Public Health England

Protecting and improving the nation's health

Cardiovascular Disease Prevention Return on Investment Tool: User Guide

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Background

The Cardiovascular Disease Prevention Return on Investment Tool (CVD Prevention ROI Tool) has been designed to help you to estimate the costs, savings and health benefits resulting from implementing a range of interventions or improvements in detection and/or management of CVD high risk conditions. The tool can estimate these results for your local authority (LA), clinical commissioning group (CCG), sustainability and transformation partnership (STP), or for England.

This document provides an overview of the aim and scope of the tool, together with a description of how the tool can be used and a worked example demonstrating how a user can set up a model run and interpret the results that come out of it.

Overview of the Tool

Aim of the tool

The aim of the tool is to help you to explore the impact of changes to CVD prevention strategies in people at high risk in your local area in terms of clinical events, mortality, costs and health benefits.

Scope of the Tool

The current tool includes only CVD prevention interventions aimed at people with one or more of the following risk factors for CVD:

- QRISK ≥ 10%;
- Hypertension;
- Familial hypercholesterolaemia (FH);
- Atrial fibrillation (AF);
- Diabetes (including type 1 and type 2 diabetes);
- Non-diabetic hyperglycaemia (NDH);
- Chronic kidney disease (CKD).

Primary prevention of CVD is not considered by this tool. The included interventions were all recommended by NICE by the beginning of 2018 for detection or management of one or more of the listed CVD risk factors. Interventions were included in the tool if there was sufficient evidence around the effectiveness of the intervention. Due to evidence limitations, lifestyle interventions are currently under-represented in the tool; however, the tool also includes the functionality for users to assess the impact of additional interventions that are happening in their local area if they have information about the effectiveness of the intervention.

The outcomes of the tool include clinical events, mortality, costs and health benefits. The tool includes costs and savings to the NHS and social care. It does not currently include wider societal costs. The tool includes demographic information about your local population, so that the outcomes are specific to your area. You can select the locality of interest from the full range of CCGs, STPs and local authorities in England, or for the whole of England.

Further information about the design of the tool can be found in the accompanying project report and the full technical appendix.

Exemplar analyses

A set of exemplar analyses based on national data can be found in the results section of the accompanying final report. This shows a set of analyses based on England, indicating the relative benefits of optimising detection, management or usage of each of the interventions to help you design your own scenarios.

Underlying Model

The underlying model is the School for Public Health Research (SPHR) diabetes and CVD prevention model, developed by the School of Health and Related Research and the University of Sheffield. Full details can be found in the accompanying technical document. This model follows individuals who are programmed to have similar characteristics and risk factors for CVD as those in the English population. Metabolic trajectories for body mass index, cholesterol, systolic blood pressure and glycaemia are predicted for each individual. Baseline characteristics and metabolic risk factors determine the individuals' probability of CVD events, diabetes microvascular complications, cancer, osteoarthritis, depression and dementia. The model also predicts death from CVD, cancer and other causes. The outcomes of the tool will reflect any impact of the interventions on these related conditions as well as CVD. Long term costs and quality-adjusted life years are collected for each individual.

Using the Tool

Key Inputs

There are two types of questions that can be answered by the tool:

1 What happens when I improve detection or management of key CVD risk factors?

This allows you to consider the impact of changing the proportion of people detected and/or well-managed for one or more of the included CVD risk factors:

- QRISK ≥ 10%;
- Hypertension;
- Familial hypercholesterolaemia (FH);
- Atrial fibrillation (AF);
- Diabetes (including type 1 and type 2 diabetes);
- Non-diabetic hyperglycaemia (NDH);
- Chronic kidney disease (CKD).

2 What happens when I improve usage of the key interventions for people at risk of CVD?

This allows you to focus in on the impact of changing the proportion of people with any CVD risk factor who are undergoing specific detection and management interventions. Usage of an intervention incorporates the proportion offered the intervention (of those eligible), uptake and retention of the intervention. Improvements in usage of the intervention might occur through offering more of the eligible population the intervention, increasing uptake and/ or reducing discontinuation of the intervention. Interventions include:

- NHS health checks;
- Annual review for people with one or more high risk condition;
- Cascade testing for FH;
- Lipid modification therapy;
- Anti-hypertensive therapy;
- Anticoagulant therapy;
- Blood glucose lowering medication for type 2 diabetes (e.g. metformin);
- NHS diabetes prevention programme;

- Structured diabetes education;
- Weight management programmes;
- Smoking cessation programmes;
- Nutritional advice for CKD;
- Insulin pump;
- Pharmacist new medicines review;
- Blood pressure self-monitoring;
- User defined intervention.

Depending upon the question that you select to answer, the tool will show an estimate of the current proportion of individuals detected and managed for each condition, or the current proportion using each intervention, based on local data sources where possible, but national data sources where not. You can modify these proportions if you have better local estimates. You can then enter the target proportion of individuals detected/ managed/ using an intervention to create your future scenario. For both questions, you can decide whether you want to phase in the changes over up to three years.

There is also the option for you to input information about an intervention which is not currently included in the tool but that you may wish to evaluate. To do this, you must have information about the effectiveness of the intervention (in terms of CVD relative risk), the target high risk group, the cost of the intervention, the duration of intervention effect and the current and target proportions of individuals undergoing the intervention.

You will also be asked to input your local area of interest, a name for your model run, and your email address to enable you to receive results.

Throughout the tool there are information boxes that you can click on to give you additional information and guide you further.

Key Outputs

Following submission of the tool inputs, the underlying model will take some time to run (estimated to be about one hour per scenario tested but this depends on how many others are using the tool at the same time). You will receive an email when the results are ready containing a link to a user output webpage with your results.

The user output interface includes a range of interactive options to enable you to choose the type of outputs that are of most interest to you. Outputs include a series of tables and graphs based around the incremental

(additional) values for each chosen scenario compared with current care (e.g. additional clinical events avoided, additional costs/savings).

You will be able to:

1 See the inputs that you selected for each scenario, as well as the numbers and proportions of people estimated to have each of the high risk conditions (including undiagnosed cases) currently in your local area.

2 See particular results by selecting particular population subgroups (if desired), a time horizon and a set of output variables of interest. You can go back and change your customised reporting choices as many times as desired.

3 Download a PDF of all results.

4 Download an Excel table of detailed results for the total population to enable further data analysis if required.

Through the email link, you will be able to return as often as you wish to your user output interface, so will be able to retrieve results or look at new outputs for the same analysis at a later date without having to rerun the model.

Worked Example

This worked example will guide you through setting up a model run and interpreting the outputs, using screenshots from the tool. Additional comments are shown in turquoise boxes.

Question: What would the 10-year cost-savings and health benefits be if detection and management of hypertension in England could be improved to reach PHE targets within the next two years?

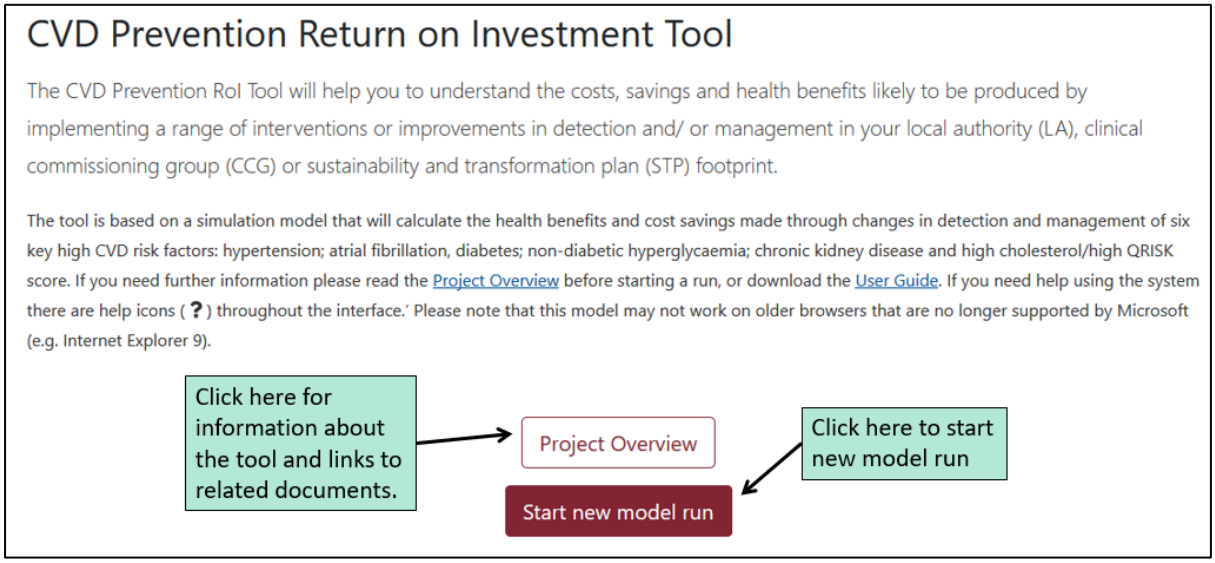
Setting up the model run

Step 1

Open the tool at https://cvd-prevention.shef.ac.uk/ and click on the Start new model run button.

Clicking on the Project Overview button allows you to see information about how to use the tool and includes links to documents associated with the tool including:

- Database of interventions and conditions, which contains detailed information about the parameters used relating to each of the risk factors and interventions in the tool, and their data sources. It is well worth looking at prior to setting up your first model run. This important resource is also linked to regularly throughout the tool.
- Project report, which contains a project summary and a set of exemplar analyses that compare the benefits of optimising detection and management of each risk factor, or usage of each intervention in turn.
- Technical report, which contains full details of the reviews carried out as part of the project and details of the model underlying the tool.



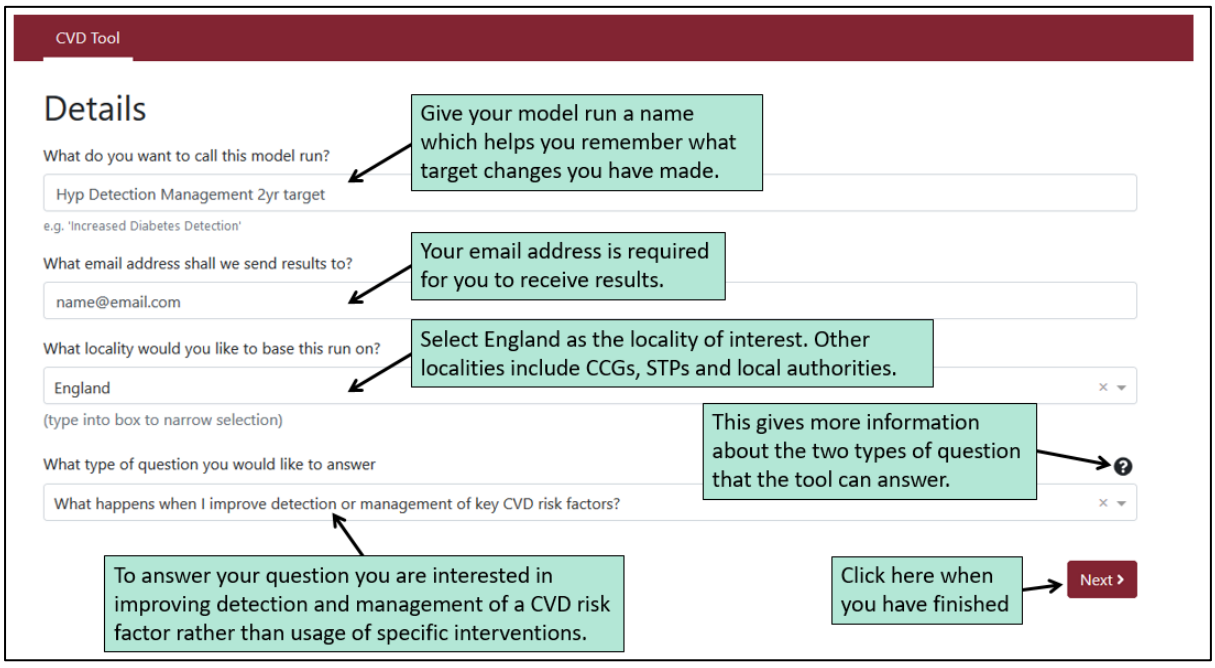
Step 2

The first input sheet has four questions, all of which must be answered before moving onto the next sheet. You must give your model run a name (ideally this will reflect the question you wish to ask, so that you can easily find your results later if you are using the tool more than once), enter your email address (necessary for receiving results), choose your locality of interest (in this case England) and select which of the two key questions you wish to answer from those available in the tool:

1 What happens when I improve detection or management of key CVD risk factors?
2 What happens when I improve usage of the key interventions for people at risk of CVD?

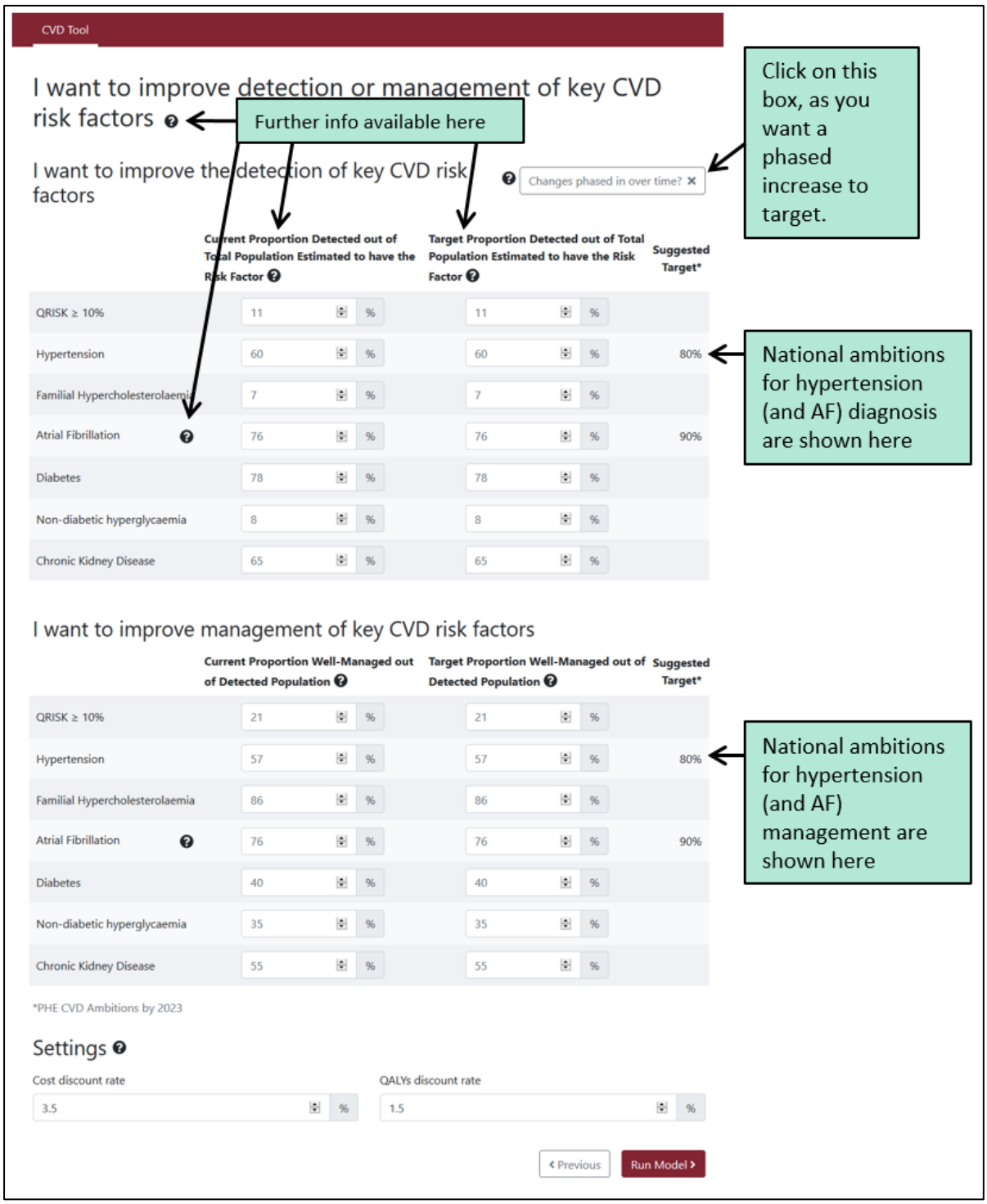
In this example you are interested in seeing the benefits of improving detection and management, so choose the first of the two questions. If you were instead interested in looking at the effect of improving usage of specific interventions then you would choose the second question. An example of this is shown in the Alternative Step 3 section on page 18.

When all four questions have been answered, click on the next button to move to the second and final input page. Note that you will be able to go back to this page from the final page if you want to make changes later.



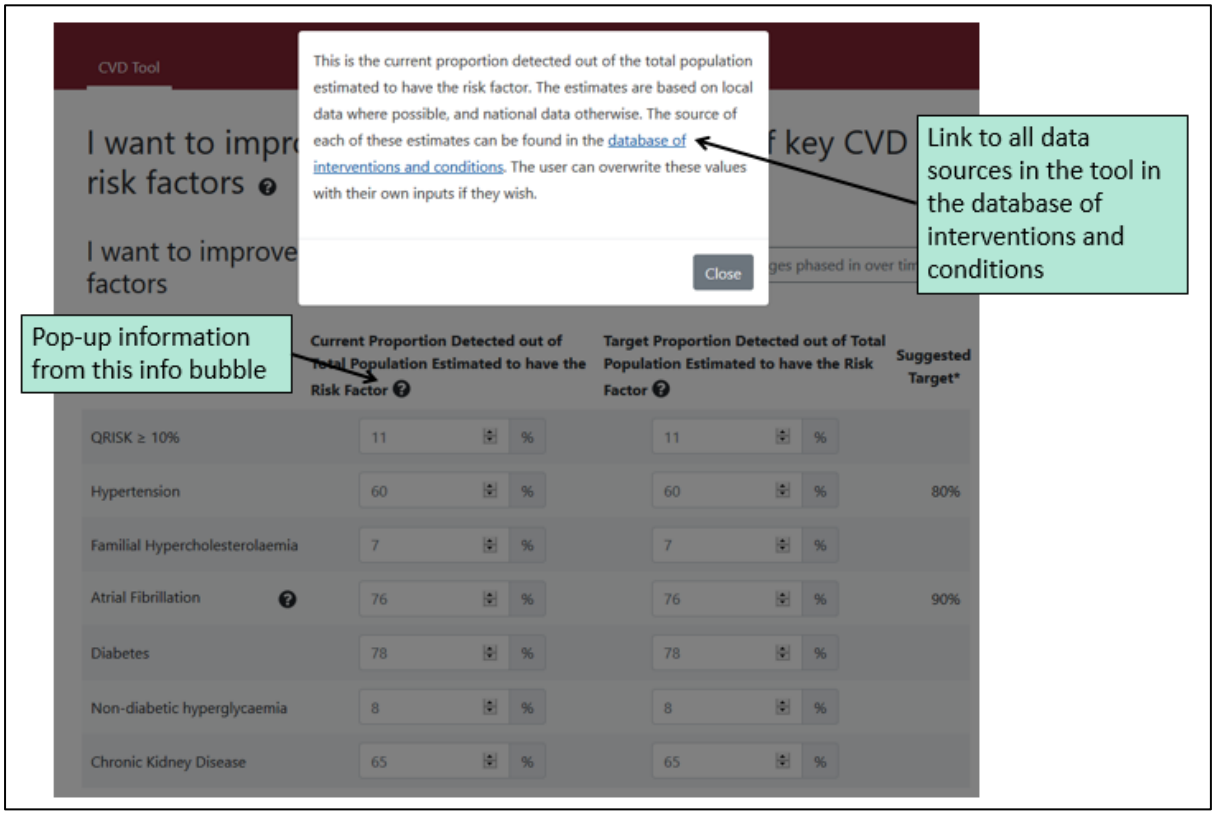
Step 3

The final input page contains quite a lot of detail. There are two very similar sections, the first focussing on detection (of individuals with high risk conditions who are currently undetected) and the second focussing on management (treatment and CVD prevention in individuals who are currently detected), for each of the high risk conditions. The first screenshot shows an overview of the whole page.

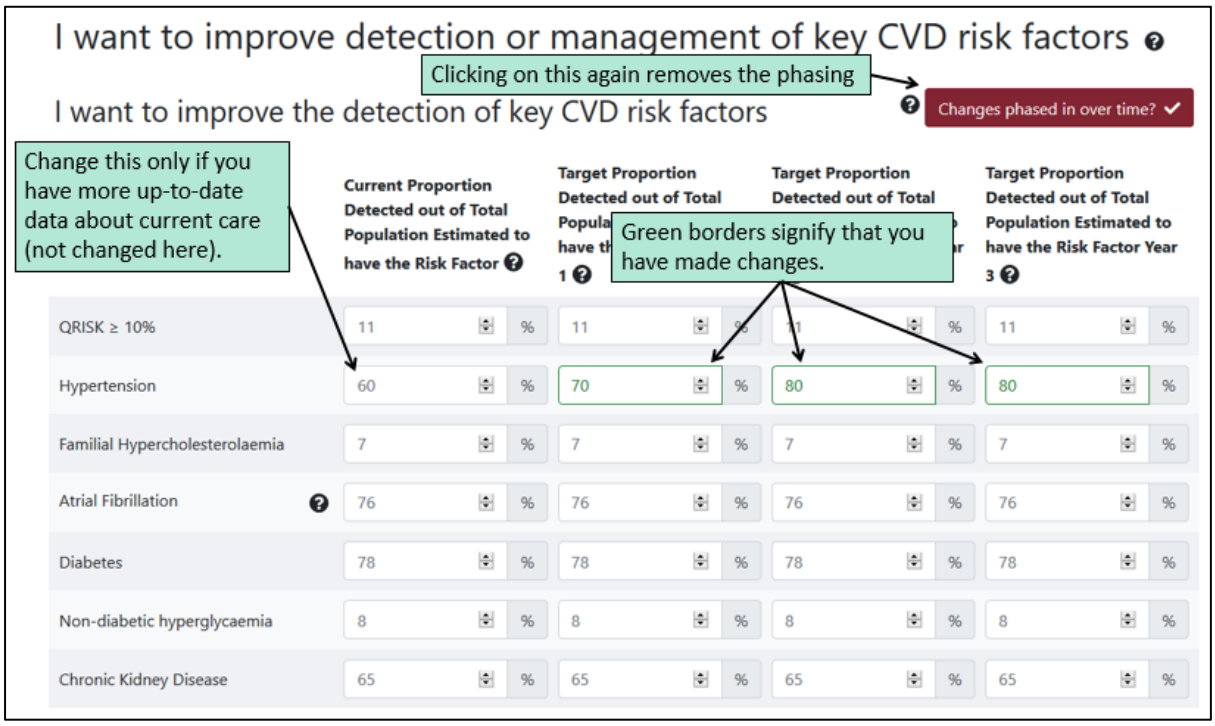


For each high risk condition, information is given about the current proportion detected and well managed in your local area. The target proportion detected and well managed is set at default to the same as the current proportion (i.e. no change). Where suggested targets are available, these have been displayed at the right.

Further information about each of the sets of inputs is available by clicking on the information bubbles. The screenshot below shows an example of the information seen in the information bubble for the 'Current proportion Detected out of Total Population Estimated to have the Risk Factor' heading. This includes another link to the database of interventions and conditions, which contains detailed information about the data sources used to determine current care, amongst other information.



When you have finished looking at the page, you will be ready to start changing some of the inputs. You want to phase in changes over two years, so before altering any of the other input boxes, you should click on the Changes phased in over time box at the top right of the page. The screenshot below shows how this alters the input page (top part only shown). The new page allows you to phase in targets over up to three years. Note that the model implements the changes from the beginning of each year, so year one targets will produce outcomes from year one onwards.



Firstly, you want to check that you are happy with the default values given for current care. If you have more up-to-date information about the current proportion detected with hypertension, you can alter the value in the relevant current care box, either by using the arrows, or typing directly into the box. We are assuming in this example that you do not have any more recent information about this value, so you will not change the value in this box.

Next, you want to phase in changes over two years to reach the PHE target of 80%. This means that you should enter 80 into the year 2 target box. You should also enter 80 into the year 3 target box as we wish the target to be achieved beyond year 2. You should also think about what assumptions you want to make in the first year. If your phase-in will be gradual, it makes sense to enter a value that is halfway between current and target care (i.e. 70%).

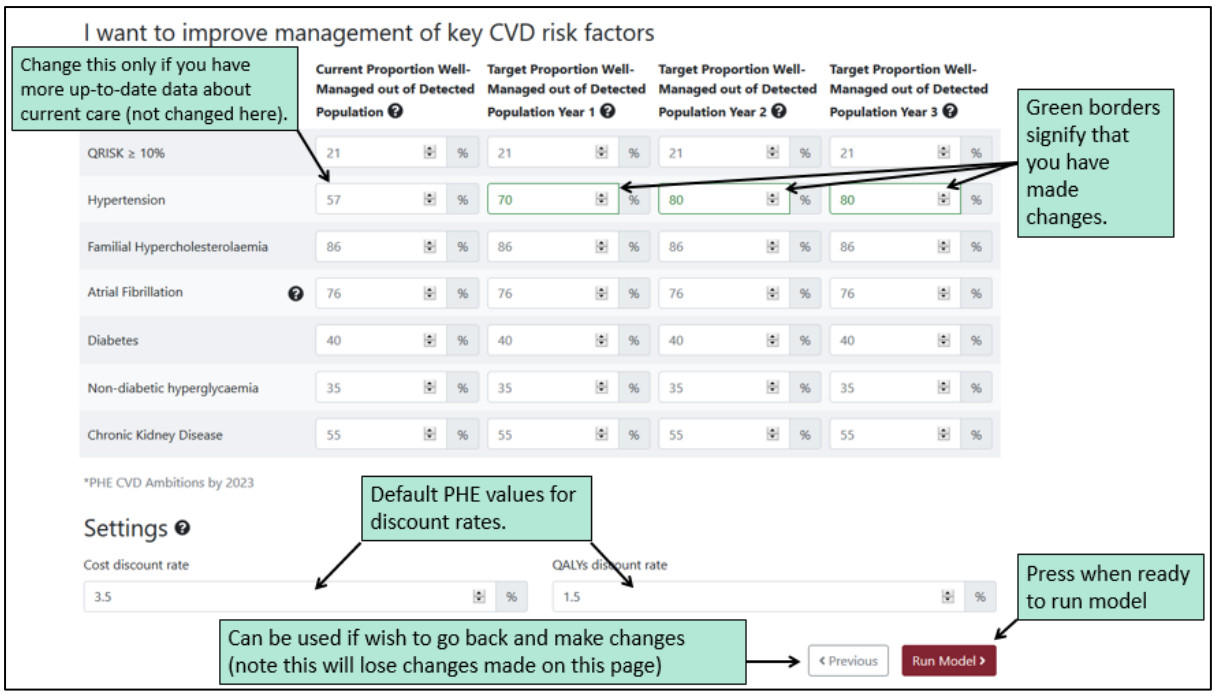
The model assumes that targets continue indefinitely into the future (i.e. in year 4, the same target will be achieved as in year 3). If you want to increase the target transiently over 1 or 2 years before returning to normal, this can also be implemented by setting the year 3 (and year 2 if desired) target values back to the same as the current care values. Note that for detection, in reality it may take several years to return to the current care levels of detection, as people cannot be ‘undetected’ with a condition once detected.

The model will allow you to look at the benefits of improving detection and management for multiple risk factors at once. However, in this example we

are only interested in hypertension, so leave the other detection boxes unchanged.

In the model, improvements in detection for each specific risk factor are assumed to come from an increase in unspecified opportunistic detection methods (rather than specific methods like NHS Health Check and Annual Review that would also detect other risk factors). It is unknown what the costs of these detection mechanisms would be, so detection costs are not included in the model, but the cost of formal diagnosis for people detected opportunistically with risk factor (e.g. including ambulatory blood pressure monitoring for hypertension diagnosis) is included in the intervention costs in the tool.

The process is identical for the management part of the page (screenshot below). Note that you can choose any combination of target scenarios that improve detection only, management only, or management and detection. It is advised not to set any of the target or current care boxes for detection or management to zero, as this can cause problems in running the model.

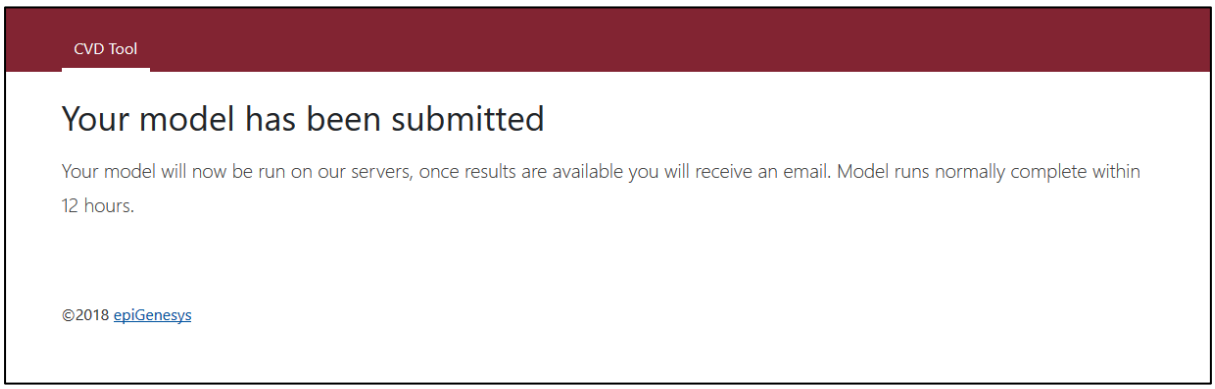


In the model, improvements in management for each specific risk factor are assumed to come from proportionally increasing usage of all NICE recommended management interventions for that risk factor that are included in the model. The list of which interventions are recommended for each high risk factor can be found in the database of interventions and conditions.

The final inputs relate to the discount rates used in the model. Costs and QALYs are often discounted to account for the fact that people place less weight on what happens in the uncertain future than they do on the present. If a discount rate of 0% is chosen then no discounting will be applied. The higher the discount rate the more future costs and QALYs will be down-weighted. The default values reflect those recommended by HM Treasury's Green Book (and used by PHE), so for this example we will assume that they should not be changed.

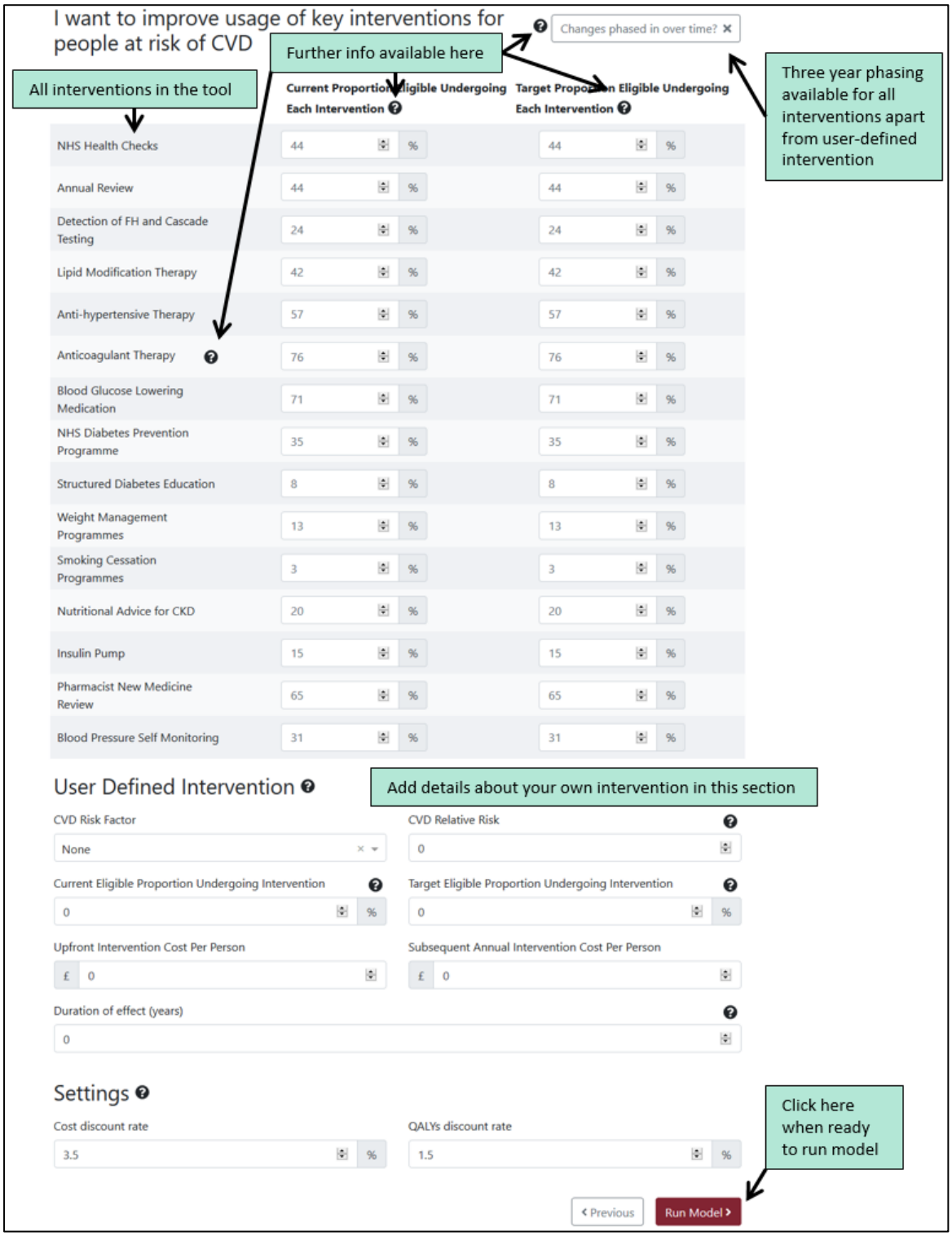
When you are satisfied that you have made the changes that you want to make, you can press the run model button. If you want to go back and make changes to the previous page, you can use the previous button to do this (although note that any information you have entered on the final page will not be saved).

After clicking on the run model button, you will see the model submission screen shown below, indicating that your model is now running. Whilst model runs each complete within an hour, your run may be put in a queue if other model runs are currently in process. You can now close your browser window.



Alternative Step 3

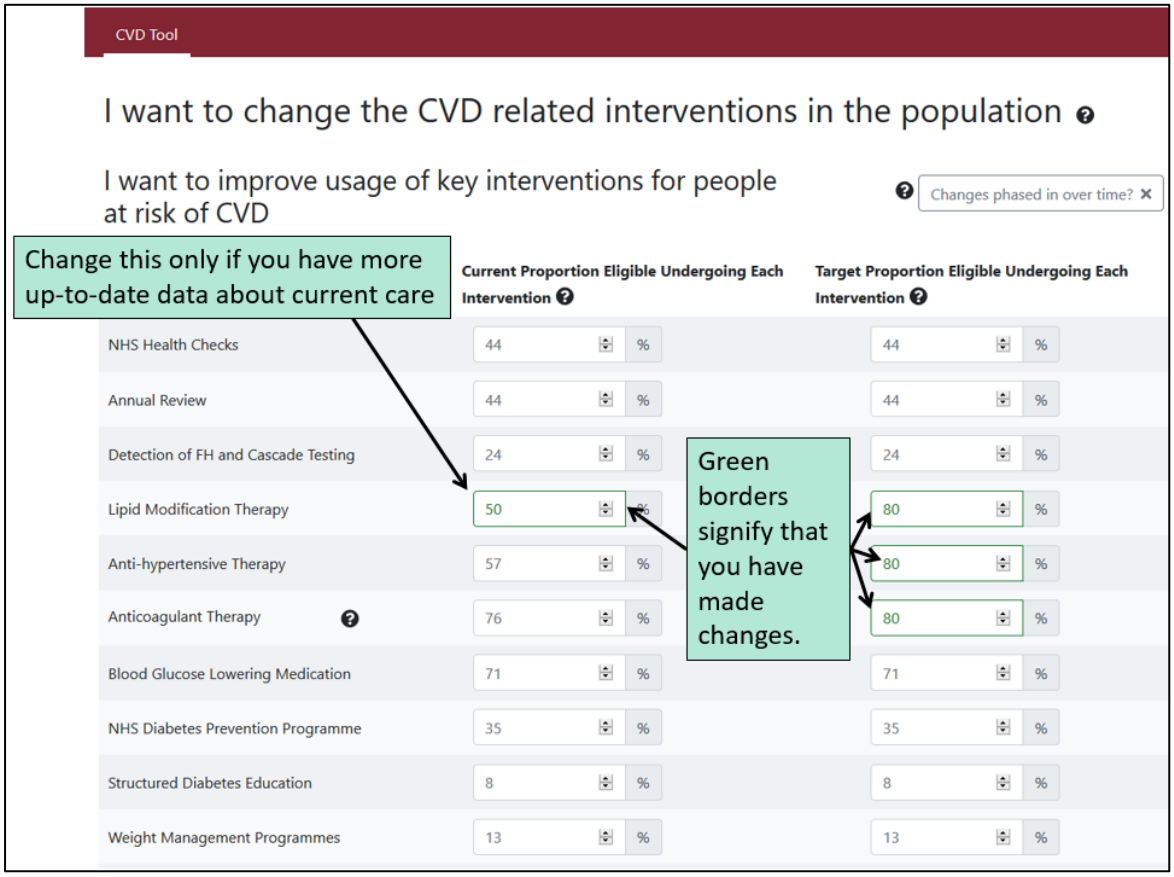
If you were interested in investigating the benefits of improving usage of specific interventions, then you would have instead chosen the 'What happens when I improve usage of the key interventions for people at risk of CVD?' question in step 2. In this case, you would instead see a final input page that looks like the below screenshot.



In the first part of the page, instead of a list of high CVD risk factors, you will see a list of interventions, each aimed at detecting and managing CVD risk factors. This part of the input page works in a very similar way to the detection and management input page. For each intervention, information is given about the current proportion undergoing the intervention of those eligible. The target proportion undergoing each intervention is set at default to the same as the current proportion (i.e. no change).

Further information about each of the sets of inputs is available by clicking on the information bubbles. Some of these information bubbles include another link to the database of interventions and conditions, which contains detailed information about the data sources used to determine current usage of interventions. The database of interventions and conditions also contains other information relating to each intervention, including effectiveness data, cost-effectiveness data, intervention costs, assumed duration of effect and eligibility criteria.

The top part of the page is shown in the screenshot below, giving an example of input changes made. As in the detection and management page, data about current proportion undergoing each intervention can be changed if you have better or more up-to-date information about current intervention usage. You can then change the target usage for one or more interventions.



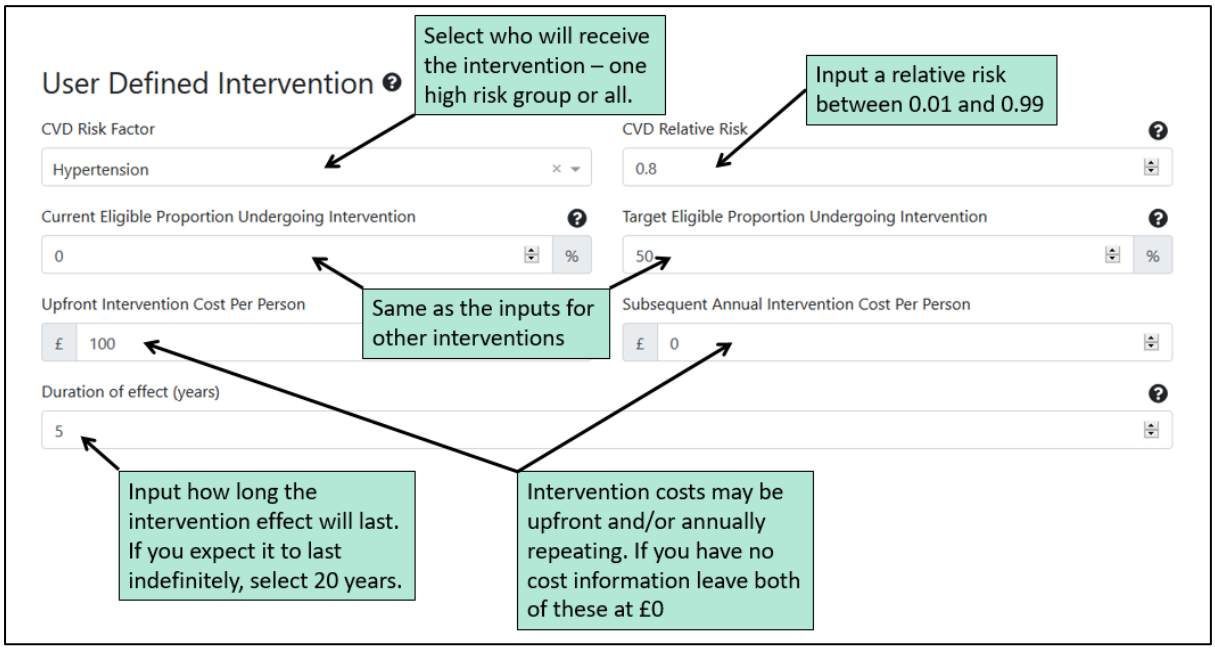
Each intervention may impact on one or more of the high CVD risk factors included in the tool, depending upon eligibility criteria. Interactions between interventions in the model mean that altering the usage of one intervention will have knock-on effects on usage of the other interventions (the population will be healthier due to intervention, so usage of some interventions may be reduced, but fewer people will die so usage of other interventions may be increased). It is possible with this part of the tool (but not possible in the detection and management part of the tool) to entirely remove interactions with any interventions you are not interested in (e.g. if they are not offered in your local area) by setting current and target usage for that intervention to 0% (see screenshot below for an example).

Setting up a User-Defined Intervention

The bottom part of the input page allows you to specify your own management intervention if you wish, and if you have some information about the costs and effectiveness of this intervention. This might include a new lifestyle intervention, a new pharmacological intervention, or you might be interested in seeing what benefits could accrue if you could increase adherence to one of the existing tool interventions. Note that you can set up a user-defined intervention at the same time as you make changes to the other interventions if you wish.

For example, let's say that in your local area you are planning to roll-out a lifestyle intervention aimed specifically at people with hypertension, which helps them reduce salt, fat, caffeine and alcohol in their diet and promotes physical activity. This will cost £100 to deliver over six months, and you aim to give it to 50% of your hypertensive population. From published studies of similar interventions you think that this will help reduce CVD by 20% in this population for five years.

The screenshot below shows what inputs you should enter to evaluate the benefits of this intervention. You must fill in at least the CVD Risk Factor, CVD Relative Risk, Duration of Effect and Target Proportion boxes for this intervention to be included in your model run.



CVD Risk Factor defines your target population; you can choose between any of the risk factors in the tool, or choose to intervene in all high risk individuals. Intervention effectiveness must be inputted as a relative risk for

CVD. So for example, a 20% risk reduction is equivalent to a relative risk of 0.8. Your intervention has an upfront cost of £100 per person, but no subsequent annual intervention cost, so this can be left as £0. Note that if your intervention had a fixed annual cost (e.g. £20), you should enter £20 in both the upfront and subsequent cost boxes. Duration of effect needs to be specified in a whole number of years, with 20 years being the maximum time horizon of the model. Finally, the current and target proportions undergoing the intervention should be inputted in the same way as for the other interventions in the tool. User-defined interventions can either be run alone, or tested in combination with target changes in usage of any of the other interventions in the tool.

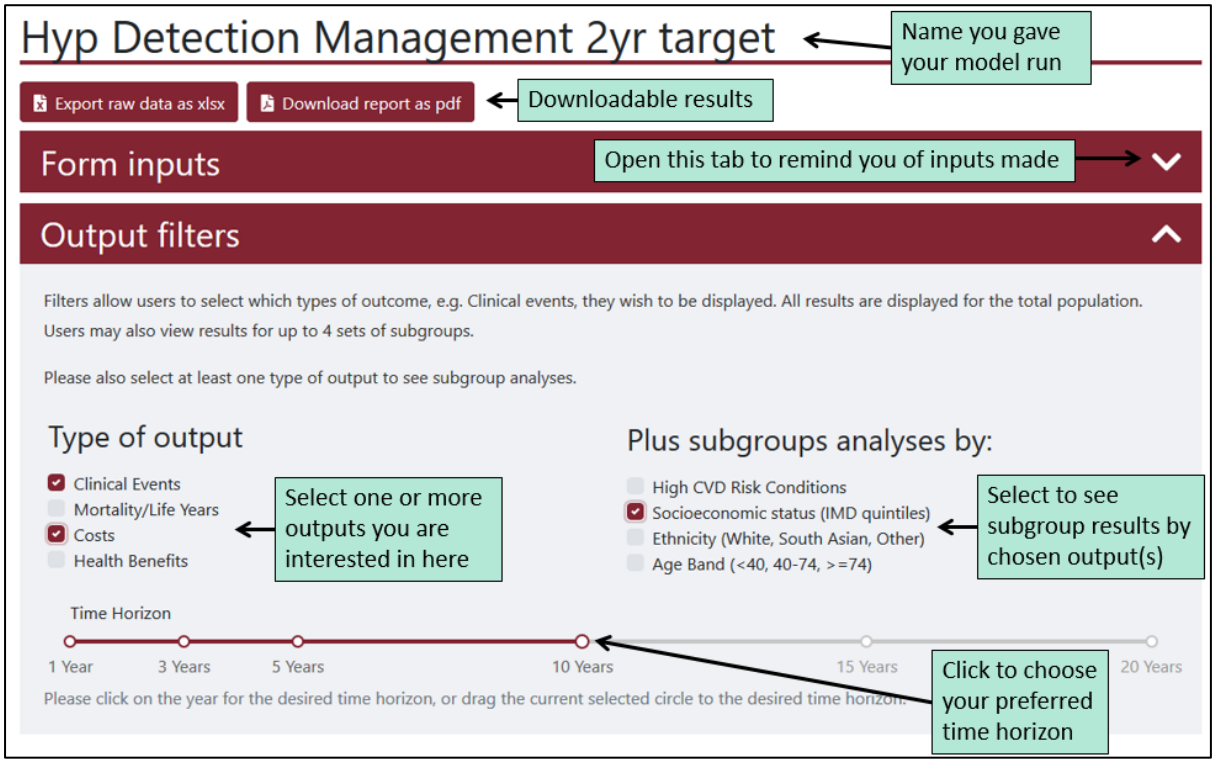
There are some restrictions on the flexibility of the user-defined intervention which may mean that the tool cannot model your intervention as well as it models the other interventions in the tool. Firstly, it is assumed that individuals are only eligible for the intervention once, even once the duration of effect is passed. This means that it can be used to model one-off lifestyle interventions (as described above), or continuous pharmacological interventions, but cannot model interventions that may be repeated regularly at intervals of two or more years. Secondly, phasing is not enabled in the user-defined intervention.

The final section of the interventions input sheet is identical to the detection and management input sheet, and will allow you to change the discount rate and set the model running.

Receiving your results

Filtering Results

Your results will be received in the form of an email including a link. This link is permanent so you can return to it as often as you wish. Clicking on the link will take you to your results page. An example of how the top of this page will look is shown in the screenshot below.



The name that you gave your model run will be at the top of the page. Underneath this, two buttons allow you to download and save your results. The PDF download includes all the results graphs, tables and text presented in your results link. The Excel download contains the raw data for the total population results (but not the subgroup results), for your own data analysis. If you open the Form inputs tab, you will be reminded of the inputs that you selected for this model run.

A large amount of output data is available from the tool, so the Output filters tab has been created to enable you to manage which outputs you see, to prevent results from becoming overwhelming. If nothing in this tab is selected, then you will only see some descriptive text and two tables: Table 1 showing the estimated total prevalence of high CVD risk factors in your population (including diagnosed and undiagnosed), and Table 2 giving you some key summary results (see example in the next section).

You can select one or more of four different types of outputs:

- Clinical events (CVD events including heart attacks, angina, stroke, transient ischaemic attack (TIA) and congestive heart failure, plus new diabetes diagnoses and end stage renal disease).
- Mortality/Life Years (includes premature mortality at age < 75, and life years).
- Costs (includes costs of each intervention in the model, plus cost-savings to the NHS [split into primary and secondary care in one analysis, and by disease area in a second analysis] and to social care, plus the net total).
- Health Benefits (includes Quality Adjusted Life Years (QALYs) and Net Monetary Benefit [NMB], which monetises the health gains assuming a value of £60,000 per QALY).

By default, all results will be shown for the total population. However, if you wish to compare results across subgroups, you can also select one or more of the subgroup boxes. Note that you must choose at least one output in addition to selecting a subgroup to see any subgroup results. A graph will be shown for each chosen subgroup, for each of your selected outputs (up to 16 graphs in total). Subgroups include high CVD risk conditions, age groups, ethnic groups and quintiles of socioeconomic deprivation.

The final selection is to decide your preferred time horizon. Graphs will be shown spanning your entire time horizon, whilst in tables, a selection of data from key years across your chosen time horizon will be shown.

You can go back and change your selection as many times as you wish.

Interpreting Results: Key Results

This section helps explain some of the graphs and tables found in the tool reports, with reference to the worked example.

Key model results are found in Table 2 (shown below), which you will be able to see without selecting any additional output filters. This includes the total number of CVD events prevented (including heart attacks, strokes, angina, transient ischaemic attack and congestive heart failure), the total costs of intervention (this includes costs of improving detection or management), the total cost savings to the NHS and social care, the net overall cost or savings of your target scenario, the total life years gained and the total quality-adjusted life years (QALYs) gained.

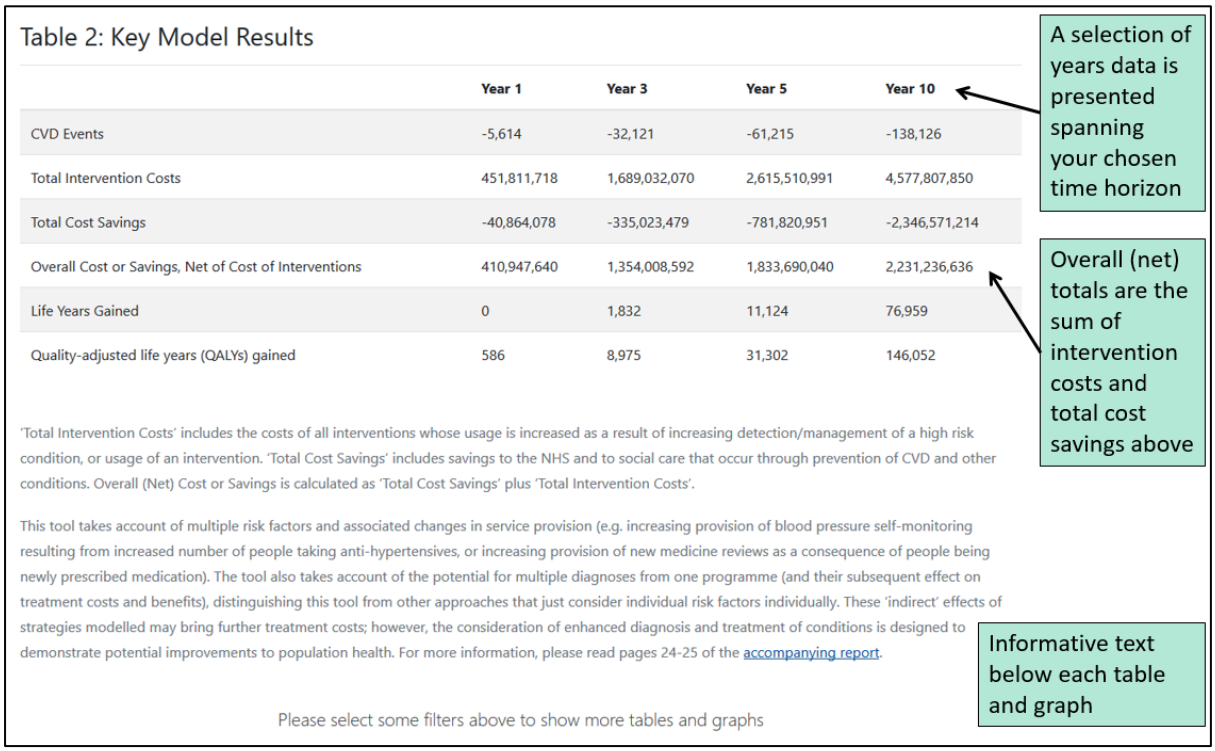


Table 2: Key Model Results

	Year 1	Year 3	Year 5	Year 10
CVD Events	-5,614	-32,121	-61,215	-138,126
Total Intervention Costs	451,811,718	1,689,032,070	2,615,510,991	4,577,807,850
Total Cost Savings	-40,864,078	-335,023,479	-781,820,951	-2,346,571,214
Overall Cost or Savings, Net of Cost of Interventions	410,947,640	1,354,008,592	1,833,690,040	2,231,236,636
Life Years Gained	0	1,832	11,124	76,959
Quality-adjusted life years (QALYs) gained	586	8,975	31,302	146,052

'Total Intervention Costs' includes the costs of all interventions whose usage is increased as a result of increasing detection/management of a high risk condition, or usage of an intervention. 'Total Cost Savings' includes savings to the NHS and to social care that occur through prevention of CVD and other conditions. Overall (Net) Cost or Savings is calculated as 'Total Cost Savings' plus 'Total Intervention Costs'.

This tool takes account of multiple risk factors and associated changes in service provision (e.g. increasing provision of blood pressure self-monitoring resulting from increased number of people taking anti-hypertensives, or increasing provision of new medicine reviews as a consequence of people being newly prescribed medication). The tool also takes account of the potential for multiple diagnoses from one programme (and their subsequent effect on treatment costs and benefits), distinguishing this tool from other approaches that just consider individual risk factors individually. These 'indirect' effects of strategies modelled may bring further treatment costs; however, the consideration of enhanced diagnosis and treatment of conditions is designed to demonstrate potential improvements to population health. For more information, please read pages 24-25 of the accompanying report.

Please select some filters above to show more tables and graphs

All results are shown as cumulative over time (i.e. for year 2, the results for year 1 and year 2 are combined), and incremental (i.e. the difference between your target scenario and unchanged current care).

Cost savings are always represented as negative, with costs represented as positive. Adding together total intervention costs and total cost savings produces the net total of overall costs/savings, which determines whether or not your scenario is cost-saving overall or whether it will cost money.

Interpreting Results: Clinical Outputs

The screenshot below shows an example of Table 3, which presents clinical outputs. Actual results will vary between model runs; however, in general you will probably find that CVD events will be reduced (negative values) and that this reduction will increase cumulatively over time.

Table 3: Clinical Events (cumulative)

	Year 1	Year 3	Year 5	Year 10
Heart Attacks	-1,137	-6,132	-12,917	-30,729
Unstable Angina	-714	-2,770	-5,176	-10,686
Stable Angina	-1,291	-7,838	-14,535	-30,675
Stroke	-1,100	-7,482	-14,392	-38,451
TIA	-342	-2,148	-3,919	-8,197
Congestive Heart Failure	-1,030	-5,752	-10,276	-19,387
Total CVD	-5,614	-32,121	-61,215	-138,126
New diabetes diagnoses	0	-6,241	-3,756	2,329
End-Stage Renal Disease	0	-6	-20	127

Sometimes you may see increases in clinical events

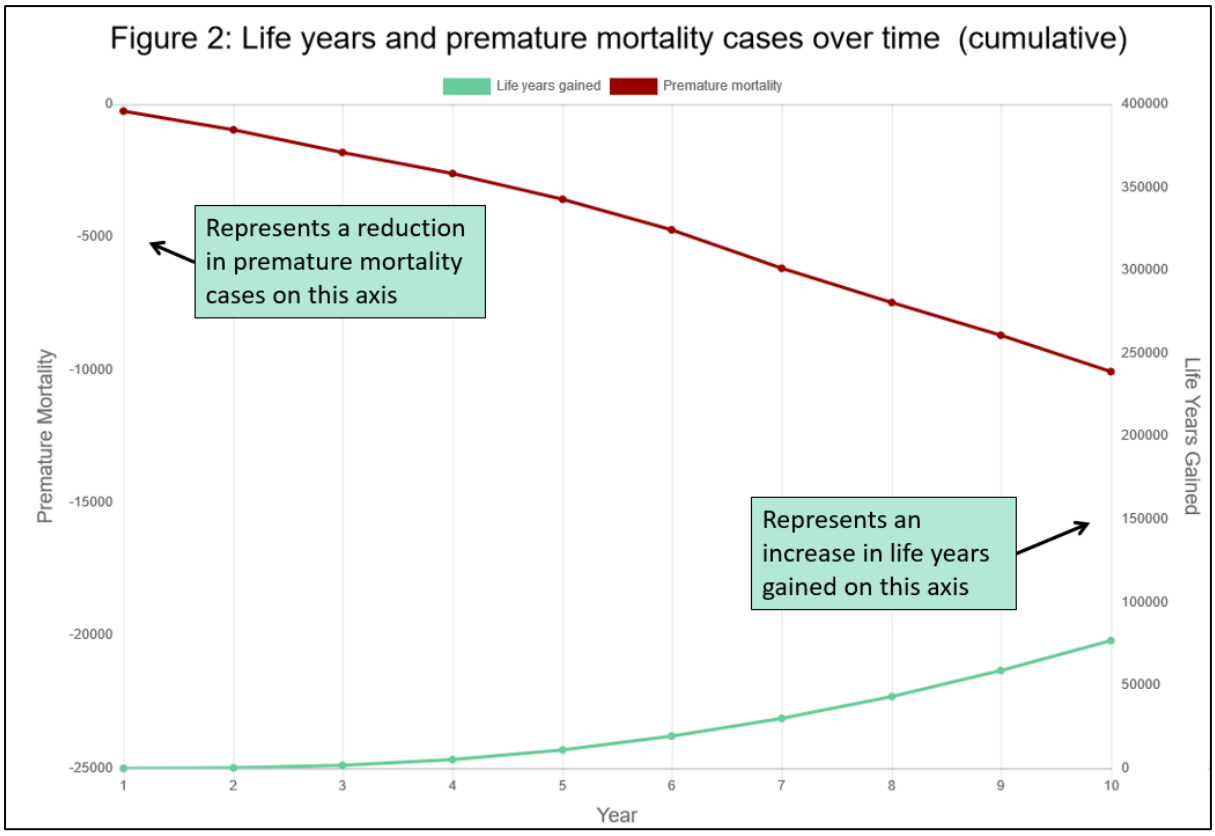
Sometimes small increases in events followed later or earlier by reductions may be seen. These are likely to be due to randomness and imply that the results for this clinical event are not likely to be statistically significant. Sometimes large increases in end stage renal disease and/or diabetes are seen at later time horizons (as shown here) because the reduction in CVD (and hence CVD death) is resulting in people living longer and developing more end stage renal disease and diabetes than they would have done otherwise (known as competing risks).

An accompanying figure (Figure 1 from the results page), displays CVD events and is fairly straightforward to interpret so is not shown here.

Interpreting Results: Mortality/Life Years

Results are given for premature mortality and life years in Table 4 from the results page (not shown), with premature mortality being specified as mortality under age 75. In general, most scenarios will produce an increase in life years and a reduction in premature mortality. A small increase in premature mortality may be seen in some scenarios, in particular those that increase usage of anticoagulants. Although highly effective, anticoagulants are also associated with a relatively small risk of major bleeding, which may be fatal. The magnitude of this effect is subject to considerable uncertainty, and the modelled effects on premature mortality when running scenarios that increase anticoagulant usage in this tool may not be statistically significant. Anticoagulants are recommended by NICE for their overall positive impacts on quality and length of life, and generally, any small increases in premature mortality are vastly outweighed by increases in life years.

Figure 2 from the results page (see example below) plots premature mortality and life years on the same graph. It is important to note that these have separate axes and therefore that there is no significance relating to the two plotted lines crossing, as they may do in some scenarios.



Interpreting Results: Costs

Costs are split in two different ways to produce a range of tables and graphs containing different information. Table 5 (screenshots below) shows intervention costs split by type of intervention, and savings split by primary care, secondary care and social care. Positive values represent costs and negative values represent savings.

Table 5: Intervention Costs, Savings and Overall Cost/Savings (cumulative)

	Year 1	Year 3	Year 5	Year 10
INTERVENTION COSTS:				
NHS Health Check Costs	0	-6,903,182	-16,921,436	-42,676,543
Annual Review Costs	0	38,773,759	87,745,006	193,200,030
Cost of diagnosing all of the high risk conditions apart from FH	74,765,376	155,106,157	159,690,450	169,787,753
Familial Hypercholesterolaemia Testing costs	0	346,919	246,223	-331,243
Cost of statin treatment	0	15,811	187,997	1,230,910
Cost of antihypertensive treatment	73,545,213	361,965,208	639,688,978	1,245,677,626
Cost of anticoagulant treatment	3,549,858	17,942,706	28,818,461	45,987,505
Cost of antidiabetic treatment (type 2 diabetes)	0	-612,484	-1,701,679	-9,065,084
Cost of NHS Diabetes Prevention Programme (DPP)	0	166,609	653,812	2,342,434
Cost of diabetes education	0	-82,028	-187,831	-128,220
Cost of weight management programmes	117,941,990	271,957,364	263,409,997	230,109,254
Cost of smoking cessation programmes	70,223,355	318,310,901	535,437,511	990,893,182
Cost of nutritional advice for CKD	0	37,262	19,007	-113,467
Cost of medicine use review	37,793,448	95,568,173	114,114,704	154,235,290
Cost of blood pressure self-monitoring	73,992,478	436,471,991	804,262,108	1,596,424,169
Cost of insulin pump	0	-33,095	47,682	234,255
Cost of user-defined intervention	0	0	0	0
Total Intervention Costs	451,811,718	1,689,032,070	2,615,510,991	4,577,807,850
SAVINGS:				
Savings in Primary Care	-5,937,127	-66,915,426	-158,042,668	-412,702,039
Savings in Secondary Care	-26,845,355	-190,248,255	-421,213,189	-1,176,436,873
Total Cost Savings (NHS)	-32,782,482	-257,163,681	-579,255,857	-1,589,138,911
Social Care Savings	-8,081,596	-77,859,798	-202,565,094	-757,432,302
Total Cost Savings (NHS + Social Care)	-40,864,078	-335,023,479	-781,820,951	-2,346,571,214
OVERALL COST OR SAVINGS, NET OF INTERVENTION (NHS AND SOCIAL CARE)	**410,947,640**	**1,354,008,592**	**1,833,690,040**	**2,231,236,636**

Cost of additional hypertension diagnosis

Indirect costs and savings accrue from year 2 onwards for all interventions.

Costs of additional hypertension management

More people eligible for anticoagulants due to hypertension diagnosis

More people eligible for lifestyle interventions due to better diagnosis of hypertension

More people eligible for medicine use review and BPSM due to increased antihypertensive usage

Not used here

Total of all above rows

Cost savings shown as negative values.

Sum of total intervention costs plus total cost savings.

You will notice that even if you selected to change usage of a single intervention, all interventions will show either some costs or savings apart from the user-defined intervention. This is because the model is calculating both the direct and indirect impact of your chosen scenario.

In the example above, you have chosen to improve detection and management of hypertension to 80%. The direct impact of doing this is implemented in the first year. You see an increase in diagnosis costs, but no change in the costs of NHS Health Check or annual review (this is because the increase in diagnosis is assumed to come from unspecified opportunistic diagnosis). You will also see an increase in cost of the interventions in the model that are recommended for management of hypertension by NICE. This includes antihypertensives, blood pressure self-monitoring, medicine use review (in people newly taking medication), smoking cessation (in smokers) and weight management (in those who are overweight or obese). You have chosen to improve both detection and management of hypertension, so the increased costs come both from newly diagnosed people undergoing these interventions, and an increase in managing existing people with hypertension. An increase in anticoagulant usage is also seen, as the increase in hypertension diagnosis increases the eligibility for anticoagulants in people who also have AF.

Indirect impacts on other interventions are seen from year 2 onwards. In this example, the cost of NHS Health Checks is reduced, but the cost of annual review is increased, as diagnosing more people with hypertension means that there are fewer people eligible for Health Checks, but more now eligible for annual review. Management interventions tend to show a reduction in costs if the increased health of people means that fewer people are eligible for the interventions (in this example, improving detection and management of hypertension has an indirect effect in delaying some cases of diabetes, so a reduction in diabetes treatment and education costs is seen). On the other hand, management interventions can show an increase in costs if people are surviving for longer in your chosen scenario, and so becoming eligible for these interventions (e.g. cost of statins or NHS DPP in the example above).

Cost savings are seen in the second part of the table and are shown as negative values. The balance between total costs and total savings is also seen in Figure 3, whilst the stacked line chart in Figure 4 illustrates the way in which savings are split into primary and secondary NHS savings, and social care savings over time (not shown here).

The final table in the costs section splits cost savings by disease area (see screenshot below). This includes CVD, end stage renal disease, blindness

and amputation (both complications of diabetes), bleeding adverse events and other. Other savings include those gained through reducing breast and bowel cancer, dementia, depression and osteoarthritis.

Table 6: Cost Savings by disease area (cumulative)

	Year 1	Year 3	Year 5	Year 10
CVD - split into:	-39,138,635	-296,074,858	-693,915,534	-2,199,810,040
Primary Care	-4,919,834	-39,187,896	-96,877,275	-311,471,935
Secondary Care	-26,269,028	-180,121,779	-396,948,171	-1,135,662,008
Social Care	-7,949,773	-76,765,183	-200,090,088	-752,676,096
End-Stage Renal Disease	0	246,871	1,289,296	18,308,321
Blindness	-253,561	-2,461,355	-6,760,593	-25,883,724
Foot Ulcer and amputation	78,686	-1,408,565	-4,649,051	-25,001,702
Bleeding adverse events	-42,267	131,265	77,497	1,008,667
Other	-1,508,302	-35,456,836	-77,862,567	-115,192,737
TOTAL SAVINGS	-40,864,078	-335,023,479	-781,820,951	-2,346,571,214

Increase from yr2 due to lower mortality

Increase due to higher anticoagulant usage

Sum of all above rows

You will note that costs are not always saved when split by disease area – certain disease areas may actually incur costs due to intervention (shown as positive values). This is particularly true of bleeding adverse events, which will increase directly in line with higher usage of anticoagulants. However, some conditions (particularly end-stage renal disease) may also be increased as a result of the intervention if people survive for longer than they would without intervention; this will in turn incur costs of treating those diseases.

Interpreting Results: Health Benefits

The last set of tables and graphs show the health benefits measured in quality adjusted life years (QALYs) and net monetary benefit (NMB) (not shown here as they are easy to interpret). NMB monetises the value of a QALY at £60,000 and combines it with the total net costs/savings to come up with a figure for total monetary benefit as follows:

Incremental NMB = (Incremental QALYs * £60,000) – Incremental Costs

Interpreting Results: Subgroup Analyses

Up to 16 graphs with subgroup results can be displayed. The interpretation of each of these will differ depending upon the chosen scenario, so only a couple of examples are given here. To enable comparison between the chosen subgroups, results in this section have been normalised so that each shows outcomes per 1,000 people in that subgroup in your locality. This differs from the total population results, which show the absolute costs and benefits that you would obtain. It is also important to note that the subgroup results refer to subgroups of the population at baseline, rather than a dynamic population that changes over time (e.g. with age).

Figure 6 (screenshot below) shows an example of the change in CVD events over time by risk condition. In this example, the hypertension group get the most benefit: this is not surprising as this is the group in which detection and management has been optimised. Other groups also benefit because some individuals will have other comorbid conditions in addition to hypertension, making them at particularly high CVD risk. Detection and management of their hypertension will reduce the CVD risk in these particularly high risk people of other groups. In some scenarios you may find that a group other than your selected group benefits most. This is particularly likely to happen if a high proportion of individuals have both conditions and/or if those with both conditions are at very high CVD risk.

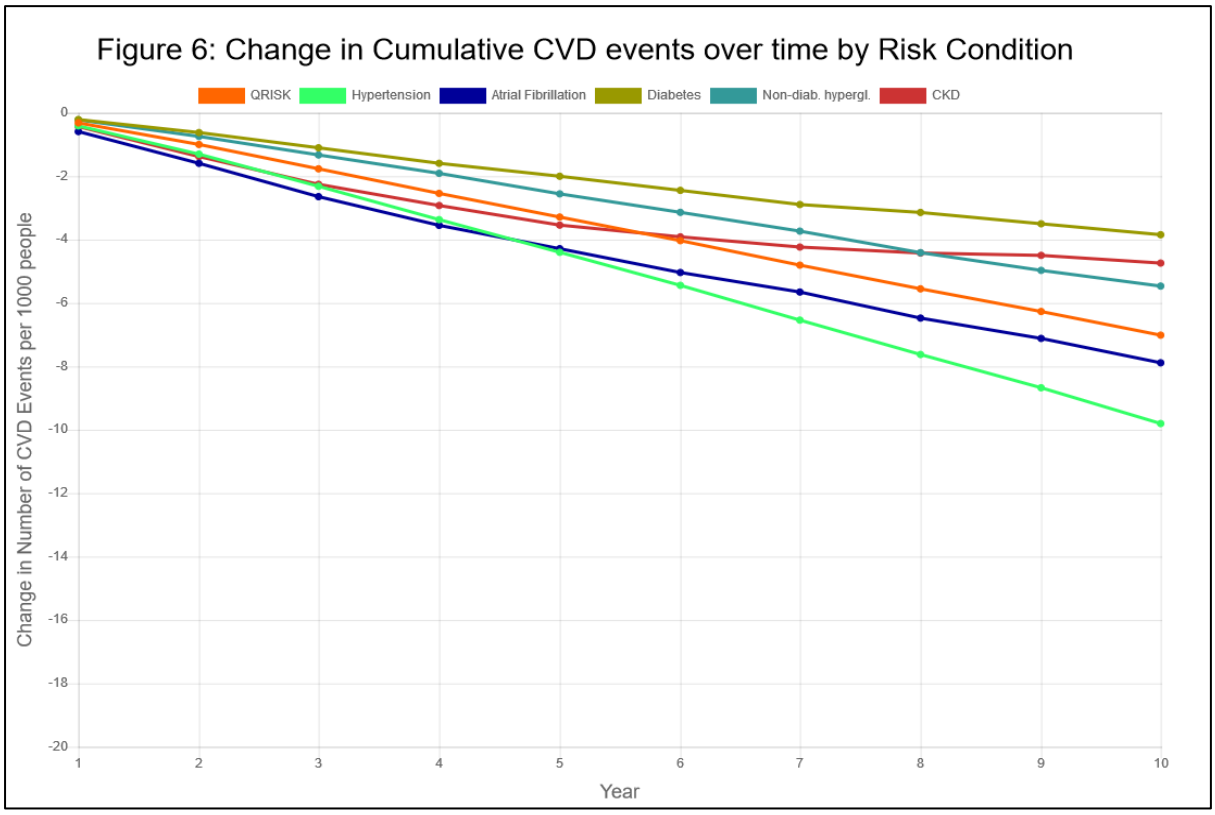


Figure 11 (screenshot below) shows an example of the change in life years over time by indices of socioeconomic deprivation (IMD) quintile, where least deprived is represented by quintile 1 (Q1) and most deprived by quintile 5 (Q5). You can see here that the outcomes for all five quintiles are very close together, and are not in order from 1-5 as might be expected. This indicates that the difference between IMD quintiles is unlikely to be significant for this outcome measure.