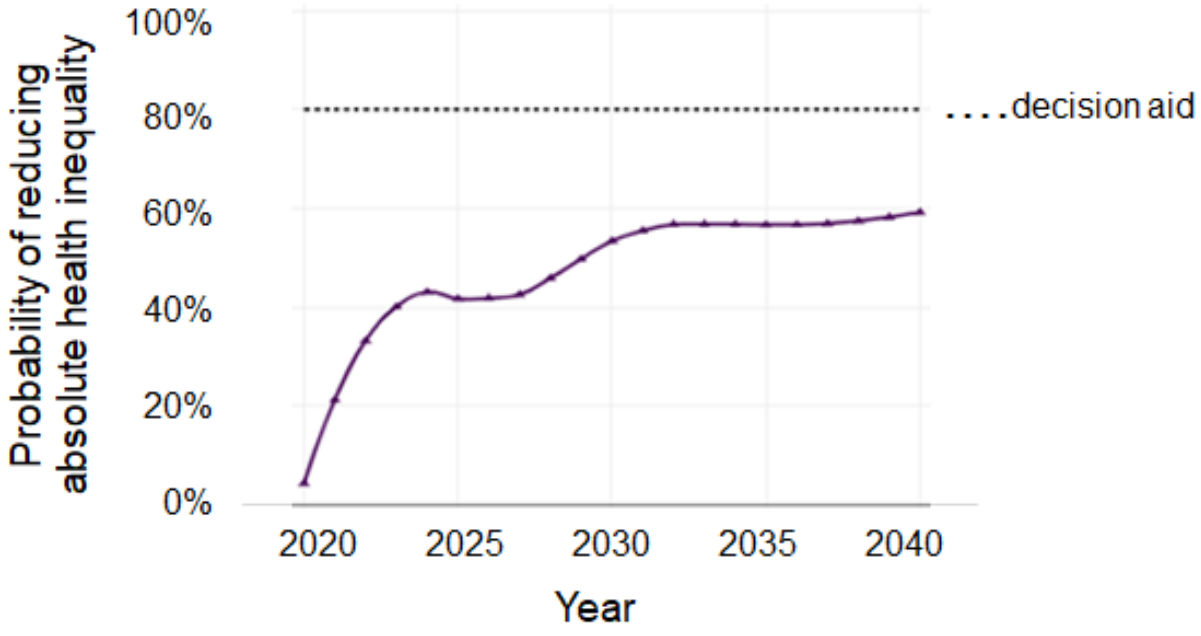


Figure Ei4 shows the probability that scenario Ei will reduce absolute health inequality by 2040.

Figure Ei4. Probability of reducing absolute health inequality for scenario Eii



Increasing uptake to 75%

Figure Eii1 shows the results of the 100 iterations and Figure Eii2 shows the median value from scenario E using a health and social care perspective .

Figure Eii 1. Cost-effectiveness plane for scenario Eii

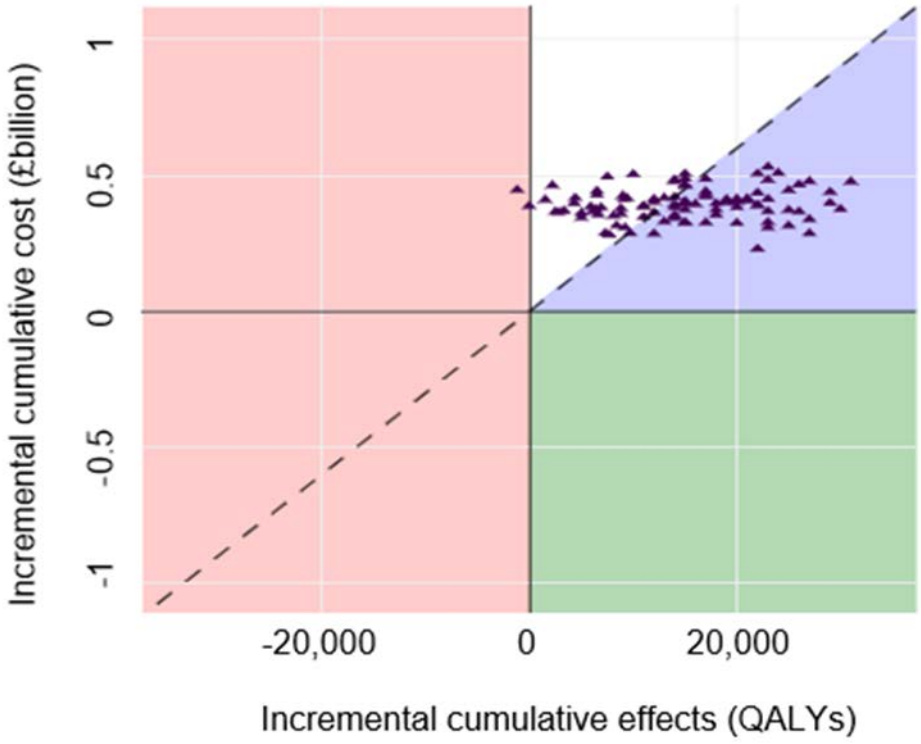


Figure Eii2. Cost-effectiveness plane showing the median value for scenario Eii

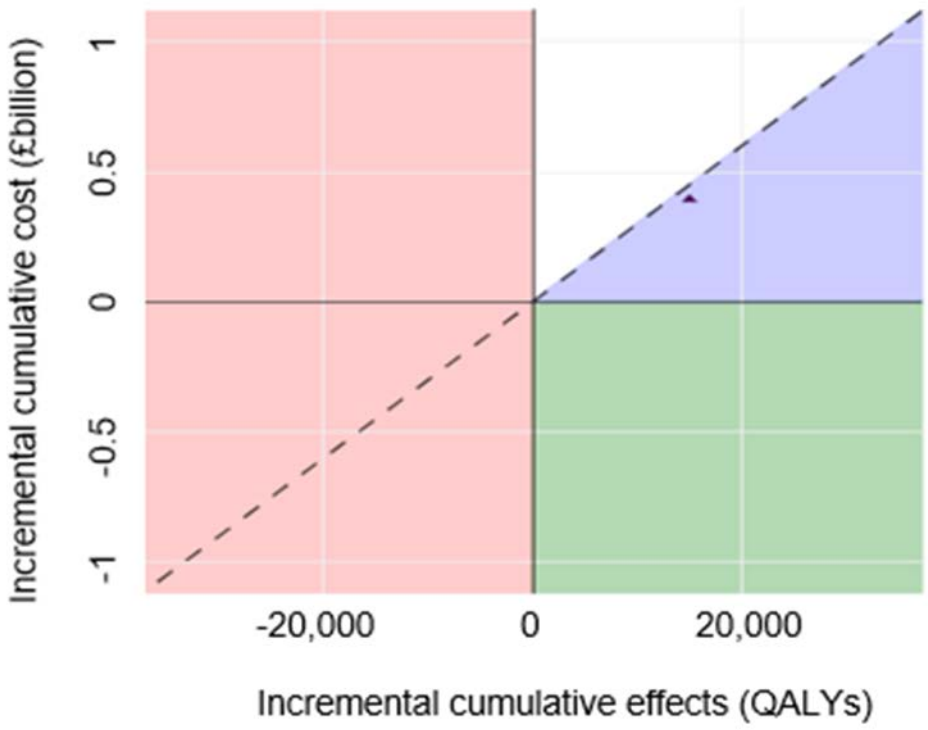


Figure Eii3 shows the probability that scenario Eii is likely to be cost effective by 2040 from a health and social care perspective using NICE upper cost-effectiveness threshold of £30,000 per QALY.

Figure Eii3. Probability of cost-effective policy for scenario Eii

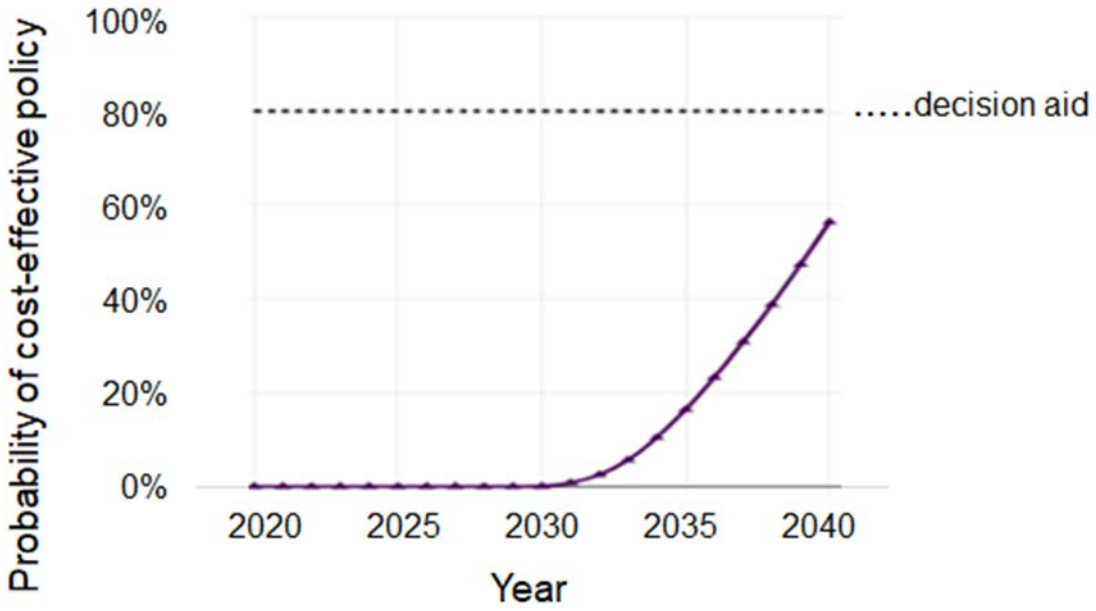
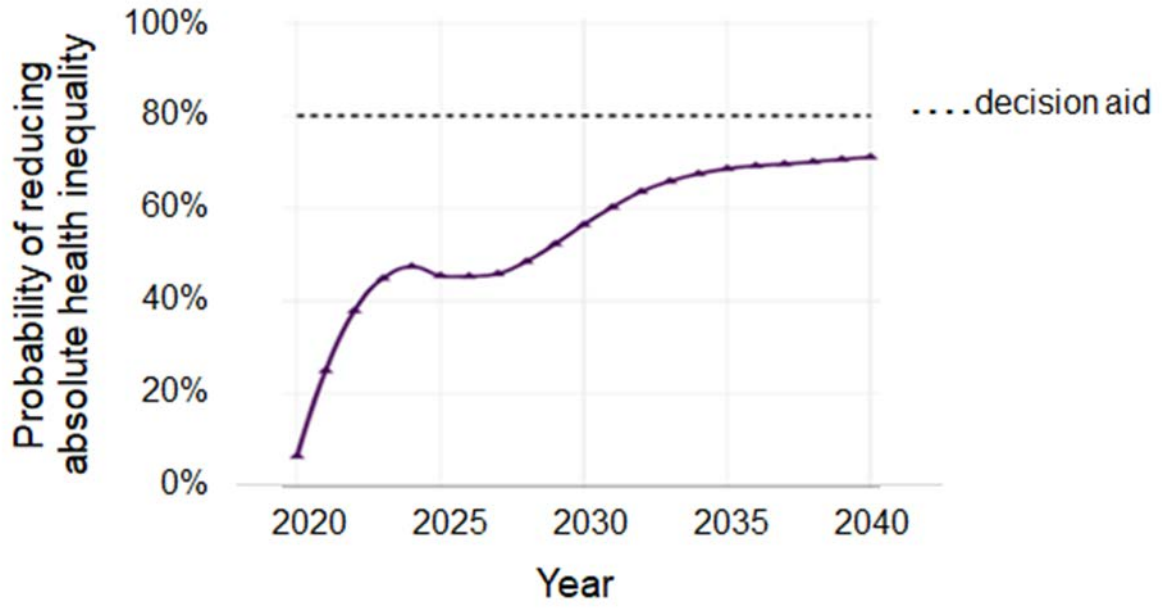


Figure Eii4 shows the probability that scenario Eii will reduce absolute health inequality by 2040.

Figure Eii4. Probability of reducing absolute health inequality for scenario Eii



Increase overall uptake to 90%

Figure Eiii1 shows the results of the 100 iterations and Figure Eiii2 shows the median value from scenario Eiii using a health and social care perspective .

Figure Eiii1. Cost-effectiveness plane for scenario Eiii

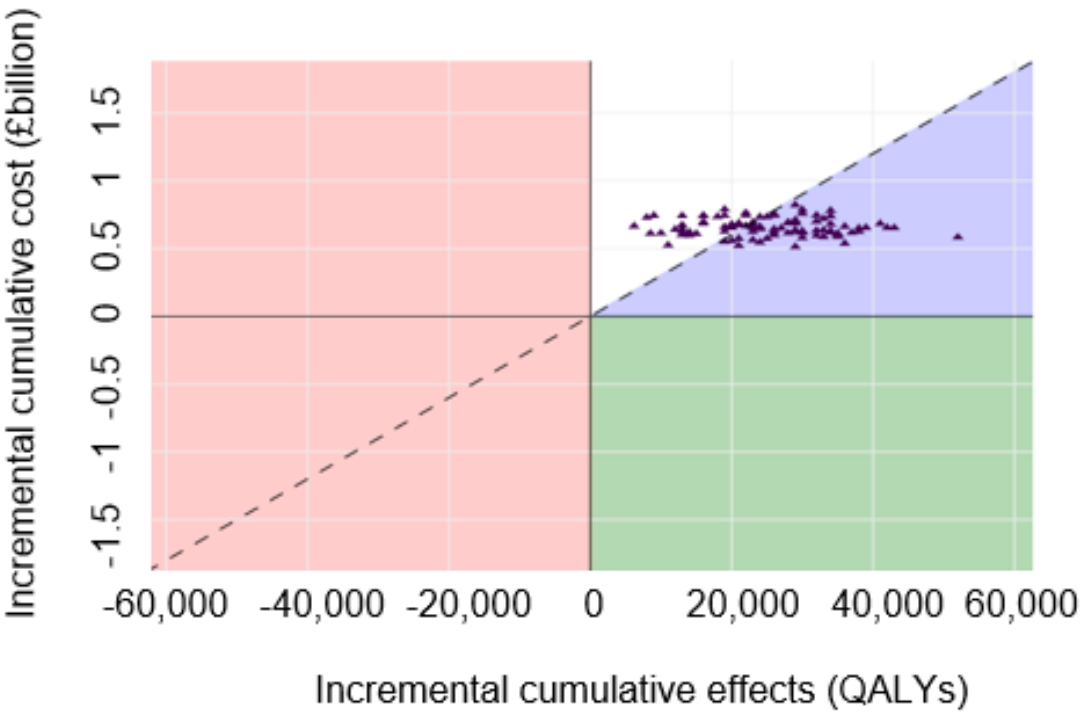


Figure Eiii2. Cost-effectiveness plane showing the median value for scenario Eiii

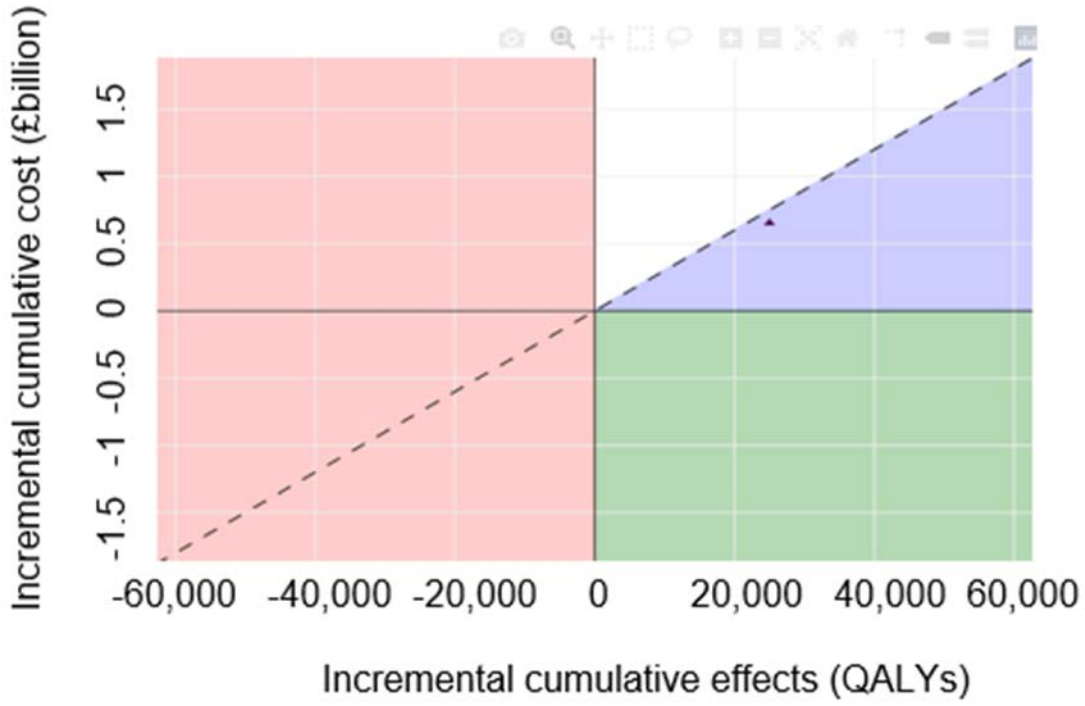


Figure Eii3 shows the probability that scenario Eiii is likely to be cost effective by 2040 from a health and social care perspective using NICE upper cost-effectiveness threshold of £30,000 per QALY.

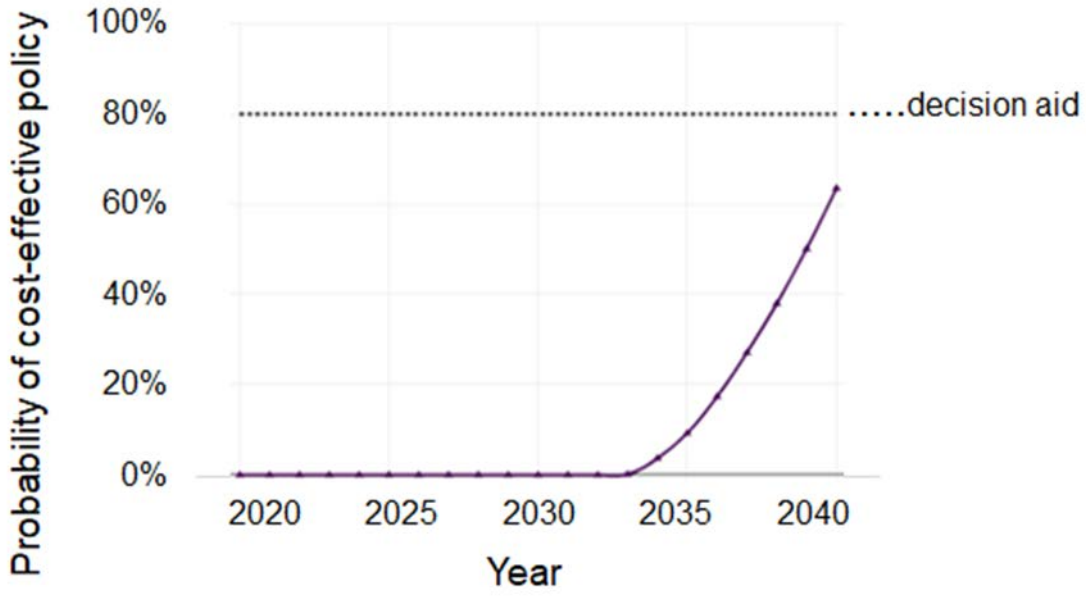
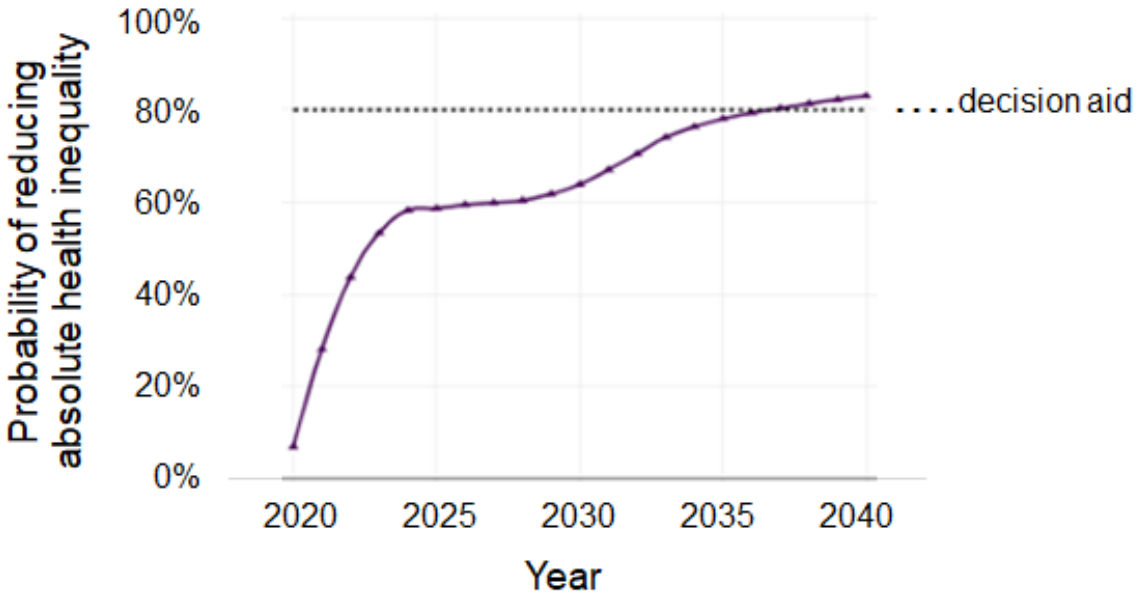


Figure Eiii4 shows the probability that scenario Eiii will reduce absolute health inequality by 2040.

Figure Eiii4. Probability of reducing absolute health inequality for scenario Eiii



Improved follow-up

Figure F1 shows the results of the 100 iterations and Figure F2 shows the median value from scenario F using a health and social care perspective .

Figure F1. Cost-effectiveness plane for scenario F

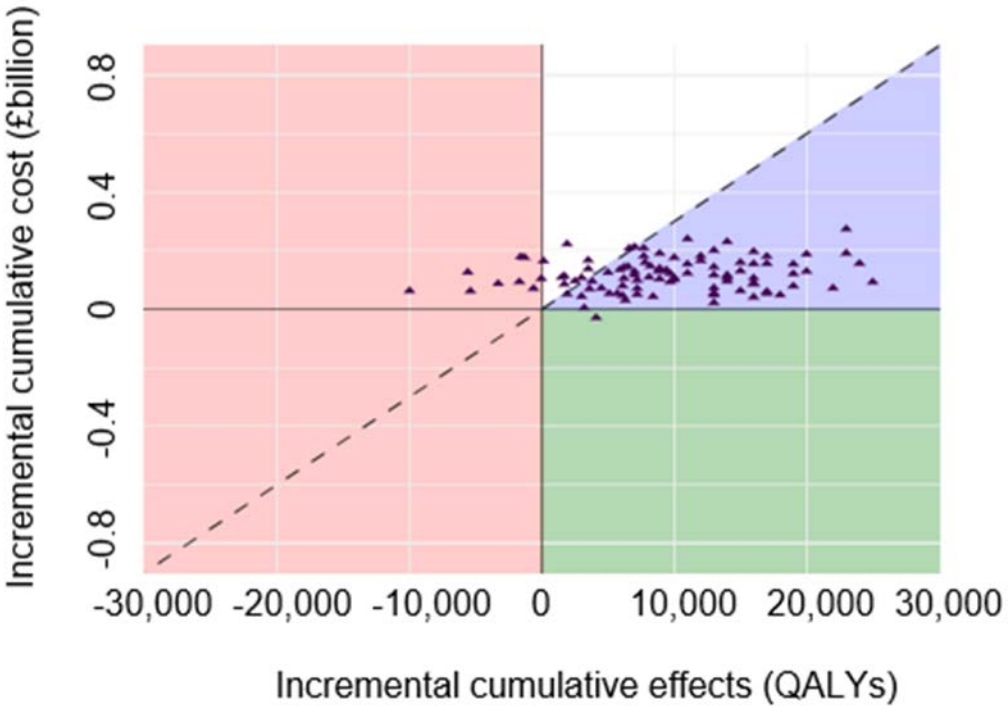


Figure F2. Cost-effectiveness plane showing the median value for scenario F

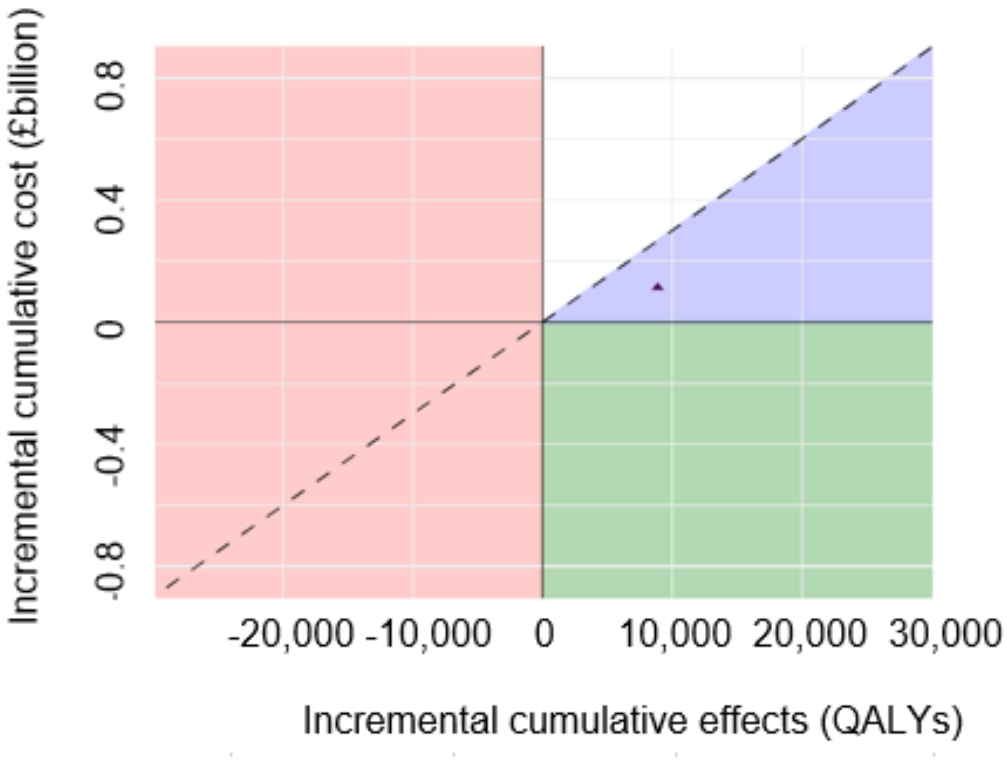


Figure F3 shows the probability that scenario F is likely to be cost effective by 2040 from a health and social care perspective using NICE upper cost-effectiveness threshold of £30,000 per QALY.

Figure F3. Probability of cost-effective policy for scenario F

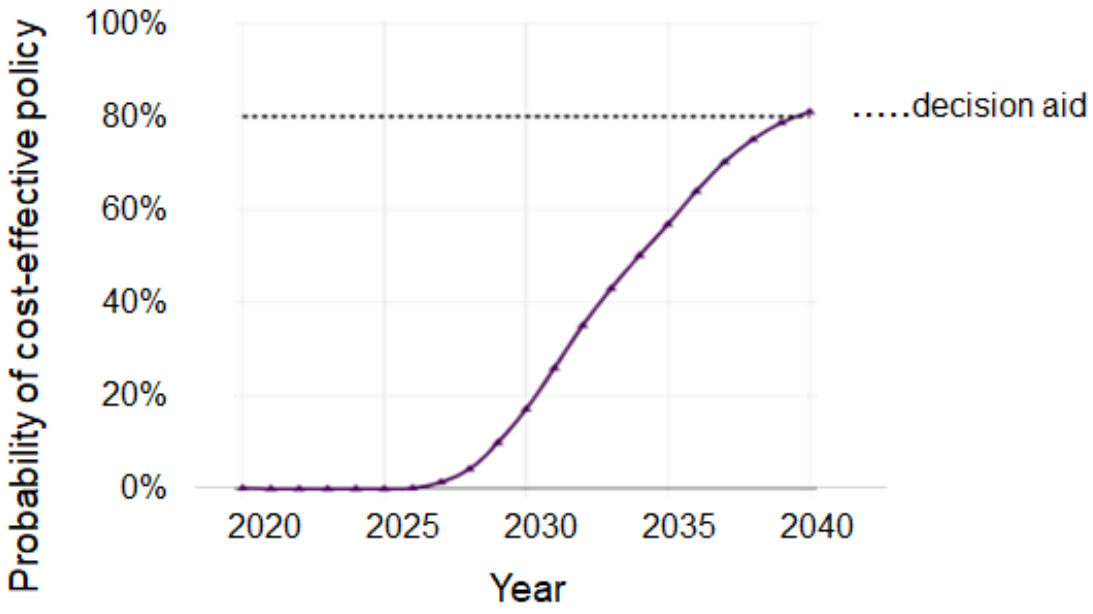
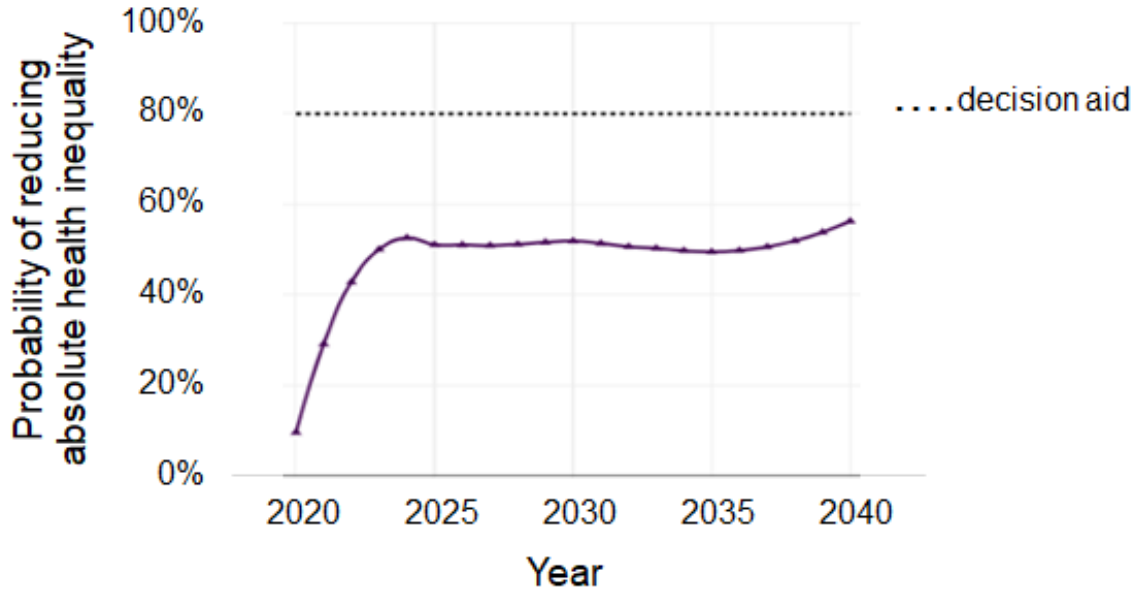


Figure F4 shows the probability that scenario F will reduce absolute health inequality by 2040.

Figure F4. Probability of reducing absolute health inequality for scenario F



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