Public Health England

Protecting and improving the nation's health

A tool to test the long term health and cost impacts of air pollution at a local authority level

About Public Health England

Public Health England exists to protect and improve the nation's health and wellbeing, and reduce health inequalities. We do this through world-leading science, knowledge and intelligence, advocacy, partnerships and the delivery of specialist public health services. We are an executive agency of the Department of Health and Social Care, and a distinct delivery organisation with operational autonomy. We provide government, local government, the NHS, Parliament, industry and the public with evidence-based professional, scientific and delivery expertise and support.

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Background

Air pollution has a significant impact upon public health, with both short (1-3) and long term health effects (4-6) increasing the risk of conditions such as asthma, cardiovascular, and respiratory disease, as well as risk of death. Knowing how air pollution is likely to impact upon health and related health costs over time is important for future policy and resource planning.

This user guide provides instructions on how to run the PHE Air Pollution Tool to answer this question.

Specifically, the tool has the ability to quantify the potential costs to the NHS and social care due to the health impacts of pollutants Nitrogen Dioxide (NO_2) and particulate matter ($PM_{2.5}$). The costs include primary care, secondary care, medication use, social care, and the combination of all the above costs.

The tool focusses on outdoor air pollution and has the ability to test different general '**what if' scenarios** for the reduction of air pollution, such as a given reduction in the levels of air pollution on the future impact on health and related cost.

Installing the tool

Step 1. Download and run the PHE_Air_Pollution_Setup.exe installer.
Step 2. Select where you want to install the tool and click Next. (If you set this to “Program Files”, you will need to run the tool with admin privileges every time you start it.)
Step 3. Select whether you want shortcuts placed on the Desktop and click Install.

After the tool is installed, you will find shortcuts for both running the tool and for opening the output folder in your Start menu in a “PHE_Air_Pollution_Tool” folder. If the relevant option was selected, shortcuts will also be placed on your desktop.

When you first run the tool, you will be prompted to accept the licence agreement. Please read over the terms and conditions then click Agree to continue.

Running the simulation

1. Initial Set Up: Location, Data Input and Risk Factor Selection

To set up a specific location, add population, exposure, cost data, and select the risk factor to be modelled, follow the instructions below:

STEP 1:

Select the geographical area of interest (Figure 1). This can be England or any local authority. If the geographical area you want to model is not in the drop down list of the 'geographical area' field, user should select 'Other region' as the geographical area.

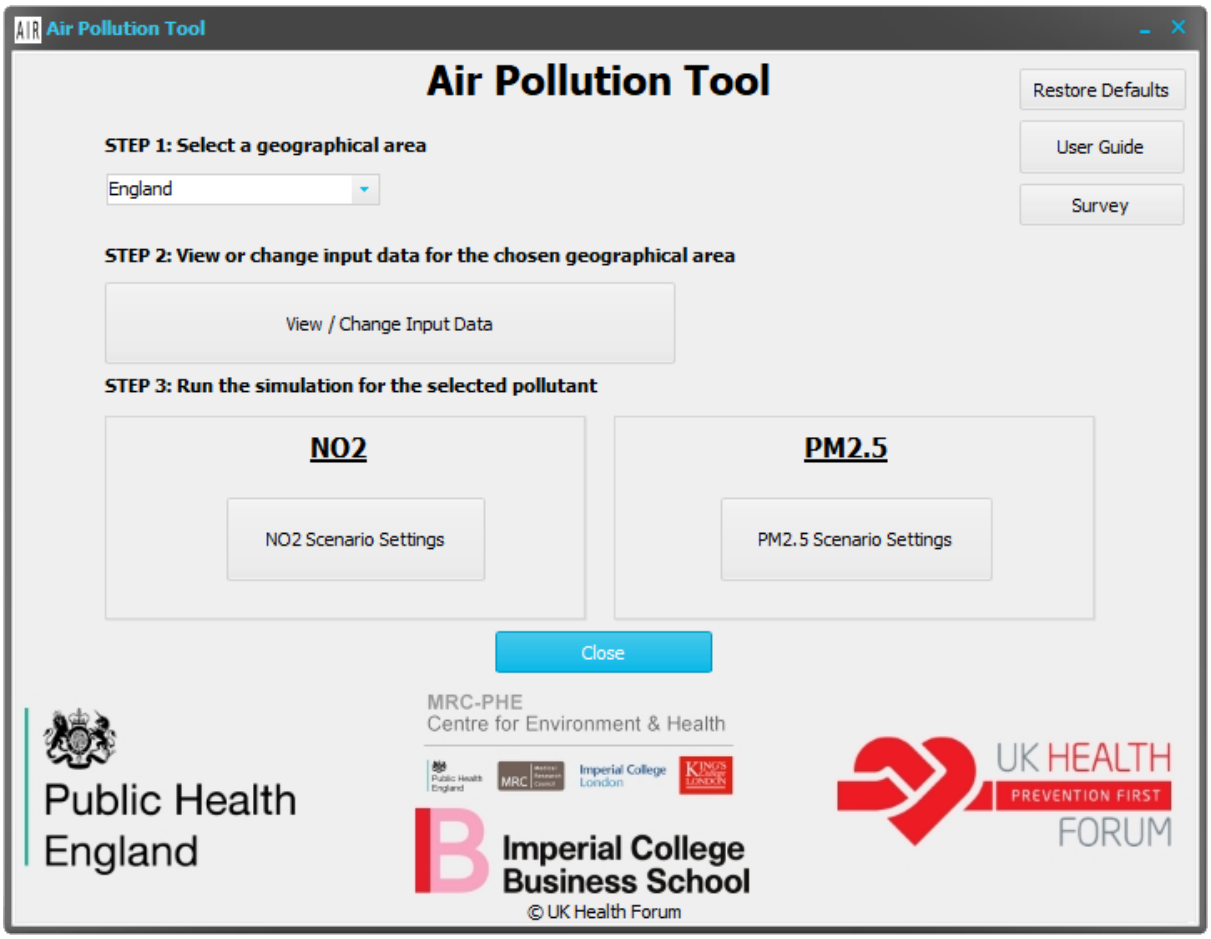


Figure 1 Tool's Main Page

STEP 2:

Click on the **'View/Change Data Input'** button (Figure 1) to input your own population, exposure, and cost data. This will open a spreadsheet which consists of four tabs - 'Notes', 'POPULATION DATA', 'EXPOSURE DATA' and 'COSTS'.

The 'Notes' tab contains information on the type of data that can be input, definitions of the headers of the various data types as well as the source of the data contained in the remaining three tabs. **Please read the information on this tab before proceeding with any changes.**

The 'POPULATION DATA' tab (Figure 2) contains population data by single-years of age and sex for the selected geographical area by user - Please use the same structure when inputting in your own data (this applies to all the remaining tabs) (7).

Geographical area:			Adur	
Males			Females	
Age	Count		Age	Count
0	370		0	357
1	411		1	339
2	427		2	368
3	396		3	436
4	410		4	378
5	424		5	376
6	393		6	356
7	392		7	369
8	350		8	318
9	344		9	345
10	351		10	305
11	328		11	294
12	358		12	281
13	314		13	305
14	297		14	274
15	365		15	340
16	386		16	338
17	390		17	323
18	361		18	310
19	358		19	281
20	278		20	255
21	325		21	253
22	272		22	269
23	293		23	305
24	322		24	330
25	334		25	285
26	278		26	330

Figure 2 The Data Format of the 'POPULATION DATA' tab

The 'EXPOSURE DATA' tab (Figure 3) holds information on the percentage of individuals of specific age-sex groupings in the population of the specified geographical area by user, who are at 'low', 'medium', or 'high' exposure to NO_2 or $PM_{2.5}$. Detailed information on 'low', 'medium', and 'high' exposure can be found under the 'Notes' tab[1]. When inputting your own data, you should only add the proportions for the 'low' and 'medium' exposure groups and the proportion of individuals in the high exposure group will automatically be calculated to total 100%. Total exposure cannot be less than nor exceed 100%. Please note that due to calculations for which these exposure values are used, a minimum value of 0.00001 and a maximum of 99.99998 are set by default for each exposure level. The excel sheets will also make adjustments if the sum of exposures is greater than 100, which could result in the input data sheet displaying a negative percentage of people with high exposure. In the use of these values in future calculations this negative high exposure will be treated as 0.00001. Please take caution when setting exposure values. **See the exposure data format for males in Figure 3 (the same format applies to females).**

Note that all geographical areas have NO_2 and non background $PM_{2.5}$ exposure[2] data.

[1] Data on air pollution exposure comes from high-resolution maps of NO_2 (200m x 200m resolution) and $PM_{2.5}$ (100 x 100m resolution), originally developed for epidemiological studies in the UK and Europe. Air pollution estimates were assigned to each postcode in England. Exposure categories correspond to dividing the exposures across all postcodes in England into three equal parts (i.e. tertiles).

[2]The following assumptions were used to derive the exposure prevalences: i) In the case of an exposure prevalence being smaller than 0.00001, a minimum threshold of 0.00001 was chosen ii) The sum of the three exposures was set to 1.iii) The maximum of each prevalence was set to 1. If a prevalence was equal to 1, for regression reasons using logarithmic functions, a maximum exposure prevalence of 0.99998 was set.

Geographical area:	Adur		
NO2			
Males			
Age Groups	Proportion in low NO2 exposure group (%)	Proportion in medium NO2 exposure group (%)	Proportion in high NO2 exposure group (%)
0-4	38.213287	56.176712	5.610001
5-9	37.962341	57.095676	4.941983
10-14	40.707581	53.950195	5.342224
15-19	40.707581	53.950195	5.342224
20-24	37.886738	55.090332	7.02293
25-29	37.945694	55.701172	6.353134
30-34	36.579346	56.485142	6.935512
35-39	38.877857	55.282753	5.83939
40-44	40.651291	53.928471	5.420238
45-49	40.808277	53.977966	5.213757
50-54	42.032761	52.894329	5.07291
55-59	43.385052	51.774918	4.84003
60-64	41.360981	54.277508	4.361511
65-69	42.301666	52.59655	5.101784
70-74	44.015324	50.643097	5.341579
75+	41.944473	53.572117	4.48341
PM2.5			
Males			
Age Groups	Proportion in low PM2.5 exposure group (%)	Proportion in medium PM2.5 exposure group (%)	Proportion in high PM2.5 exposure group (%)
0-4	0.199568	8.923941	90.876491
5-9	0.2635	8.587987	91.148513
10-14	0.48157	9.700171	89.818259
15-19	0.481564	9.70017	89.818266
20-24	0.435567	9.063688	90.500745
25-29	0.311255	9.456488	90.232257
30-34	0.253528	9.190531	90.555941
35-39	0.242662	9.845113	89.912225
40-44	0.270313	8.821769	90.907918
45-49	0.285697	8.533694	91.180609
50-54	0.326669	8.423581	91.24975
55-59	0.337595	9.162415	90.49999
60-64	0.276232	9.312863	90.410905

Figure 3 The format of the males exposure data in the 'EXPOSURE DATA' tab

The ‘COSTS’ tab holds the annual costs per case for the types of costs being modelled (Primary Care Costs, Secondary Care Costs, Medication Costs, and Social Care Costs) for the NO_2 or $PM_{2.5}$ associated diseases. See Figure 4 for the format of the costs table in the ‘COSTS’ tab.

Note that all geographical areas have cost data for England set as default.

NO2 Disease	Primary Care Costs (GBP/person/year)	Secondary Care Costs (GBP/person/year)	Medication Costs (GBP/person/year)	Social Care Costs (GBP/person/year)
asthma	21.280001	27.02	87.57	0.5
diabetes	375	536.75	276.880005	601.559998
lung cancer	51.73	466.630005	35.099998	89.379997
PM 2.5 Disease	Primary Care Costs (GBP/person/year)	Secondary Care Costs (GBP/person/year)	Medication Costs (GBP/person/year)	Social Care Costs (GBP/person/year)
coronary heart disease	71.57	1460.459961	818.599976	109.699997
copd	400.429993	587.47998	126.790001	85.300003
stroke	36.450001	722.840027	504.100006	76.050003
asthma	21.280001	27.02	87.57	0.5
diabetes	375	536.75	276.880005	601.559998
lung cancer	51.73	466.630005	35.099998	89.379997

Figure 4 The format of annual costs for the modelled diseases in the 'COSTS' tab

Within each tab users should only change/edit data in the yellow-highlighted cells (white and grey cells should not be edited). Numbers only should be entered (ie. and no letters).

You will need to save and close the excel sheet in order to return to the tool. This ensures that any edited data is not lost. Also note that you cannot return to the tool without closing the spreadsheet.

STEP 2:
Select the risk factor of interest by clicking on either the "**NO_2 Scenario Settings**" button for Nitrogen dioxide (NO_2) or the "**$PM_{2.5}$ Scenario Settings**" button for particulate matter ($PM_{2.5}$). Clicking on either risk factor button will take you to the "Setup" page in Figure 5 where you can set the start and stop year of the simulation, the cohort, scenario and discounting rate as well as change the geographical location if required.

2. Setup

The "Setup" page is divided into 3 parts (Figure 5): 1st column is the key, 2nd contains the values / parameters which the user can adjust and 3rd is built-in comments to guide the user. [3]

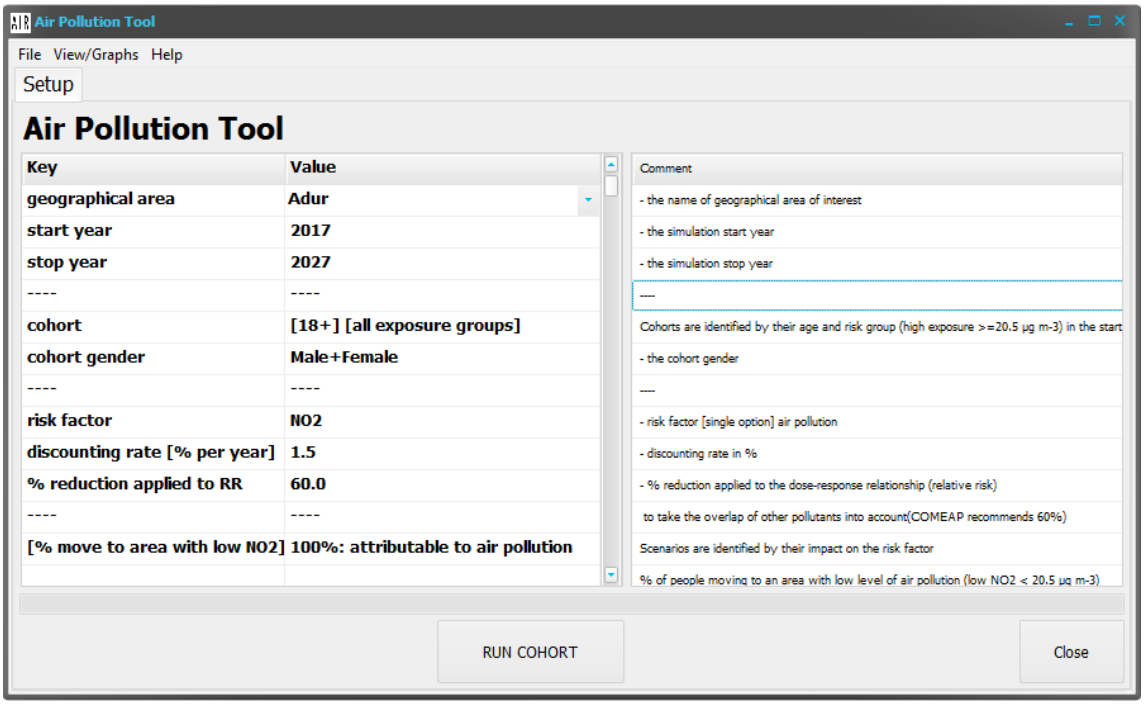


Figure 5 Page Setup

You can select the geographical area, start and stop year of the simulation (until 2040), cohort type and gender, risk factor of interest, scenario to be simulated and discounting rate using the drop down menu under the "Value" field.

You can also display the population distribution by age in your selected geographical area by selecting 'View/Graphs' and age range of the cohort of interest. This will display the population distribution for your selection in the 'Graphics' tab. For example

[3] Please note that that you can have the view of the tool in both dark and light mode. To switch between these modes: go to **View/Graph\Swap to dark mode** for dark mode and **View/Graph\Swap to light mode** for light mode.

Figure 6 shows the procedure for viewing the “all ages” distribution for Adur. Click on “**Setup**” to return to the setup page after viewing the population distribution (Figure 7).

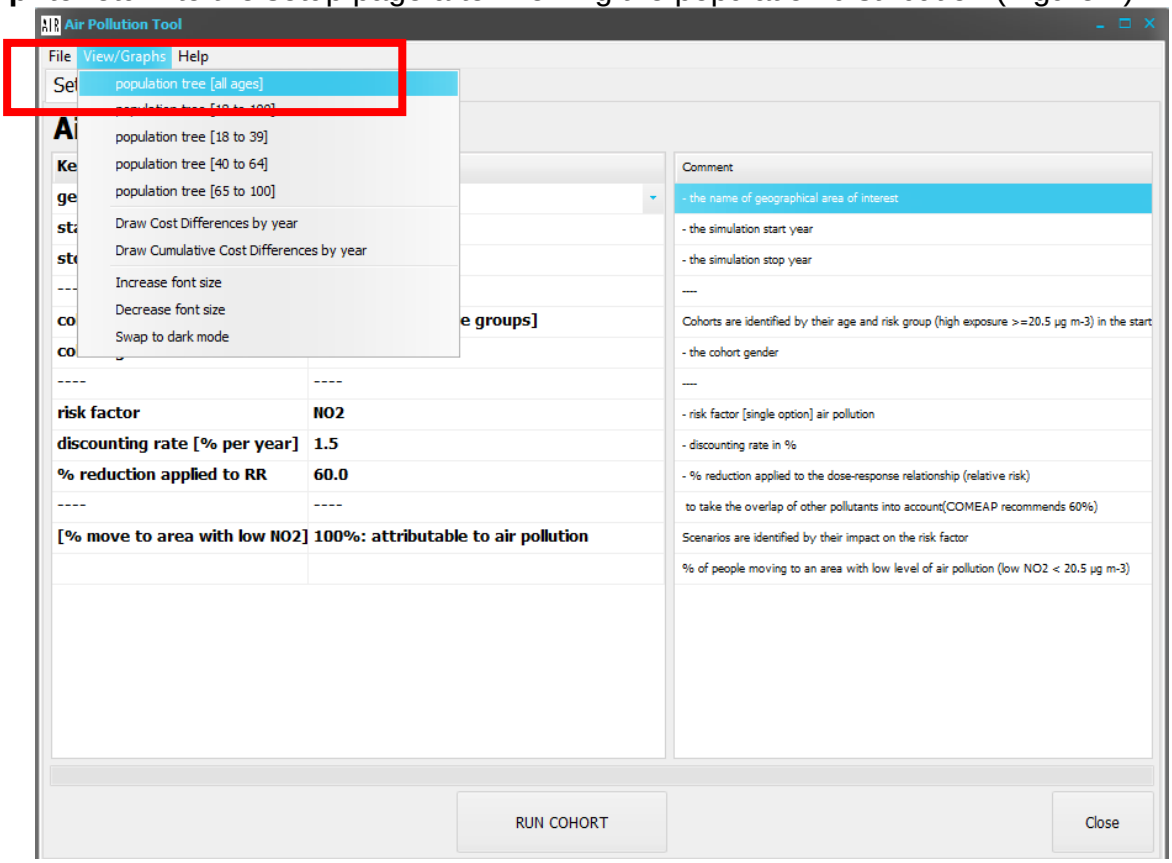


Figure 6 Steps to display Population Distribution by age

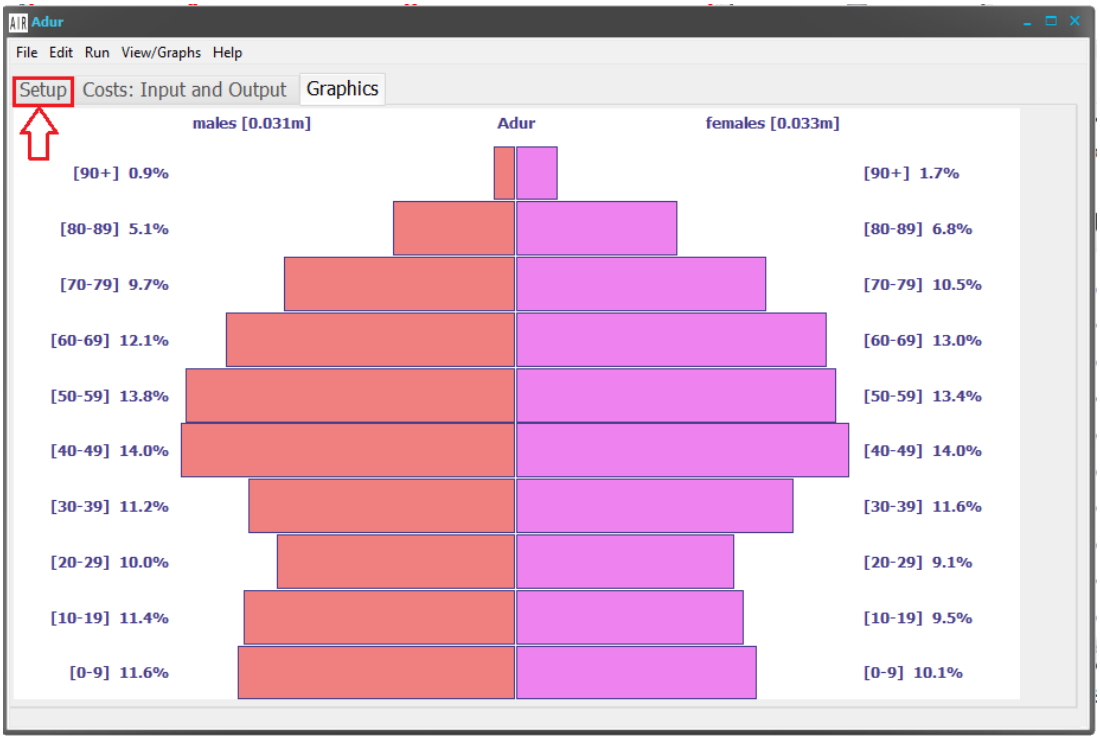


Figure 7 Distribution of the Population of Adur by age

3. Run length of the simulation

Select the **start** and **stop** year for the simulation from the "Setup" page (Figure 5). For example, you can run the simulation starting in 2015 and end it in 2025 (Figure 8). Note that 2040 is the last year that can be selected (Figure 9).

Key	Value
geographical area	Adur
start year	2015
stop year	2025

Figure 8 Selecting start and stop years of the simulation

Key	Value
geographical area	Adur
start year	2018
stop year	2040

Figure 9 Selecting 2018 as a star year and 2040 as the stop year

4. Select a cohort

Choose the cohort that you would like from the Setup page (Figure 5). See the "[18+][all exposure groups]" group below as an example (Figure 10)

Figure 10 The [18+][all exposure groups] cohort

Cohorts and their meaning:

Cohort selection option	Definition
[1 to 18] [all exposure[4] groups[	all children in the country who are below the age of 18 years old, regardless of their risk to the pollutant under consideration
18+ [all exposure groups]	all adults in the country who are above the age of 18 years old, regardless of their risk to the pollutant under consideration
[18 to 39] [all exposure groups]	- all adults in the country who are 18-39 years old, regardless of their risk to the pollutant under consideration.
[40 to 64] [all exposure groups]	all adults in the country who are 40-64 years old, regardless of their risk to the pollutant under consideration.
65+ [all exposure groups]	all adults in the country who are 65 years or above, regardless of their risk of the pollutant under consideration.
[1 to 18] [Individuals exposed to high pollution levels]	all children in the country who are below the age of 18 years old and are 'at risk' of the pollutant under consideration (>=20.5µg/m^3 for NO_2 or >= 12.3µg/m^3 for $PM_{2.5}$)
[18+] [Individuals exposed to high pollution levels]	all adults in the country who are above the age of 18 years old and are 'at risk' of the pollutant under consideration (>=20.5µg/m^3 for NO_2 or >= 12.3µg/m^3 for $PM_{2.5}$)
[18 to 39] [Individuals exposed to high pollution levels]	all adults in the country who are 18-39 years old and are 'at risk' at risk of the pollutant under consideration (>=20.5µg/m^3 for NO_2 or >= 12.3µg/m^3 for $PM_{2.5}$).
[40 to 64] [Individuals exposed to high pollution levels]	all adults in the country who are 40-64 years old and are 'at risk' of the pollutant under consideration (>=20.5µg/m^3 for NO_2 or >= 12.3µg/m^3 for $PM_{2.5}$).
[65+] [Individuals exposed to high pollution levels]	all adults in the country who are 65 years old or above and are 'at risk' of the pollutant under consideration (>=20.5µg/m^3 for NO_2 or >= 12.3µg/m^3 for $PM_{2.5}$).

5. Select a scenario

'% move to area with low NO_2/$PM_{2.5}$' is a hypothetical scenario in which a selected proportion (%) of the population who are in the 'medium' and 'high' exposure groups are shifted to a lower exposure group, i.e. an area where exposure to NO_2 is <20.5µg/m^3 and $PM_{2.5}$ is <12.3µg/m^3. For example when the user selects 20%, it will result in moving 20% of the entire medium and high exposure groups to the low exposure group. Figure 11 shows that you can move the entire modelled population to

[4]Note: dose-response relationships were available for adults, with the exception of asthma where dose-response functions were available also for children. Therefore, changes will only be observed with asthma in the child cohort.

an area with good air quality. The outputs here represent attributable cases due to air pollution.

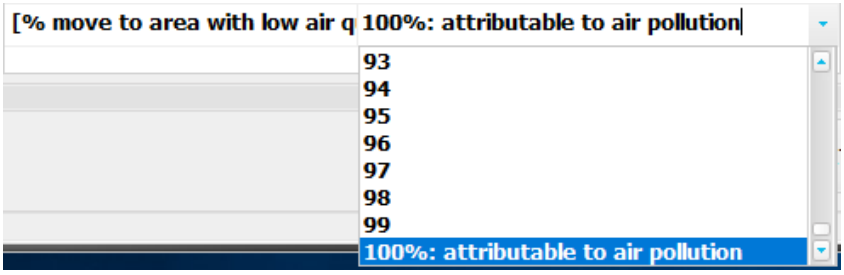


Figure 11 The "100% move to area with good air quality" scenario

6. Discounting rates

You can also add discounting rate to the costs which will be output (Figure 12).

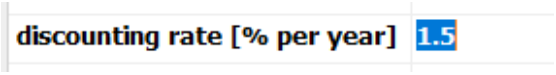


Figure 12. Adding discount rate

NICE recommend a discount rate of 1.5% for the UK (8), but this can be adjusted as necessary. The glossary defines discounting and describes the method used to calculate it.

7. Dose Response

The **'% reduction applied to the dose-response'** field is only available for NO_2 since only evidence exists for the adjustment of NO_2 dose-response. This function is used to adjust the percentage of the original relative risk in the disease files to take the overlap of other pollutants into account. For example if the user selects 20% reduction from the drop down, this would mean they want to reduce the dose-response by 20%. A default of 60% has been set as this is the recommended value by COMEAP. Figure 13 shows an example of selecting 20% reduction of the original relative risk.

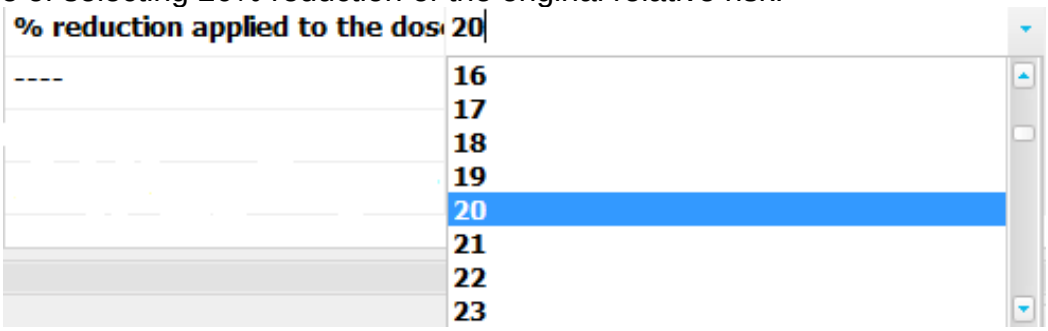


Figure 13 Selecting the percentage of the original relative risk in disease file to use in modelling disease

8. Running the cohort

Once you have completed the setup in the “Setup” tab, you can click the large **Run cohort** button at the bottom of the page (Figure 14). This will run the simulation. A progress bar will show you how the simulation is advancing. You can reset the simulation by closing the window and selecting the risk factor of interest again – all inputs will be defaulted back to the preloaded inputs.

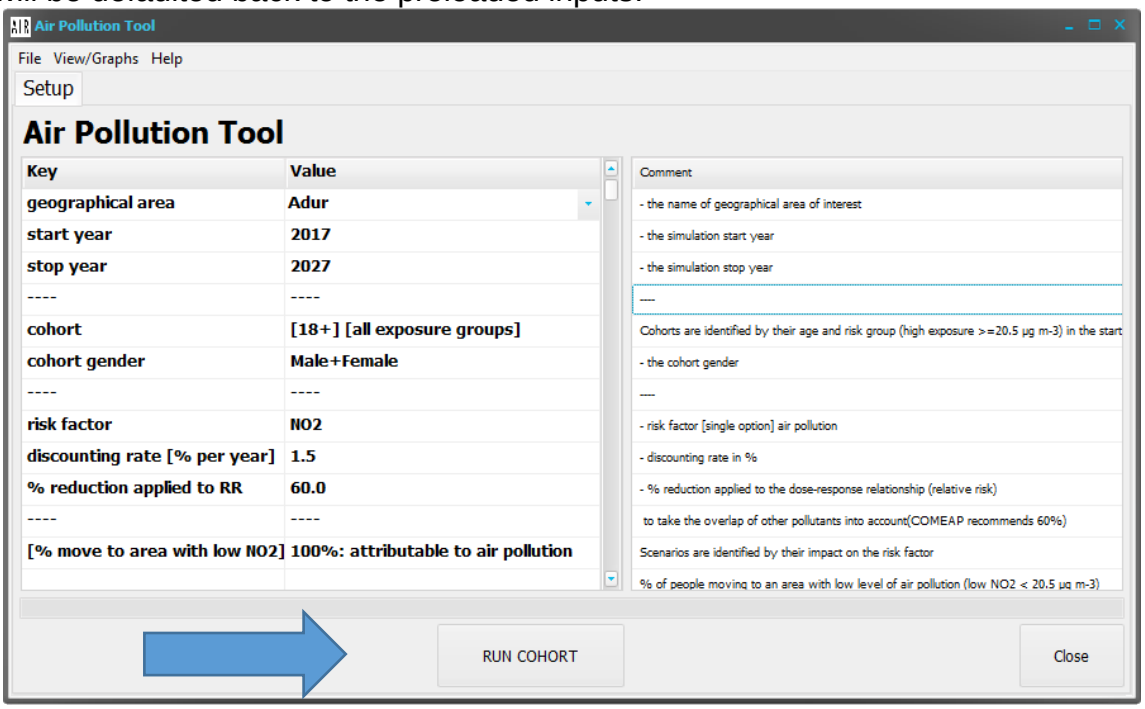


Figure 14 Running the simulation for a cohort

9. Interpreting the outputs

9.1 Cost outputs

The cost outputs will be displayed in the “Output: Costs” tab ( ).

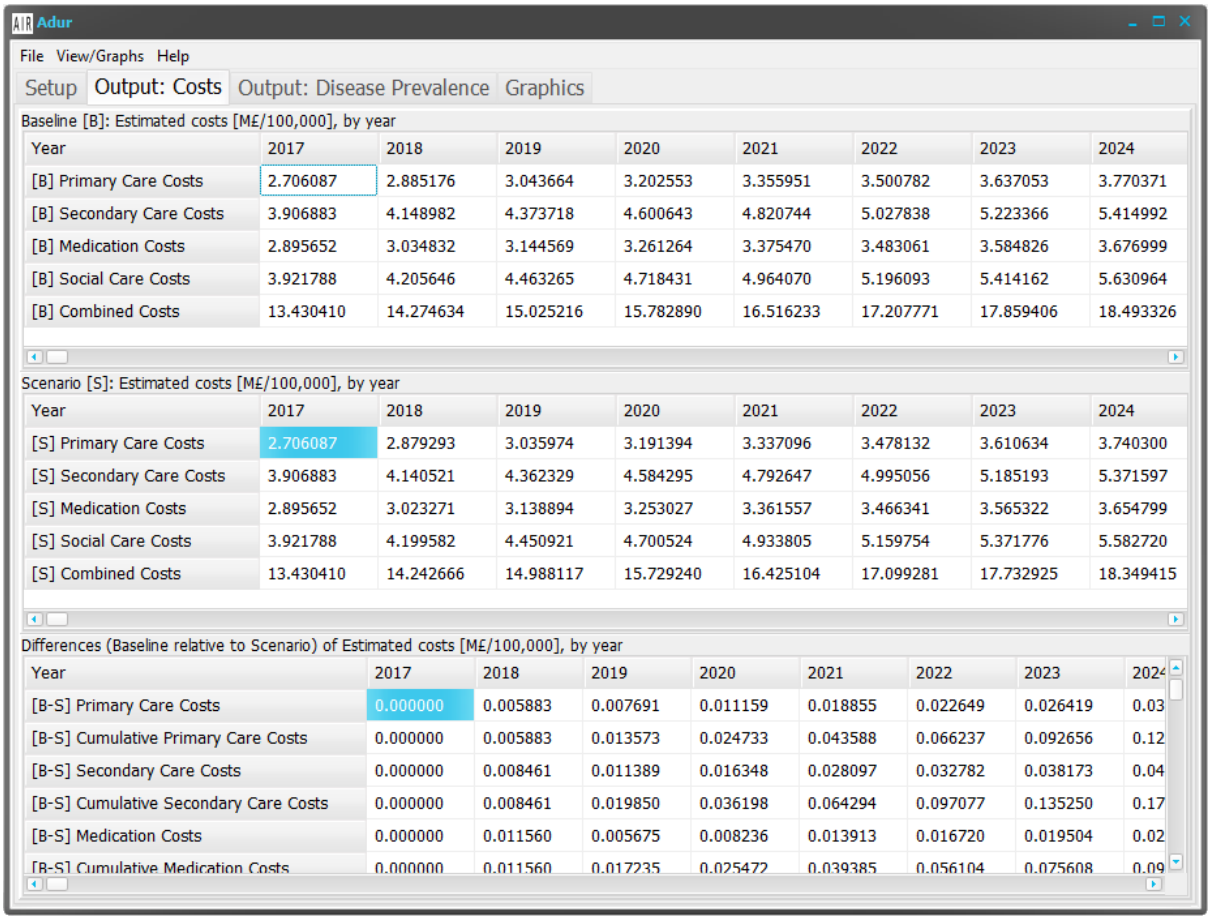


Figure 15 Cost Outputs after simulation run

Using the primary care costs as an example, the displayed costs represent the total primary care costs for each scenario for all the modelled diseases in each year of the simulation. You can see the baseline costs for each year under the field “Baseline [B]”; and the cost for each year for the specified scenario under the field “Scenario [S]”. The difference in cost between the latter and the former scenarios for each year is presented under the “Difference [B-S]”. **Note that the explanation also applies to Secondary Care, Medication, Social care and Combined costs.**

Cumulative cost difference [B-S]: Appearing under each cost in the differences section, you will see the cumulative cost difference. This is the moving sum of the difference in cost between the baseline and the scenario across the duration of the simulation run. This field is populated when some proportion of the population moves from areas of high exposure to low exposure.

You can also display the cost differences and cumulative cost differences by year by clicking on View/Graphs/Draw Cost Differences by year and View/Graphs/Draw Cumulative Cost Differences by year, respectively as illustrated in Figure 16 and Figure 17 or by right clicking a row of interest in the cost difference table (after drawing the cost figure of interest, you might need to refresh the difference table by clicking on the scroll bar).

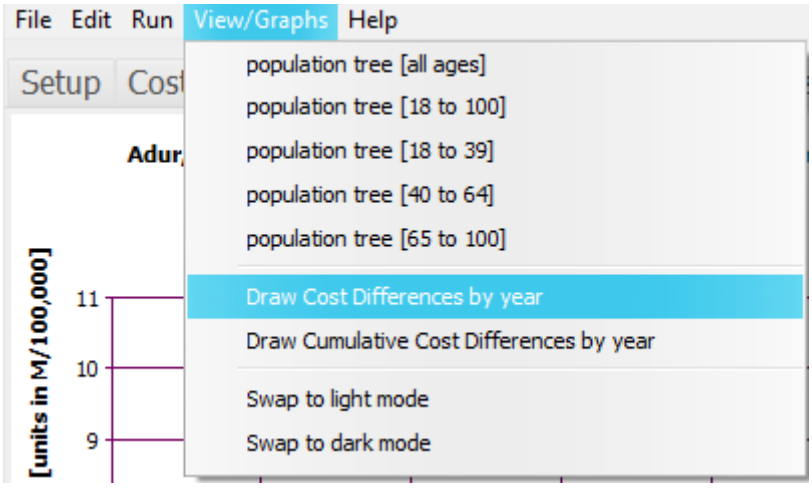


Figure 16 How to display cost graphs

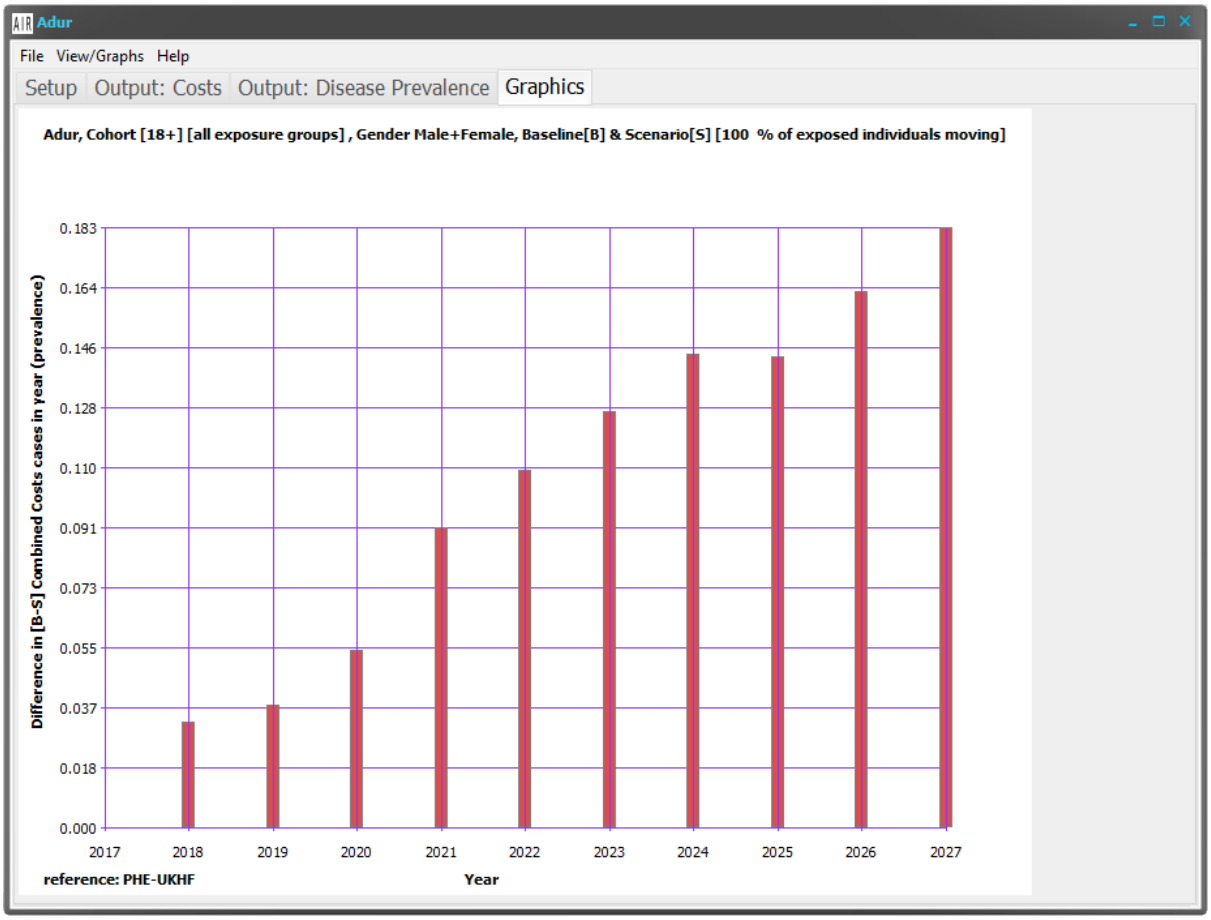


Figure 17 Combined cost differences by year

9.2 Output: Disease Prevalence

You will also notice the appearance of the “Output: Disease Prevalence” tab at the top of the page after the run.

The user should be able to see three tables in ‘Output: Disease prevalence (Figure 18).

1. **‘Baseline table’**: shows the number of people living with each modelled disease in a given year, and the number of people who have died in each year as a baseline, if nothing changes.
2. **‘Scenario table’**: shows the number of people living with each modelled disease in a given year, and the number of people who have died in each year in the scenario that was specified (NOTE: if the scenario you selected was ‘No Change’ then the Baseline table and Scenario table will show the same data).
3. **‘Changes table’**: Shows the difference between the **‘Baseline table’** and the **‘Scenario table’.** Note that you can also draw the difference by right clicking on the row of the disease of interest (after drawing the figure of interest, you might need to refresh the difference table by clicking on the scroll bar).

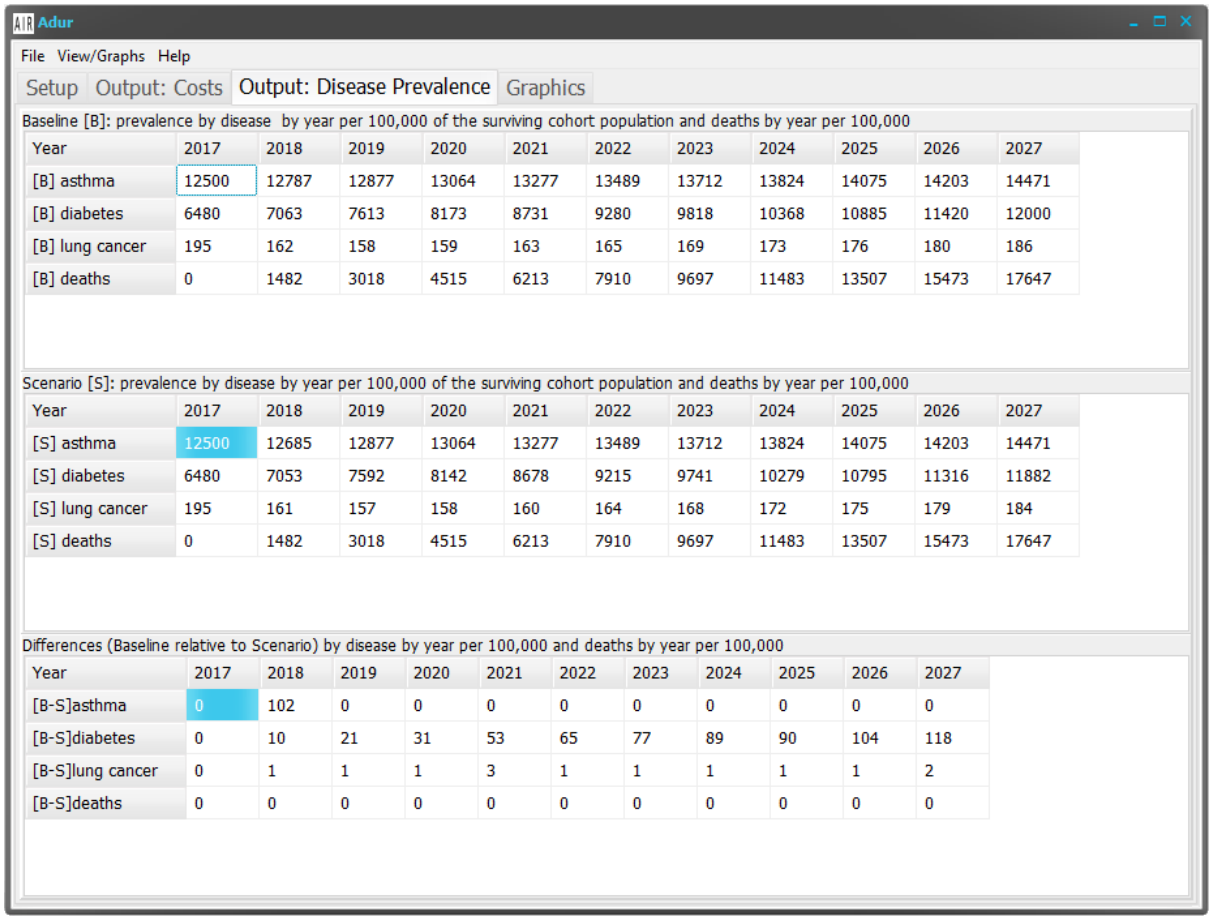


Figure 18 Output: Disease prevalence

10. Output Files

All the outputs are saved in the output folder under the country, risk factor, and time and date of the run. You can access the output folder by doing one of the following:

- File\Open Output Folder
- Opening the Output Folder shortcut from the start menu under All Programs > PHE_Air_Pollution_Tool
- Or from the shortcut on the Desktop if you enabled this during installation.

Output Files	**Content of Output Files**
Base_Prev.txt	The baseline prevalence rate per 100,000 by year
Sce_Prev.txt	The scenario prevalence rate per 100,000 by year
Diff_Prev.txt	The difference in prevalence cases between baseline and scenario
Sce_Costs.txt	The scenario cost rate (£M per 100,000) by year
Base_Costs.txt	The baseline cost rate (£M per 100,000) by year (all costs included)
Diff_Costs.txt	The difference in costs between baseline and scenario
{COST_PARAMETER}_Input_Data.txt	A list of the cost per case input data used by the simulation for this cost parameter (£/patient/year).
{COST_PARAMETER}_{Baseline/Scenario/Difference}	Per disease costs (£m per 100,000 people) for this cost type in the baseline/scenario/difference between baseline and scenario runs
Assorted TRJ files	Trajectories created for each sub-population There are 6 parameters: (age, sex, intervention year, risktype depending on the risk factor of interest (8: NO_2 and 9: $PM_{2.5}$) p-tile is the percentile of the individual, weight and the exposure data).

Because of the nature of asthma as a disease, some fluctuations may be observed in the outputs. These are explained in more detail in appendix 4.

User guide appendices

Appendix 1 provides a glossary of terms.

Appendix 2 provides some worked examples from the tool to ease interpretation of the outputs. It may be a useful exercise to run the same parameters and follow the comparisons provided.

Appendix 3 provides an explanation of how the costs are calculated.

Appendix 1: Glossary of terms

1. Baseline – This refers to the 'steady state' of the risk factor assuming no change from current exposure levels.
2. Data pack - This is a single file which contains all of the disease and population statistics required by the tool.
3. Disease exposure – this refers to the number of days per person that an individual has a disease. For example, 500 diabetes days refers to the number of days an individual is alive and lives with a disease.
4. Distribution –the frequency of various outcomes in a sample population. The frequency or count of the occurrences of values within a particular group or interval, and in this way, the table summarizes the distribution of values in the sample.
5. Incidence – the occurrence of *new* cases of the disease – not to be confused with prevalence.
6. Prevalence – this is the total number of cases of a disease in a particular population. This indicates how widespread the disease is.
7. Probability – this is the chance of a disease occurring. Probability always lies within 0 and 1.
8. Simulation – the imitation of a real-world process or system over time, in this case the simulation of a virtual country population.
9. Discounting – A technique which allows the calculation of present values of inputs and benefits which accrue in the future. Discounting is based on a time preference which assumes that individuals prefer to forego a part of the benefits if they accrue it now, rather than fully in the uncertain future. By the same reasoning, individuals prefer to delay costs rather than incur them in the present. The strength of this preference is expressed by the discount rate which is inserted in economic evaluations.

The equation below shows how discounting works on the individual costs (primary care, secondary care, medication and social care costs) for each scenario for each simulated year:

$$= \left(\sum_{j=1}^{no.of\ diseases} Prevalence_{j,i} * Cost_j\right) * \left(1 - \frac{Discount\ rate}{100}\right)^i$$

Where:
"i" = each year of the simulation (for example if your simulation starts from 2017 and ends at 2020, i = 1 will refer to 2017, i = 2 will be 2018 and so on to 2020). In effect the value of "i" depends on the run duration of the simulation.

$Prevalence_{ji}$ = Prevalence of $disease_j$ per scenario in each year of the simulation
$disease_j$ = the diseases being run in the simulation

$Cost_j$ = cost type per case of $disease_j$
Discount rate = input discounting rate by user

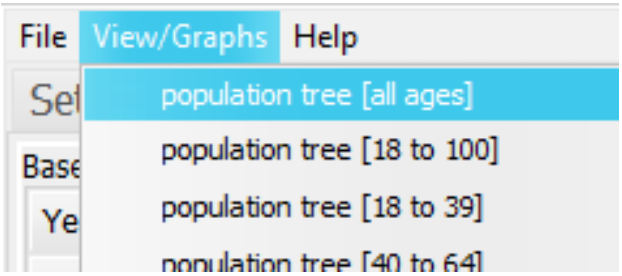
Appendix 2. Example of analysis

In order to ease interpretation of the findings from the tool, we have provided some example analyses below.

Comparison of 2 local authorities: South Lakeland versus Lambeth

Demographic comparison

Figure 19 and Figure 20 show the population distributions for Lambeth and South Lakeland, produced from:



From these figures we can deduce that:

- The largest proportion of the population is aged between 30-39 years old in Lambeth and 50-69 years old in South Lakeland.
-
- Around 64% and 38% of the population are younger than 40 years old in Lambeth and South Lakeland respectively. Therefore, Lambeth has a much younger population than South Lakeland.

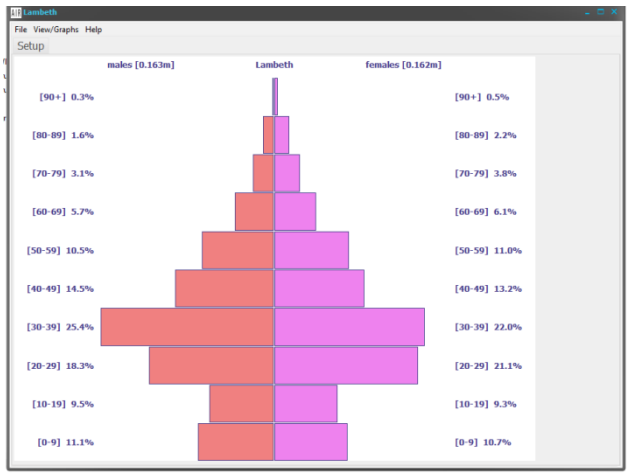


Figure 19 Demographics of Lambeth

Figure 20 Demographics of South Lakeland

Exposure Comparison

In terms of the 3 categories described for both pollutants (i.e. Low: NO_2 < 20.5 microgram m^{-3}, medium: NO_2 from 20.5 to 28.5 microgram m^{-3}, high: NO_2 >= 28.5 microgram m^{-3} and low: $PM_{2.5}$ < 12.3 microgram m^{-3}, medium: $PM_{2.5}$ from 12.3 to 13.5 microgram m^{-3}, high: $PM_{2.5}$ >= 13.5 microgram m^{-3}), 99% of the Lambeth population lives in the most highly polluted categories for both NO_2 and $PM_{2.5}$, whereas only between 4% and <1% of the South Lakeland population live in high exposure NO_2/$PM_{2.5}$ areas. These figures can be seen in the excel sheet data input of the tool and can be summarised by the Table 1 and Table 2.

Table 1. Average prevalence for the three air pollution categories of $PM_{2.5}$ in 2015 for adults for South Lakeland and Lambeth

Pollutant	Population	Low air pollution prevalence (%)	Medium air pollution Prevalence (%)	High air pollution Prevalence (%)
$PM_{2.5}$	Lambeth, adults, male	0.0	0.0	100.0
$PM_{2.5}$	Lambeth, adults, female	0.0	0.0	100.0
$PM_{2.5}$	South Lakeland, adults, male	100.0	0.0	0.0
$PM_{2.5}$	South Lakeland, adults, female	100.0	0.0	0.0

Table 2. Average prevalence for the three air pollution categories of NO_2 in 2015 for adults for South Lakeland and Lambeth

Pollutant	Population	Low air pollution prevalence (%)	Medium air pollution Prevalence (%)	High air pollution Prevalence (%)
$N0_2$	Lambeth, adults, male	0.0	0.0	100.0
$N0_2$	Lambeth, adults, female	0.0	0.0	100.0
$N0_2$	South Lakeland, adults, male	83.6	12.0	4.4
$N0_2$	South Lakeland, adults, female	83.8	11.9	4.3

Tool inputs – worked example

For a worked example of the tool, you could use the following input parameters:

Start year: 2017
Stop year: 2037
Cohort: [18+] [all exposure groups]
Cohort gender: Male + Female
Discounting: 1.5%
% reduction applied to RR: 60.0% (For NO_2)
Scenario: 100% move to area with low air pollution

Results

Some results can be extracted from the baseline epidemiological and economic results:

- For NO_2, South Lakeland (Table 9) with a large proportion of elderly people in its population has a larger prevalence rate of lung cancer and diabetes compared to Lambeth (Table 3) between 2017 and 2037 (The same pattern of results can be derived for the 4 types of costs) (Table 15, Table 21).
- Similarly, for $PM_{2.5}$, as expected South Lakeland (Table 12) with a large proportion of elderly in its population has a larger rate of CHD, COPD, diabetes and lung cancer compared to Lambeth (Table 6) between 2017 and 2037. The same analysis can be derived for the 4 types of costs (Table 18, Table 24).

A variety of results can be extracted to illustrate the effect of the interventions:

- As expected, the impact of the NO_2 and $PM_{2.5}$ interventions on South Lakeland which has very low NO_2 and $PM_{2.5}$ exposures, is negligible. Note that the instability of the prevalence gains and costs avoided is due to the uncertainty caused by the fact that most individuals in the cohort are not affected by the intervention.
-
- The impact of the NO_2 scenario (ie. 100% of the population move to an area with low air pollution) (Table 5) on Lambeth is the following:
    - 253 prevalence cases per 100,000 of population in asthma are expected to be avoided by 2037
    - 715 prevalence cases per 100,000 of population in diabetes are expected to be avoided by 2037
    - 6 prevalence cases per 100,000 of population in lung cancer are expected to be avoided by 2037

- The impact of the $PM_{2.5}$ scenario (ie. 100% of the population move to area with low air pollution) on Lambeth is the following (Table 8. Difference (Baseline relative to Scenario) by disease per 100,000 and deaths by year per 100,000 in Lambeth (Table 8):
    - 662 prevalence cases per 100,000 of population in CHD are expected to be avoided by 2037
    - 935 prevalence cases per 100,000 of population in diabetes are expected to be avoided by 2037
    - 10 prevalence cases per 100,000 of population in lung cancer are expected to be avoided by 2037
    - Note that there is no published associated asthma effect on adults and consequently, the results are to be interpreted with caution for this specific cohort: the only cases avoided are caused by ageing of the children over the years. Therefore the trends appear bumpy and unstable.
- The costs avoided by moving 100% of the population to an area with low level of air pollution:
    - As expected, the impact of this scenario in South Lakeland, which has very low NO_2 and $PM_{2.5}$ exposures, is negligible. Note that the instability in the costs avoided are due to the uncertainty caused by the fact that most individuals in the cohort are not affected by the intervention. (Table 23, Table 26)
- The impact of the NO_2 scenario (ie. 100% of the population move to area with low air pollution) (Table 17) on Lambeth is the following:
    - A cumulative cost of £2.42 million per 100,000 of population in primary care are expected to be avoided by 2037
    - A cumulative cost of £3.48 million per 100,000 of population in secondary care are expected to be avoided by 2037
    - A cumulative cost of £1.91 million per 100,000 of population in medication are expected to be avoided by 2037
    - A cumulative cost of £3.83 million per 100,000 of population in social care are expected to be avoided by 2037

Epidemiological results

Lambeth

NO2

Baseline

Table 3. Baseline prevalence by disease by year per 100,000 of the surviving cohort population and deaths by year per 100,000 in Lambeth

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
[B] asthma	13600	13775	13953	14132	14319	14511	14707	14904	15007	15217	15437	15657	15784	16020	16159	16410	16573	16723	16895	17186	17386
[B] diabetes	3380	3791	4186	4606	5022	5444	5883	6337	6779	7239	7719	8204	8703	9209	9717	10256	10806	11412	11872	12572	13069
[B] lung cancer	79	68	68	69	71	74	78	82	85	88	93	98	103	107	112	119	125	130	136	143	153
[B] deaths	0	546	1112	1667	2281	2912	3573	4221	4943	5675	6462	7239	8108	8980	9926	10877	11982	12994	14155	15340	16686

Scenario

Table 4. Scenario prevalence by disease by year per 100,000 of the surviving cohort population and deaths by year per 100,000 in Lambeth

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
[S] asthma	13600	13775	13953	14132	14319	14509	14602	14798	15005	15110	15327	15548	15672	15800	16047	16184	16331	16610	16781	16955	17133
[S] diabetes	3380	3750	4115	4494	4879	5269	5665	6075	6495	6910	7344	7806	8258	8717	9189	9689	10190	10712	11221	11765	12354
[S] lung cancer	79	67	66	67	69	72	75	79	82	85	90	95	100	103	109	115	122	127	132	138	147
[S] deaths	0	546	1112	1667	2281	2902	3563	4210	4932	5664	6440	7227	8085	8968	9914	10852	11857	12994	14155	15340	15550

Differences

Table 5. Difference (Baseline relative to Scenario) by disease per 100,000 and deaths by year per 100,000 in Lambeth

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
[B-S]asthma	0	0	0	0	0	2	105	106	2	107	110	109	112	220	112	226	242	113	114	231	253
[B-S]diabetes	0	41	71	112	143	175	218	262	284	329	375	398	445	492	528	567	616	700	651	807	715
[B-S]lung cancer	0	1	2	2	2	2	3	3	3	3	3	3	3	4	3	4	3	3	4	5	6
[B-S]deaths	0	0	0	0	0	10	10	11	11	11	22	12	23	12	12	25	125	0	0	0	136

PM2.5

Baseline

Table 6. Baseline prevalence by disease by year per 100,000 of the surviving cohort population and deaths by year per 100,000 in Lambeth

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
[B] coronary heart disease	1240	1319	1379	1440	1502	1575	1639	1714	1770	1848	1917	1998	2060	2145	2221	2322	2403	2509	2596	2718	2801
[B] copd	1080	1017	938	903	861	852	825	830	821	841	847	881	890	928	952	1005	1024	1074	1105	1167	1204
[B] stroke	1380	1390	1390	1399	1399	1409	1409	1430	1431	1453	1465	1499	1512	1548	1574	1646	1686	1749	1804	1882	1955
[B] asthma	13600	13794	13997	14194	14403	14608	14720	14930	15158	15275	15512	15639	15890	16033	16183	16460	16629	16801	16997	17176	17402
[B] diabetes	3380	3796	4199	4616	5031	5460	5877	6319	6763	7210	7670	8156	8625	9122	9621	10158	10683	11231	11758	12353	12992
[B] lung cancer	79	69	68	69	71	74	77	81	84	88	92	97	102	106	111	117	124	130	135	142	151
[B] deaths	0	689	1430	2114	2881	3605	4395	5141	6000	6815	7724	8601	9589	10571	11607	12740	13895	15075	16414	17647	19190

Scenario

Table 7. Scenario prevalence by disease by year per 100,000 of the surviving cohort population and deaths by year per 100,000 in Lambeth

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
[S] coronary heart disease	1240	1279	1308	1337	1368	1408	1439	1481	1503	1546	1591	1635	1672	1719	1769	1827	1869	1945	2000	2079	2139
[S] copd	1080	988	882	822	759	727	682	667	642	643	634	647	645	663	674	704	712	744	762	801	820
[S] stroke	1380	1379	1369	1378	1368	1367	1366	1376	1376	1386	1387	1419	1420	1454	1479	1525	1563	1613	1665	1729	1797
[S] asthma	13600	13794	13996	14191	14397	14599	14810	14913	15134	15353	15477	15705	15842	16085	16240	16368	16535	16819	16994	17173	17376
[S] diabetes	3380	3756	4118	4492	4875	5260	5642	6039	6445	6856	7276	7711	8150	8593	9055	9540	10023	10538	11040	11577	12057
[S] lung cancer	79	66	63	64	66	68	71	75	78	81	85	90	94	98	103	109	116	120	126	132	141
[S] deaths	0	689	1420	2093	2838	3541	4297	5020	5831	6621	7481	8307	9254	10169	11235	12108	13250	14416	15607	16822	18203

Differences

Table 8. Difference (Baseline relative to Scenario) by disease per 100,000 and deaths by year per 100,000 in Lambeth

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
[B-S]coronary heart disease	0	40	71	103	134	167	200	233	267	302	326	363	388	426	452	495	534	564	596	639	662
[B-S]copd	0	29	56	81	102	125	143	163	179	198	213	234	245	265	278	301	312	330	343	366	384
[B-S]stroke	0	11	21	21	31	42	43	54	55	67	78	80	92	94	95	121	123	136	139	153	158
[B-S]asthma	0	0	1	3	6	9	-90	17	24	-78	35	-66	48	-52	-57	92	94	-18	3	3	26
[B-S]diabetes	0	40	81	124	156	200	235	280	318	354	394	445	475	529	566	618	660	693	718	776	935
[B-S]lung cancer	0	3	5	5	5	6	6	6	6	7	7	7	8	8	8	8	8	10	9	10	10
[B-S]deaths	0	0	10	21	43	64	98	121	169	194	243	294	335	402	372	632	645	659	807	825	987

South Lakeland

NO2

Baseline

Table 9. Baseline prevalence by disease by year per 100,000 of the surviving cohort population and deaths by year per 100,000 in South Lakeland

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
[B] asthma	12300	12500	12708	12913	13145	13271	13518	13657	13809	14085	14269	14443	14643	14834	15072	15147	15406	15656	15797	16048	16233
[B] diabetes	7190	7825	8431	9039	9629	10225	10814	11400	11968	12559	13070	13709	14143	14706	15203	15818	16231	16784	17246	17682	18224
[B] lung cancer	220	183	178	180	185	188	193	198	201	205	212	218	222	224	231	237	241	244	248	254	259
[B] deaths	0	1626	3316	4987	6872	8778	10803	12867	15075	17371	19904	22399	25156	27877	31062	34048	37552	41044	44928	48588	53139

Scenario

Table 10. Scenario prevalence by disease by year per 100,000 of the surviving cohort population and deaths by year per 100,000 in South Lakeland

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
[S] asthma	12300	12500	12708	12913	13145	13271	13518	13657	13809	14085	14269	14443	14643	14834	15072	15147	15406	15656	15797	16048	16233
[S] diabetes	7190	7815	8420	9018	9618	10203	10792	11400	11968	12441	13070	13586	14143	14706	15203	15684	16231	16643	17246	17682	18070
[S] lung cancer	220	183	178	180	184	187	192	198	200	205	211	217	222	224	229	236	241	243	248	254	257
[S] deaths	0	1626	3316	4987	6872	8778	10803	12867	15075	17371	19904	22399	25156	27877	31062	34048	37552	41044	44928	48588	53139

Differences

Table 11. Difference (Baseline relative to Scenario) by disease per 100,000 and deaths by year per 100,000 in South Lakeland

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
[B-S]asthma	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
[B-S]diabetes	0	10	11	21	11	22	22	0	0	118	0	123	0	0	0	134	0	141	0	0	154
[B-S]lung cancer	0	0	0	0	1	1	1	0	1	0	1	1	0	0	2	1	0	1	0	0	2
[B-S]deaths	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

PM2.5

Baseline

Table 12. Baseline prevalence by disease by year per 100,000 of the surviving cohort population and deaths by year per 100,000 in South Lakeland

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
[B] coronary heart disease	3400	3500	3552	3621	3644	3695	3729	3767	3781	3810	3833	3877	3882	3903	3930	3994	4003	4049	4069	4159	4164
[B] copd	2910	2632	2334	2134	1941	1803	1638	1544	1437	1370	1290	1245	1188	1162	1122	1114	1085	1081	1064	1072	1060
[B] stroke	3800	3806	3771	3770	3709	3695	3672	3664	3616	3606	3587	3588	3548	3548	3540	3567	3536	3556	3577	3624	3612
[B] asthma	12300	12550	12814	13061	13339	13496	13785	13940	14252	14423	14619	14806	15039	15243	15343	15565	15842	15965	16244	16361	16562
[B] diabetes	7190	7846	8480	9090	9684	10277	10847	11417	12014	12500	13022	13551	14010	14586	15074	15565	15983	16546	16990	17431	17823
[B] lung cancer	220	180	171	171	175	178	182	187	190	195	200	206	210	212	218	223	229	231	235	242	246
[B] deaths	0	2030	4178	6191	8448	10619	12994	15207	17786	20192	22850	25471	28535	31406	34590	37741	41443	45138	49031	52905	57729

Scenario

Table 13. Scenario prevalence by disease by year per 100,000 of the surviving cohort population and deaths by year per 100,000 in South Lakeland

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
[S] coronary heart disease	3400	3500	3552	3621	3644	3695	3718	3767	3781	3810	3833	3877	3869	3903	3930	3981	3989	4035	4069	4144	4164
[S] copd	2910	2632	2334	2134	1941	1803	1638	1544	1437	1370	1290	1243	1186	1160	1121	1113	1083	1080	1063	1070	1058
[S] stroke	3800	3806	3771	3770	3709	3695	3672	3664	3616	3606	3587	3588	3548	3535	3540	3567	3536	3556	3577	3624	3612
[S] asthma	12300	12550	12814	13061	13339	13496	13785	13940	14252	14423	14619	14806	15039	15243	15343	15565	15842	15965	16244	16361	16562
[S] diabetes	7190	7846	8480	9090	9684	10277	10847	11417	12014	12500	13022	13551	14010	14586	15074	15565	15983	16546	16990	17431	17823
[S] lung cancer	220	180	171	171	175	178	182	187	190	195	200	205	210	212	218	223	229	231	235	242	246
[S] deaths	0	2030	4178	6191	8448	10619	12994	15207	17786	20192	22850	25471	28535	31406	34590	37741	41443	45138	49031	52905	57729

Differences

Table 14. Difference (Baseline relative to Scenario) by disease per 100,000 and deaths by year per 100,000 in South Lakeland

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
[B-S]coronary heart disease	0	0	0	0	0	0	11	0	0	0	0	0	13	0	0	13	14	14	0	15	0
[B-S]copd	0	0	0	0	0	0	0	0	0	0	0	2	2	2	1	1	2	1	1	2	2
[B-S]stroke	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0
[B-S]asthma	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
[B-S]diabetes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
[B-S]lung cancer	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
[B-S]deaths	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Economic results

Lambeth

NO2

Baseline

Table 15. Baseline Costs by year per 100,000 of the surviving cohort population and deaths by year per 100,000 in Lambeth

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
[B] Primary Care Costs	1.56 09 95	1.69 25 00	1.81 45 03	1.94 14 93	2.0 63 06 2	2.1 82 78 1	2.3 04 39 1	2.4 26 94 0	2.5 39 49 0	2.6 55 99 5	2.7 75 15 4	2.8 91 72 8	3.0 06 91 0	3.1 22 00 4	3.2 31 94 8	3.3 49 14 1	3.4 63 81 9	3.5 90 29 0	3.6 70 87 4	3.8 17 70 8	3.9 01 72 6
[B] Secondary Care Costs	2.21 85 51	2.40 21 69	2.57 65 06	2.75 83 69	2.9 32 81 7	3.1 04 95 6	3.2 80 12 9	3.4 56 61 5	3.6 18 69 8	3.7 86 09 6	3.9 57 92 2	4.1 26 01 3	4.2 92 34 4	4.4 57 88 1	4.6 16 61 0	4.7 85 99 5	4.9 51 66 2	5.1 33 89 7	5.2 50 65 9	5.4 62 19 2	5.5 84 87 8
[B] Medication Costs	2.12 95 80	2.22 44 41	2.31 23 09	2.40 37 73	2.5 62 2	2.6 27 4	2.7 41 7	2.8 15 1	2.9 35 3	3.0 20 7	3.0 45 3	3.0 59 8	3.1 95 3	3.2 67 0	3.3 73 4	3.4 53 2	3.4 29 0	3.5 97 3	3.6 93 7	3.7 15 8	3.8 89 7
[B] Social Care Costs	2.04 71 34	2.25 90 77	2.45 58 18	2.66 06 08	2.8 52 3	3.0 49 5	3.2 45 1	3.4 42 3	3.6 26 4	3.8 14 1	4.0 05 0	4.1 93 3	4.3 81 7	4.5 66 1	4.7 45 4	4.9 33 4	5.1 19 1	5.3 24 0	5.4 56 8	5.6 91 6	5.8 27 6
[B] Combined Costs	7.95 62 58	8.57 81 88	9.15 91 37	9.76 42 42	10.40 26	10.91 05	11.49 97	12.08 88	12.61 73	13.17 79	13.74 19	14.29 83	14.84 65	15.39 75	15.91 55	16.48 22	17.02 01	17.62 50	18.01 67	18.71 71	19.11 66

Scenario

Table 16. Scenario Costs by disease by year per 100,000 of the surviving cohort population and deaths by year per 100,000 in Lambeth

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
[S]	1.	1.	1.	1.	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6
Primary	56	67	78	90	12	21	27	36	44	46	52	63	65	66	69	75	78	85	82	86	99
Care	09	73	85	12	48	79	54	38	94	18	10	24	59	39	65	64	27	28	88	73	33
Costs	95	05	70	56	6	7	5	5	3	8	9	3	6	9	4	7	2	7	9	7	7
[S]	2.	2.	2.	2.	2.8	3.0	3.1	3.3	3.4	3.6	3.7	3.9	4.0	4.2	4.3	4.5	4.6	4.8	4.9	5.1	5.2
Second	21	38	53	70	59	16	69	26	82	28	81	41	89	34	83	37	85	39	80	30	94
ary	85	00	86	00	68	94	39	26	33	21	11	42	41	48	67	03	81	85	69	72	09
Care	51	33	26	26	6	6	2	9	2	8	5	8	7	9	0	5	2	9	2	0	3
Costs																					
[S]	2.	2.	2.	2.	2.4	2.5	2.6	2.6	2.7	2.8	2.9	2.9	3.0	3.1	3.1	3.2	3.3	3.4	3.4	3.5	3.6
Medicat	12	21	29	37	54	33	02	81	60	27	04	86	54	22	99	71	41	22	89	62	41
ion	95	32	31	40	28	11	79	44	42	42	81	10	91	80	39	49	64	33	90	17	03
Costs	80	25	68	70	5	9	6	5	5	8	5	6	0	0	8	7	5	6	8	7	9
[S]	2.	2.	2.	2.	2.7	2.9	3.1	3.3	3.4	3.6	3.8	3.9	4.1	4.3	4.4	4.6	4.8	4.9	5.1	5.3	5.5
Social	04	23	41	59	75	51	25	00	75	41	11	90	57	22	87	60	28	99	57	26	09
Care	71	46	42	60	37	61	19	60	30	35	67	32	69	46	95	88	16	05	74	40	06
Costs	34	95	06	49	8	7	6	7	9	7	0	0	4	4	0	2	2	8	2	9	3
[S]	7.	8.	9.	9.	10.	10.	11.	11.	12.	12.	13.	13.	14.	14.	15.	15.	16.	16.	17.	17.	18.
Combin	95	50	03	57	10	62	12	64	16	64	14	68	16	64	14	64	13	64	11	60	14
ed	62	52	45	13	18	34	49	47	30	31	97	10	76	61	06	50	38	65	12	60	35
Costs	58	58	70	99	35	78	29	06	11	90	10	97	18	52	71	59	90	40	33	43	32

Differences

Table 17. Difference (Baseline relative to Scenario) by Costs per 100,000 and deaths by year per 100,000 in Lambeth

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
[B-S]	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Primary	00	01	02	04	05	06	07	09	09	10	12	12	14	15	16	17	18	20	18	23	20
Care Costs	00	51	59	02	05	09	68	05	45	98	30	84	13	56	22	34	55	50	79	09	23
	00	95	33	37	77	84	45	55	46	07	45	86	13	05	95	94	46	03	85	70	90
[B-S]	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	1.	1.	1.	1.	2.	2.	2.
Cumulative	00	01	04	08	13	19	26	36	45	56	68	81	95	11	27	44	63	83	02	25	46
Primary	00	51	11	13	19	29	97	03	48	46	77	62	75	31	54	89	44	94	74	84	08
Care Costs	00	95	28	65	42	26	71	26	73	80	26	11	24	30	25	19	65	68	53	23	13
[B-S]	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Secondary	00	02	03	05	07	08	11	13	13	15	17	18	20	22	23	24	26	29	26	33	29
Care Costs	00	21	78	83	31	80	07	03	63	78	68	45	29	33	29	89	58	40	99	14	07
	00	36	80	43	31	10	37	47	65	78	06	86	28	92	40	60	50	38	67	72	85
[B-S]	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	1.	1.	1.	2.	2.	2.	2.	3.	3.
Cumulative	00	02	06	11	19	27	39	52	65	81	99	17	37	60	83	08	35	64	91	24	53
Secondary	00	21	00	83	14	95	02	05	69	48	16	62	91	25	54	44	02	43	42	57	65
Care Costs	00	36	16	59	90	00	38	84	49	27	33	19	47	39	78	38	88	26	93	65	51
[B-S]	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Medication	00	01	01	02	03	04	06	07	06	08	09	10	11	12	12	14	15	15	14	18	16
Costs	00	12	91	97	73	51	36	37	99	77	76	14	10	78	63	10	06	76	50	29	28
	00	16	41	03	37	55	21	05	27	79	38	92	44	69	36	35	45	36	29	80	58
[B-S]	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	1.	1.	1.	1.	1.	1.
Cumulative	00	01	03	06	09	14	20	27	34	43	53	63	74	87	00	14	29	45	59	77	94
Medication	00	12	03	00	73	25	61	98	98	75	52	67	77	56	19	29	36	12	63	92	21
Costs	00	16	58	61	98	53	74	79	06	85	23	15	58	28	63	98	43	79	08	88	46
[B-S] Social	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Care Costs	00	02	04	06	08	09	12	14	15	17	19	20	22	24	25	27	29	32	29	36	31
	00	43	16	45	11	77	00	20	16	30	42	30	35	35	73	22	12	59	86	47	84
	00	82	12	59	45	78	64	75	25	24	20	23	63	57	14	73	70	32	56	07	04
[B-S]	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	1.	1.	1.	2.	2.	2.	2.	3.	3.	3.
Cumulative	00	02	06	13	21	30	42	57	72	89	09	29	51	76	01	29	58	90	20	57	88
Social Care	00	43	59	05	16	94	95	16	32	62	04	35	70	06	79	02	14	74	60	07	91
Costs	00	82	95	53	98	76	40	15	40	64	84	07	70	27	41	13	83	15	72	78	82
[B-S]	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	0.
Combined	00	07	12	19	24	29	37	43	45	52	59	61	67	75	77	83	89	98	90	11	97
Costs	00	29	45	28	21	19	12	66	24	84	17	75	88	04	88	57	33	26	16	01	44

	00	30	66	42	90	26	68	82	64	88	10	87	47	23	84	61	11	09	37	30	36

PM2.5

Baseline

Table 18. Baseline Costs by disease by year per 100,000 of the surviving cohort population and deaths by year per 100,000 in Lambeth

Year	**20 17**	**20 18**	**20 19**	**20 20**	**20 21**	**20 22**	**20 23**	**20 24**	**20 25**	**20 26**	**20 27**	**20 28**	**20 29**	**20 30**	**20 31**	**20 32**	**20 33**	**20 34**	**20 35**	**20 36**	**20 37**
[B] Primary Care Costs	2.1 32 50 7	2.2 38 81 6	2.3 29 47 4	2.4 39 12 3	2.5 41 66 1	2.6 58 73 2	2.7 58 29 7	2.8 77 55 8	2.9 86 75 9	3.1 03 18 1	3.2 16 13 8	3.3 42 22 7	3.4 50 57 0	3.5 73 19 0	3.6 86 77 1	3.8 21 71 5	3.9 33 75 4	4.0 59 88 5	4.1 68 64 4	4.3 03 99 0	4.4 37 75 3
[B] Second ary Care Costs	5.6 61 51 9	5.8 81 41 2	6.0 47 91 8	6.2 48 34 1	6.4 32 50 4	6.6 56 61 0	6.8 36 10 4	7.0 68 60 9	7.2 48 88 3	7.4 77 51 5	7.6 81 85 8	7.9 30 32 4	8.1 16 73 2	8.3 60 58 5	8.5 73 55 4	8.8 66 81 1	9.0 85 57 6	9.3 60 21 8	9.5 82 07 8	9.8 87 42 0	10. 14 49 02
[B] Medicat ion Costs	3.9 77 23 5	4.1 08 21 5	4.2 10 00 1	4.3 21 52 8	4.4 24 92 7	4.5 44 45 7	4.6 35 51 5	4.7 58 07 2	4.8 53 47 7	4.9 65 38 9	5.0 72 78 6	5.1 94 53 0	5.2 92 16 3	5.4 12 28 6	5.5 17 10 8	5.6 72 57 8	5.7 83 22 9	5.9 22 22 1	6.0 36 12 9	6.1 91 50 2	6.3 25 15 1
[B] Social Care Costs	2.3 80 23 5	2.5 94 23 4	2.7 90 39 0	2.9 92 64 1	3.1 86 05 0	3.3 85 30 7	3.5 68 23 6	3.7 63 54 7	3.9 48 93 8	4.1 35 18 5	4.3 19 20 1	4.5 14 59 5	4.6 89 82 6	4.8 78 05 0	5.0 58 23 8	5.2 57 21 5	5.4 37 53 3	5.6 27 41 2	5.7 97 40 1	5.9 98 02 6	6.2 06 02 1
[B] Combin ed Costs	14. 15 14 94	14. 82 26 75	15. 37 77 83	16. 00 16 33	16. 58 51 44	17. 24 51 06	17. 79 81 51	18. 46 77 87	19. 03 80 57	19. 68 12 69	20. 28 99 84	20. 98 16 76	21. 54 92 90	22. 22 41 12	22. 83 56 72	23. 61 83 19	24. 24 00 93	24. 96 97 36	25. 58 42 51	26. 38 09 39	27. 11 38 27

Scenario

Table 19. Scenario Costs by disease by year per 100,000 of the surviving cohort population and deaths by year per 100,000 in Lambeth

Year	**20 17**	**20 18**	**20 19**	**20 20**	**20 21**	**20 22**	**20 23**	**20 24**	**20 25**	**20 26**	**20 27**	**20 28**	**20 29**	**20 30**	**20 31**	**20 32**	**20 33**	**20 34**	**20 35**	**20 36**	**20 37**
[S] Primary Care Costs	2.1 32 50 7	2.2 09 23 5	2.2 72 30 3	2.3 55 60 2	2.4 37 69 0	2.5 29 81 3	2.6 12 47 5	2.7 07 00 4	2.7 98 13 9	2.8 98 24 8	2.9 92 33 0	3.0 97 97 5	3.1 93 00 0	3.2 95 71 9	3.3 96 57 1	3.5 07 24 6	3.6 05 89 4	3.7 21 53 4	3.8 22 13 0	3.9 36 71 2	4.0 24 87 3
[S] Second ary Care Costs	5.6 61 51 9	5.7 76 72 4	5.8 56 19 5	5.9 78 68 2	6.0 89 61 2	6.2 31 86 7	6.3 48 68 2	6.5 03 08 9	6.6 20 63 4	6.7 81 89 4	6.9 31 04 2	7.1 12 46 7	7.2 51 67 0	7.4 30 46 8	7.6 03 92 8	7.8 10 45 6	7.9 76 39 1	8.2 06 25 8	8.3 92 05 4	8.6 26 67 4	8.8 04 21 7
[S] Medicat ion Costs	3.9 77 23 5	4.0 55 86 6	4.1 14 43 7	4.1 87 78 8	4.2 53 46 6	4.3 31 10 2	4.3 97 21 2	4.4 72 13 4	4.5 35 05 5	4.6 18 41 9	4.6 89 69 8	4.7 83 96 3	4.8 49 18 9	4.9 42 39 3	5.0 27 36 5	5.1 27 47 0	5.2 10 07 4	5.3 32 30 1	5.4 26 04 7	5.5 44 59 6	5.6 36 45 4
[S] Social Care Costs	2.3 80 23 5	2.5 62 68 5	2.7 28 94 0	2.9 01 99 8	3.0 73 04 1	3.2 43 41 6	3.4 04 51 1	3.5 72 33 4	3.7 35 75 2	3.9 00 69 8	4.0 63 41 3	4.2 31 62 3	4.3 09 18 2	4.5 92 53 1	4.7 16 96 5	4.8 89 16 5	5.0 50 95 0	5.2 26 68 0	5.3 87 59 1	5.5 62 30 3	5.7 02 84 8
[S] Combin ed Costs	14. 15 14 94	14. 60 45 13	14. 97 18 73	15. 42 40 71	15. 85 38 09	16. 33 61 99	16. 76 28 82	17. 25 45 59	17. 68 95 81	18. 19 92 57	18. 67 64 83	19. 22 60 28	19. 68 59 51	20. 22 17 64	20. 74 48 27	21. 33 43 35	21. 84 33 09	22. 48 67 71	23. 02 78 22	23. 67 02 86	24. 16 83 90

Differences

Table 20. Difference (Baseline relative to Scenario) by Costs per 100,000 and deaths by year per 100,000 in Lambeth

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
[B-S]	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.4
Primary	00	02	05	08	10	12	14	17	18	20	22	44	57	77	90	14	27	38	46	67	12
Care Costs	00	95	71	35	39	89	58	05	86	49	38	25	57	47	20	46	86	35	51	27	88
	00	81	71	20	71	19	22	53	20	33	08	2	0	0	0	9	0	1	3	8	1
[B-S]	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.	1.	1.5	1.8	2.1	2.4	2.7	3.0	3.3	3.7	4.1	4.5
Cumulative	00	02	08	17	27	40	54	71	90	11	33	81	38	16	06	20	48	87	33	00	13
Primary	00	95	67	02	42	31	89	95	81	30	68	15	72	19	39	86	72	07	58	86	74
Care Costs	00	81	52	73	44	63	84	38	58	91	99	1	1	1	1	0	0	1	4	3	4
[B-S]	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.8	0.8	0.9	0.9	1.0	1.1	1.1	1.1	1.2	1.3
Secondary	00	10	19	26	34	42	48	56	62	69	75	17	65	30	69	56	09	53	90	60	40
Care Costs	00	46	17	96	28	47	74	55	82	56	08	85	06	11	62	35	18	96	02	74	68
	00	82	24	56	92	43	22	20	49	21	17	7	0	8	6	4	5	1	4	3	7
[B-S]	0.	0.	0.	0.	0.	1.	1.	2.	3.	3.	4.	5.2	6.1	7.0	8.0	9.1	10.	11.	12.	13.	15.
Cumulative	00	10	29	56	90	33	82	38	01	71	46	79	44	74	43	00	20	36	55	81	15
Secondary	00	46	64	60	89	36	11	66	48	05	13	18	24	36	98	34	95	34	35	42	49
Care Costs	00	82	07	63	55	98	20	40	88	09	26	3	3	1	7	2	27	87	12	55	42
[B-S]	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.6
Medication	00	05	09	13	17	21	23	28	31	34	38	10	42	69	89	45	73	89	10	46	88
Costs	00	23	55	37	14	33	83	59	84	69	30	56	97	88	74	10	15	92	08	90	69
	00	49	65	40	61	54	03	39	23	71	88	8	4	9	3	8	5	0	3	6	7
[B-S]	0.	0.	0.	0.	0.	0.	0.	1.	1.	1.	2.	2.6	3.0	3.5	4.0	4.5	5.1	5.7	6.3	7.0	7.7
Cumulative	00	05	14	28	45	66	90	19	50	85	23	49	92	62	52	97	70	60	70	17	06
Medication	00	23	79	16	31	64	47	07	91	61	91	76	73	62	36	47	62	54	63	53	23
Costs	00	49	14	54	15	69	72	11	34	04	92	0	4	3	6	4	9	9	1	7	4
[B-S] Social	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.2	0.2	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.5
Care Costs	00	03	06	09	11	14	16	19	21	23	25	82	97	24	41	68	86	00	09	35	03
	00	15	14	06	30	18	37	12	31	44	57	97	73	86	27	05	58	73	81	72	17
	00	48	50	43	09	91	25	14	86	86	88	2	4	8	4	0	4	1	0	3	3
[B-S]	0.	0.	0.	0.	0.	0.	0.	0.	1.	1.	1.	1.7	2.0	2.4	2.7	3.1	3.4	3.8	4.3	4.7	5.2
Cumulative	00	03	09	18	29	43	60	79	00	24	49	79	77	02	43	11	98	99	08	44	47
Social Care	00	15	29	36	66	85	22	34	66	11	69	91	64	51	78	83	42	15	96	68	86
Costs	00	48	99	42	50	42	67	80	67	53	41	3	7	5	8	9	3	4	5	7	0
[B-S]	0.	0.	0.	0.	0.	0.	1.	1.	1.	1.	1.	1.7	1.8	2.0	2.0	2.2	2.3	2.4	2.5	2.7	2.9
Combined	00	21	40	57	73	90	03	21	34	48	61	55	63	02	90	83	96	82	56	10	45
Costs	00	81	59	75	13	89	52	32	84	20	35	64	33	34	84	98	78	96	43	65	43
	00	61	11	59	33	08	72	26	78	12	00	8	8	5	2	2	4	4	0	0	8
[B-S]	0.	0.	0.	1.	1.	2.	3.	5.	6.	7.	9.	11.	13.	15.	17.	19.	21.	24.	26.	29.	32.
Cumulative	00	21	62	20	93	84	87	09	43	92	53	29	15	15	24	53	92	41	96	67	62
Combined	00	81	40	16	29	18	71	03	88	08	43	00	33	56	65	05	72	02	66	73	27
Costs	00	61	72	31	64	71	43	69	47	58	59	07	45	90	32	14	98	61	92	41	80

South Lakeland

NO2

Baseline

Table 21. Baseline prevalence by Costs by year per 100,000 of the surviving cohort population and deaths by year per 100,000 in South Lakeland

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
[B] Primary Care Costs	2.9 69 37 4	3.1 61 69 4	3.3 38 79 6	3.5 10 87 5	3.6 71 37 3	3.8 26 16 6	3.9 75 53 7	4.1 16 48 6	4.2 46 48 5	4.3 81 53 4	4.4 84 23 5	4.6 23 29 2	4.6 93 42 0	4.7 99 90 8	4.8 83 13 3	4.9 95 25 1	5.0 46 42 0	5.1 35 34 6	5.1 92 74 5	5.2 41 78 4	5.3 16 48 7
[B] Secondary Care Costs	4.2 94 23 7	4.5 53 86 4	4.8 04 33 0	5.0 50 32 9	5.2 80 77 6	5.5 02 63 9	5.7 17 06 3	5.9 19 74 4	6.1 05 98 1	6.2 99 40 5	6.4 47 80 3	6.6 47 88 9	6.7 48 54 6	6.9 00 60 9	7.0 20 84 0	7.1 82 51 8	7.2 55 80 1	7.3 82 84 0	7.4 65 33 6	7.5 36 15 6	7.6 43 56 1
[B] Medication Costs	3.0 75 60 0	3.2 18 62 0	3.3 50 63 6	3.4 78 48 0	3.5 99 36 8	3.7 08 71 6	3.8 21 94 4	3.9 21 68 7	4.0 14 10 7	4.1 17 93 9	4.1 91 87 3	4.2 91 90 4	4.3 42 48 5	4.4 19 22 5	4.4 81 36 9	4.5 55 29 3	4.5 94 67 2	4.6 61 18 7	4.6 98 23 4	4.7 34 99 9	4.7 86 99 9
[B] Social Care Costs	4.3 51 03 0	4.6 58 86 6	4.9 42 34 2	5.2 18 01 1	5.4 74 37 0	5.7 24 99 6	5.9 63 24 5	6.1 91 38 5	6.4 01 59 2	6.6 16 30 9	6.7 81 96 0	7.0 06 27 9	7.1 19 33 8	7.2 91 03 9	7.4 24 23 6	7.6 08 24 5	7.6 89 58 2	7.8 31 83 1	7.9 26 40 4	8.0 04 81 8	8.1 26 13 6
[B] Combined Costs	14. 69 02 42	15. 59 30 43	16. 43 61 02	17. 25 76 94	18. 02 58 87	18. 76 25 16	19. 47 77 89	20. 14 93 03	20. 76 81 66	21. 41 51 88	21. 90 58 70	22. 56 93 63	22. 90 37 90	23. 41 07 82	23. 80 95 78	24. 34 13 05	24. 58 64 72	25. 01 12 02	25. 28 27 19	25. 51 77 54	25. 87 31 84

Scenario

Table 22. Scenario Costs by year per 100,000 of the surviving cohort population and deaths by year per 100,000 in South Lakeland

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
[S] Primary Care Costs	2.9 69 37 4	3.1 58 00 0	3.3 34 79 4	3.5 03 34 9	3.6 67 44 1	3.8 18 46 8	3.9 67 95 4	4.1 16 48 6	4.2 46 43 2	4.3 42 91 0	4.4 84 19 2	4.5 84 18 8	4.6 93 42 0	4.7 99 90 8	4.8 83 05 0	4.9 55 15 3	5.0 46 42 0	5.0 94 41 1	5.1 92 74 5	5.2 41 78 4	5.2 73 72 6
[S] Secondary Care Costs	4.2 94 23 7	4.5 48 57 7	4.7 98 60 2	5.0 39 55 7	5.2 74 77 9	5.4 91 25 7	5.7 05 85 3	5.9 19 74 4	6.1 05 56 7	6.2 44 12 4	6.4 47 40 2	6.5 91 58 5	6.7 48 54 6	6.9 00 60 9	7.0 20 08 4	7.1 24 81 0	7.2 55 80 1	7.3 23 33 5	7.4 65 15 6	7.5 36 77 6	7.5 81 77 5
[S] Medication Costs	3.0 75 60 0	3.2 15 89 3	3.3 47 68 1	3.4 72 92 4	3.5 96 46 8	3.7 03 03 6	3.8 16 35 0	3.9 21 68 7	4.0 14 07 6	4.0 89 42 2	4.1 91 84 3	4.2 63 03 4	4.3 42 48 5	4.4 19 22 5	4.4 81 31 5	4.5 25 68 3	4.5 94 09 2	4.6 30 67 6	4.6 98 96 4	4.7 34 23 9	4.7 55 99 1
[S] Social Care Costs	4.3 51 03 0	4.6 52 94 1	4.9 35 92 2	5.2 05 93 8	5.4 68 05 7	5.7 12 64 2	5.9 51 07 6	6.1 91 38 5	6.4 01 51 3	6.5 54 35 2	6.7 81 88 3	6.9 43 54 4	7.1 19 33 8	7.2 91 03 9	7.4 24 09 1	7.5 43 91 5	7.6 89 58 2	7.7 66 15 9	7.9 26 40 4	8.0 04 81 8	8.0 57 53 1
[S] Combined Costs	14. 69 02 42	15. 57 54 10	16. 41 69 96	17. 22 17 67	18. 00 67 44	18. 72 54 03	19. 44 12 33	20. 14 93 03	20. 76 75 95	21. 23 08 10	21. 90 53 17	22. 38 23 51	22. 90 37 90	23. 41 07 82	23. 80 85 37	24. 14 95 67	24. 58 64 72	24. 81 27 81	25. 28 77 19	25. 51 27 54	25. 66 84 61

Differences

Table 23. Difference (Baseline relative to Scenario) by Costs per 100,000 and deaths by year per 100,000 in South Lakeland

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
[B-S]	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Primary	00	00	00	00	00	00	00	00	00	03	00	03	00	00	00	04	00	04	00	00	04
Care Costs	00	36	40	75	39	76	75	00	00	86	00	91	00	00	00	00	00	09	00	00	27
	00	94	02	26	32	98	82	00	46	22	44	04	00	00	84	98	00	35	00	00	62
[B-S]	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Cumulative	00	00	00	01	01	02	03	03	03	07	07	11	11	11	11	15	15	19	19	19	23
Primary	00	36	76	52	91	68	44	44	44	31	31	22	22	22	23	24	24	33	33	33	61
Care Costs	00	94	96	22	54	51	33	33	79	01	46	50	50	50	34	32	32	67	67	67	28
[B-S]	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Secondary	00	00	00	01	00	01	01	00	00	05	00	05	00	00	00	05	00	05	00	00	06
Care Costs	00	52	57	07	59	13	12	00	04	52	04	63	00	00	07	77	00	88	00	00	17
	00	87	28	72	97	82	11	00	13	82	01	03	00	00	55	07	00	95	00	00	86
[B-S]	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Cumulative	00	00	01	02	02	03	05	05	05	10	10	16	16	16	16	22	22	28	28	28	34
Secondary	00	52	10	17	77	91	03	03	07	60	64	27	27	27	35	12	12	01	01	01	19
Care Costs	00	87	15	88	85	66	77	77	91	72	74	77	77	77	32	39	39	34	34	34	20
[B-S]	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Medication	00	00	00	00	00	00	00	00	00	02	00	02	00	00	00	02	00	03	00	00	03
Costs	00	27	29	55	29	56	55	00	00	85	00	88	00	00	00	96	00	02	00	00	15
	00	27	55	57	00	81	95	00	31	17	30	70	00	00	57	04	00	22	00	00	68
[B-S]	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Cumulative	00	00	00	01	01	01	02	02	02	05	05	08	08	08	08	11	11	14	14	14	17
Medication	00	27	56	12	41	98	54	54	54	39	39	28	28	28	29	25	25	27	27	27	43
Costs	00	27	82	39	39	20	15	15	46	63	93	63	63	63	19	23	23	45	45	45	13
[B-S] Social	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Care Costs	00	00	00	01	00	01	01	00	00	06	00	06	00	00	00	06	00	06	00	00	06
	00	59	64	20	63	23	21	00	00	19	00	27	00	00	01	43	00	56	00	00	86
	00	25	20	73	13	54	69	00	79	57	77	35	00	00	45	29	00	71	00	00	06
[B-S]	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Cumulative	00	00	01	02	03	04	05	05	05	11	11	18	18	18	18	24	24	31	31	31	37
Social Care	00	59	23	44	07	30	52	52	53	72	73	01	01	01	02	45	45	02	02	02	88
Costs	00	25	46	18	31	85	54	54	33	90	67	01	01	01	46	75	75	46	46	46	52
[B-S]	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Combined	00	01	01	03	01	03	03	00	00	18	00	18	00	00	00	19	00	19	00	00	20
Costs	00	76	91	59	91	71	65	00	05	43	05	70	00	00	10	17	00	57	00	00	47
	00	33	06	28	42	14	57	00	70	77	53	12	00	00	40	39	00	22	00	00	22
[B-S]	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.
Cumulative	00	01	03	07	09	12	16	16	16	35	35	53	53	53	53	73	73	92	92	92	13
Combined	00	76	67	26	18	89	54	54	60	04	09	79	79	79	90	07	07	64	64	64	12
Costs	00	33	39	67	09	22	79	79	49	26	79	91	91	91	31	70	70	91	91	91	14

PM2.5

Baseline

Table 24. Baseline prevalence by Costs by year per 100,000 of the surviving cohort population and deaths by year per 100,000 in South Lakeland

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
[B] Primary Care Costs	4.5 16 47 3	4.5 91 85 4	4.6 45 24 4	4.7 27 34 7	4.7 98 59 1	4.8 87 71 7	4.9 56 54 0	5.0 46 00 6	5.1 36 08 6	5.1 99 59 6	5.2 66 98 1	5.3 47 03 8	5.3 94 76 0	5.4 87 64 1	5.5 43 76 6	5.6 13 24 0	5.6 47 49 4	5.7 30 04 5	5.7 72 10 7	5.8 20 28 4	5.8 41 33 6
[B] Secondary Care Costs	13. 71 61 61	13. 83 27 69	13. 83 75 72	13. 93 26 16	13. 91 59 62	13. 99 20 88	14. 01 21 04	14. 07 80 66	14. 09 12 25	14. 10 99 12	14. 12 23 69	14. 19 02 78	14. 14 37 77	14. 20 35 85	14. 21 51 80	14. 30 49 99	14. 25 40 16	14. 33 85 43	14. 33 83 91	14. 43 34 15	14. 37 16 00
[B] Medication Costs	8.1 43 37 9	8.2 69 21 1	8.3 25 13 4	8.4 11 60 2	8.4 29 03 7	8.4 83 63 0	8.5 19 48 0	8.5 59 66 9	8.5 78 74 3	8.5 89 64 1	8.5 99 19 4	8.6 34 38 4	8.6 08 57 9	8.6 36 63 5	8.6 34 21 2	8.6 80 51 2	8.6 51 02 0	8.6 86 73 1	8.6 87 69 9	8.7 30 70 6	8.6 90 51 5
[B] Social Care Costs	5.2 61 22 3	5.5 55 50 7	5.8 19 84 5	6.0 74 20 8	6.3 02 43 8	6.5 32 26 9	6.7 36 86 3	6.9 40 73 7	7.1 45 27 2	7.2 90 85 9	7.4 46 99 2	7.6 06 20 5	7.7 16 69 1	7.8 85 93 1	8.0 04 83 8	8.1 27 35 3	8.2 00 39 3	8.3 44 33 0	8.4 24 80 3	8.5 08 61 7	8.5 54 59 7
[B] Combined Costs	31. 63 72 34	32. 24 93 44	32. 62 77 92	33. 14 57 75	33. 44 60 26	33. 89 57 06	34. 22 49 83	34. 62 44 77	34. 95 13 24	35. 19 00 06	35. 43 55 35	35. 77 79 05	35. 86 38 04	36. 21 37 91	36. 39 79 91	36. 72 61 05	36. 75 29 26	37. 09 96 48	37. 22 30 03	37. 49 30 23	37. 45 80 46

Scenario

Table 25. Scenario prevalence by Costs by year per 100,000 of the surviving cohort population and deaths by year per 100,000 in South Lakeland

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
[S] Primary Care Costs	4.5 16 47 3	4.5 91 85 4	4.6 45 24 4	4.7 27 34 7	4.7 98 59 1	4.8 87 71 7	4.9 55 82 2	5.0 46 00 6	5.1 36 08 6	5.1 99 59 6	5.2 66 98 1	5.3 46 31 6	5.3 93 31 6	5.4 86 59 3	5.5 43 44 2	5.6 12 17 9	5.6 46 07 9	5.7 28 96 1	5.7 71 80 1	5.8 18 87 7	5.8 40 74 4
[S] Secondary Care Costs	13. 71 61 61	13. 83 27 69	13. 83 75 72	13. 93 26 16	13. 91 59 62	13. 99 20 88	13. 99 74 31	14. 07 80 66	14. 09 12 25	14. 10 99 12	14. 12 23 69	14. 18 88 87	14. 12 69 61	14. 19 48 99	14. 21 47 05	14. 28 93 95	14. 23 70 40	14. 32 22 75	14. 33 79 43	14. 41 60 93	14. 37 07 32
[S] Medication Costs	8.1 43 37 9	8.2 69 21 1	8.3 25 13 4	8.4 11 60 2	8.4 29 03 7	8.4 83 63 0	8.5 11 25 6	8.5 59 66 9	8.5 78 74 3	8.5 89 64 1	8.5 99 19 4	8.6 34 13 9	8.5 99 49 0	8.6 31 04 2	8.6 34 10 9	8.6 71 92 8	8.6 41 82 2	8.6 77 77 1	8.6 87 60 3	8.7 21 30 3	8.6 90 32 7
[S] Social Care Costs	5.2 61 22 3	5.5 55 50 7	5.8 19 84 5	6.0 74 20 8	6.3 02 43 8	6.5 32 26 9	6.7 35 76 0	6.9 40 73 7	7.1 45 27 2	7.2 90 85 9	7.4 46 99 2	7.6 05 98 6	7.7 15 35 9	7.8 84 97 9	8.0 04 76 8	8.1 26 14 7	8.1 99 05 4	8.3 43 07 7	8.4 24 73 8	8.5 07 25 5	8.5 54 47 2
[S] Combined Costs	31. 63 72 34	32. 24 93 44	32. 62 77 92	33. 14 57 75	33. 44 60 26	33. 89 57 06	34. 20 02 68	34. 62 44 77	34. 95 13 24	35. 19 00 06	35. 43 55 35	35. 77 53 30	35. 83 51 25	36. 19 75 10	36. 39 70 22	36. 72 96 54	36. 75 39 95	37. 07 20 83	37. 22 20 88	37. 46 35 28	37. 45 62 72

Differences

Table 26. Difference (Baseline relative to Scenario) by Costs per 100,000 and deaths by year per 100,000 in South Lakeland

Year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
[B-S]	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Primary	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
Care Costs	00	00	00	00	00	00	07	00	00	00	00	07	14	10	03	10	14	10	03	14	05
	00	00	00	00	00	00	19	00	00	00	00	22	44	47	24	61	16	85	05	07	92
[B-S]	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Cumulative	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	01
Primary	00	00	00	00	00	00	07	07	07	07	07	14	28	39	42	53	67	78	81	95	01
Care Costs	00	00	00	00	00	00	19	19	19	19	19	41	85	32	57	17	33	18	23	29	21
[B-S]	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Secondary	00	00	00	00	00	00	01	00	00	00	00	00	01	00	00	01	01	01	00	01	00
Care Costs	00	00	00	00	00	00	46	00	00	00	00	13	68	86	04	56	69	62	04	73	08
	00	00	00	00	00	00	72	00	00	00	00	90	17	86	75	03	77	68	48	20	68
[B-S]	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Cumulative	00	00	00	00	00	00	01	01	01	01	01	01	03	04	04	05	07	09	09	10	10
Secondary	00	00	00	00	00	00	46	46	46	46	46	60	28	15	20	76	46	08	13	86	95
Care Costs	00	00	00	00	00	00	72	72	72	72	72	63	79	65	41	44	21	89	37	57	26
[B-S]	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Medication	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
Costs	00	00	00	00	00	00	82	00	00	00	00	02	90	55	01	85	91	89	00	94	01
	00	00	00	00	00	00	24	00	00	00	00	44	88	93	03	84	98	62	97	04	87
[B-S]	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Cumulative	00	00	00	00	00	00	00	00	00	00	00	00	01	02	02	03	04	04	05	05	05
Medication	00	00	00	00	00	00	82	82	82	82	82	84	75	31	32	18	10	99	00	94	96
Costs	00	00	00	00	00	00	24	24	24	24	24	68	57	49	52	36	34	96	92	97	84
[B-S] Social	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Care Costs	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
	00	00	00	00	00	00	11	00	00	00	00	02	13	09	00	12	13	12	00	13	01
	00	00	00	00	00	00	02	00	00	00	00	20	32	52	69	05	40	54	65	63	26
[B-S]	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Cumulative	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
Social Care	00	00	00	00	00	00	11	11	11	11	11	13	26	36	36	48	62	74	75	89	90
Costs	00	00	00	00	00	00	02	02	02	02	02	22	54	07	76	80	20	74	39	02	28
[B-S]	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Combined	00	00	00	00	00	00	02	00	00	00	00	00	02	01	00	02	02	02	00	02	00
Costs	00	00	00	00	00	00	47	00	00	00	00	25	86	62	09	64	89	75	09	94	17
	00	00	00	00	00	00	17	00	00	00	00	77	81	79	71	53	30	68	14	94	74
[B-S]	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Cumulative	00	00	00	00	00	00	02	02	02	02	02	02	05	07	07	09	12	15	15	18	18
Combined	00	00	00	00	00	00	47	47	47	47	47	72	59	22	32	96	86	61	70	65	83
Costs	00	00	00	00	00	00	17	17	17	17	17	94	75	54	25	78	08	77	91	85	59

Appendix 3: How are costs calculated?

Following the simulation run, the tool simply scales the aggregated individual disease costs according to the relative disease prevalence in years after the start year.

In any year, the total healthcare cost for the disease *D* is denoted $C_D(year)$. If the prevalence of the disease is denoted $P_D(year)$ we assume a simple relationship between the two of the form
for some constant κ, where κ,is defined as the cost per case

$$C_D(year) = \kappa P_D(year)$$

Appendix 4: Explaining asthma scenario outputs

Asthma is treated as a chronic, fatal disease within the tool. However, there is some instability in the tool outputs for asthma that can be explained by a number of factors: impact from other diseases, type of cohort run (high exposure vs. all exposure groups), level of exposure in the population (for example, Lambeth is high, South Lakeland is low).

The following relative risks (RR) for asthma are included within the tool:

Respiratory outcomes					
				$PM_{2.5}$	NO_2
Asthma (children <18 years)	Chronic	Yes	Child	Khreis et al. 2016 (9) In children >6 years: OR 1.04 (1.02; 1.07) per 1μg/m^3 →Converted OR **1.48 (1.22 ; 1.97) per 10μg/m^3**	Khreis *et al.* 2016 (9) In children =<6 years : OR 1.08 (1.04; 1.12) per 4μg/m^3→*Converted to OR 1.212 (1.103; 1.328)* per 10μg/m^3→*REDUCED by 60%* → **1.08 (1.01; 1.12) per 10μg/m^3** In children >6 years: OR 1.03 (1.00; 1.06) per 4μg/m^3→*Converted to OR 1.08 (1.00; 1.16)* per 10μg/m^3→ *REDUCED by 60%* → **1.03 (1.00; 1.06) per 10μg/m^3**
Asthma (adults)	Chronic	Yes	Adult	NOT MODELLED	Jaquemin *et al.* 2015 (10) *In adults:* OR 1.10 (0.99;1.21) per 10μg/m^3 →*REDUCED by 60%* → **1.04 (0.996; 1.08*)* per 10μg/m^3**

The following examples provide some explanation for the results observed for asthma. The scenario '100% attributable cases' is run for each example.

$PM_{2.5}$

For $PM_{2.5,}$ a RR for children above age 6 years was available. Therefore, individuals who live in a high exposure area have an increased risk of contracting asthma if they are aged between 7 and 18 years compared to those living in a low exposure area. For all other individuals the risk is equal.

Example 1: 18+ cohort, all exposure groups, England

When we run this cohort we see that moving 100% of people from a high exposure area to low exposure area results in instability in the prevalence cases avoided and in some years fewer cases of asthma in the high exposure area compared to low exposure group (‘negative cases avoided – see Figure 21). This is because adults do not have a differing risk of asthma in the high vs low exposure areas. However, they do have an increased risk of other diseases, therefore, people may have died of diseases such as CHD, COPD, lung cancer in the high exposure group, while those in the low exposure group have survived and continue to live with asthma. Therefore, these results should not be interpreted in isolation.

We can see this more clearly when we run asthma alone in the tool, thus removing any possibility of additional impacts from other diseases. Here we see that, since there are no RR for adults, it makes no difference to the prevalence of asthma when moving adults from areas of high to low exposure (Figure 22). This also highlights the importance of considering the impact from other $PM_{2.5}$ related diseases within tools.

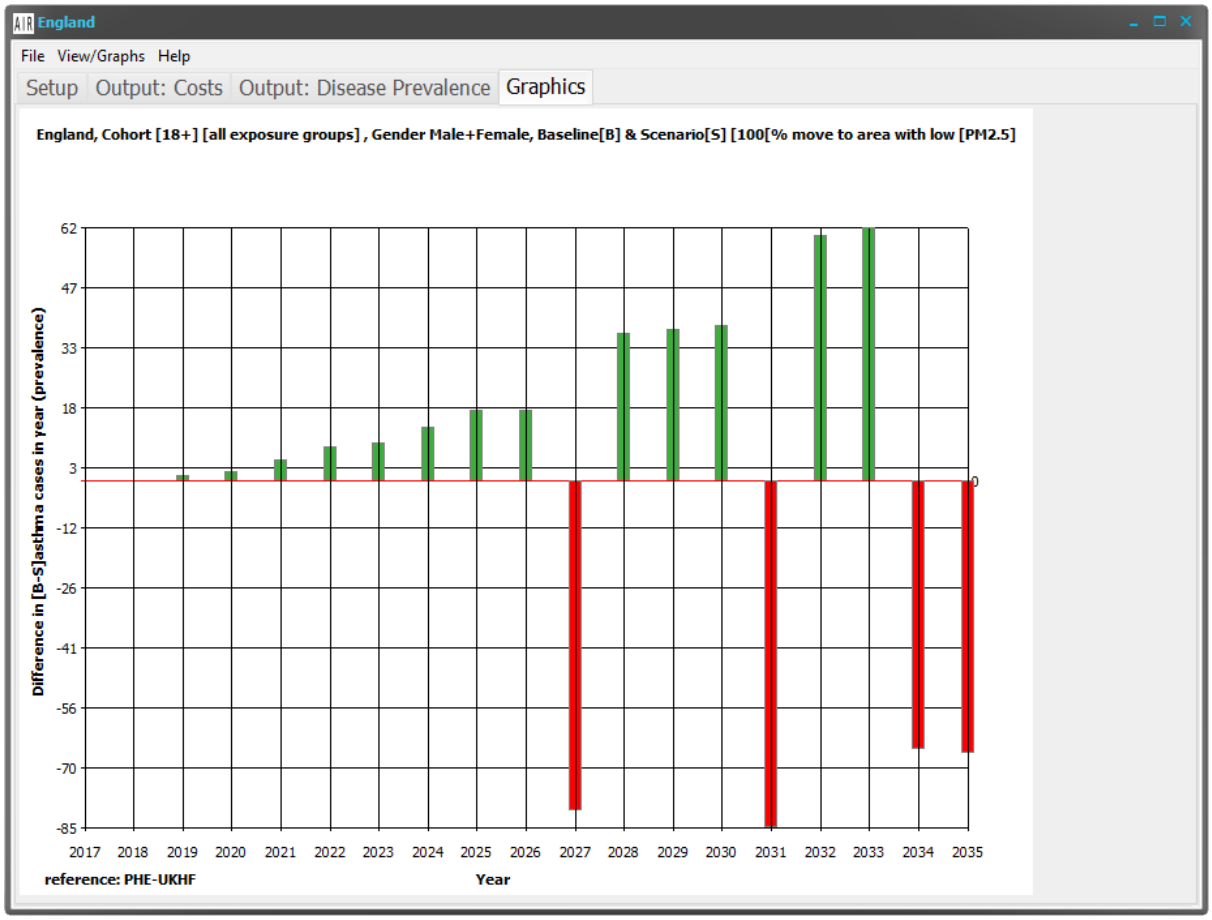


Figure 21 Asthma prevalence cases avoided as a result of moving 100% from an area of high exposure to low exposure (all diseases considered in the tool)

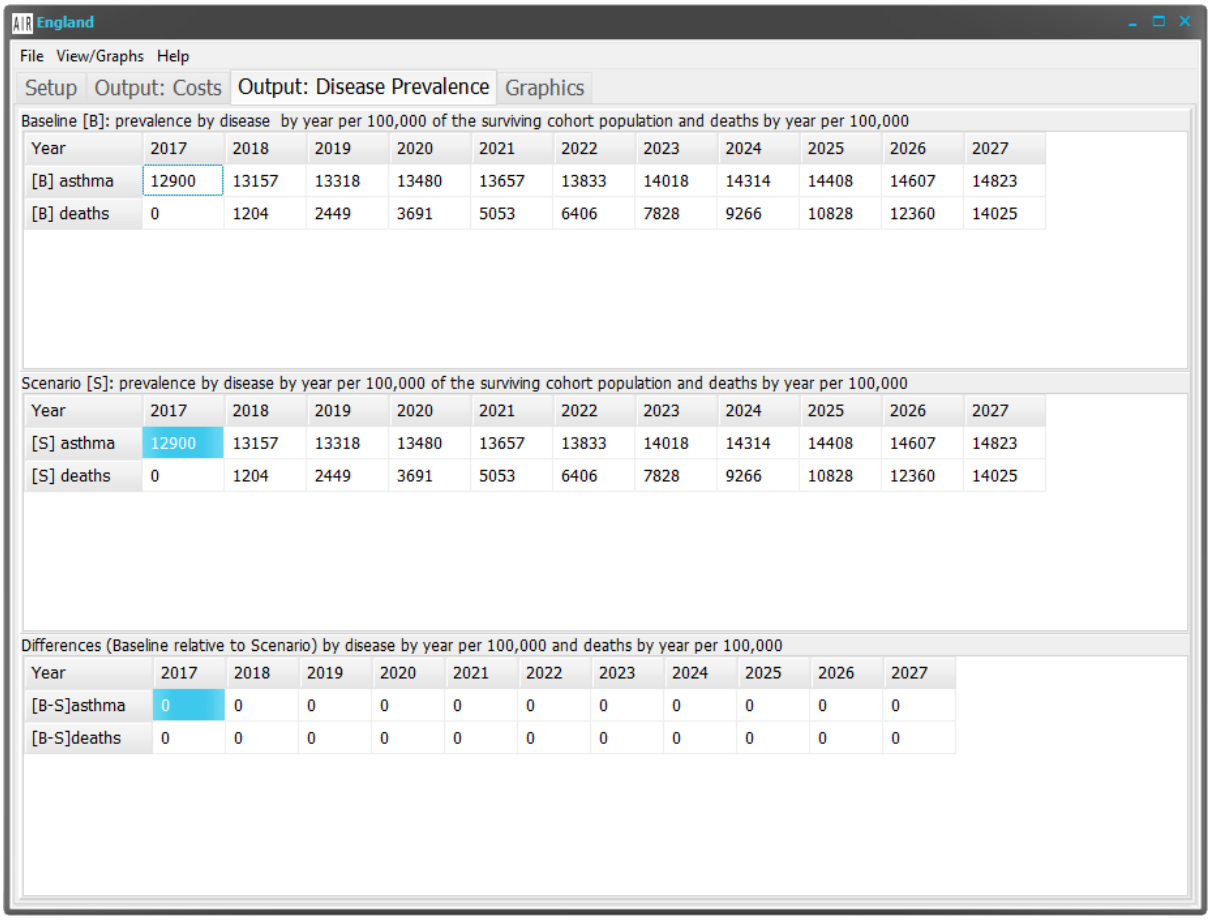


Figure 22 Asthma prevalence cases avoided as a result of moving 100% from an area of high exposure to low exposure (only asthma in the tool)

Note: The tool is a deterministic model which calculates the probability of representative individuals in a population living with a particular disease. The tool calculates the total prevalence of each disease for an individual from the probability of each disease state. Disease states are defined as a state in which an individual may be living with between one and four different diseases. The total disease prevalence is calculated from taking a weighted average over the whole population.

Example 2: Child cohort (1-18 years), high pollution area, England

A simulation where children in a high pollution area are moved to an area of low pollution has a large and important impact on the prevalence of asthma. This is because, from age 7 years, children have an increased probability of contracting asthma if they live in a high exposure area, compared to a less exposed area (Figure 23)

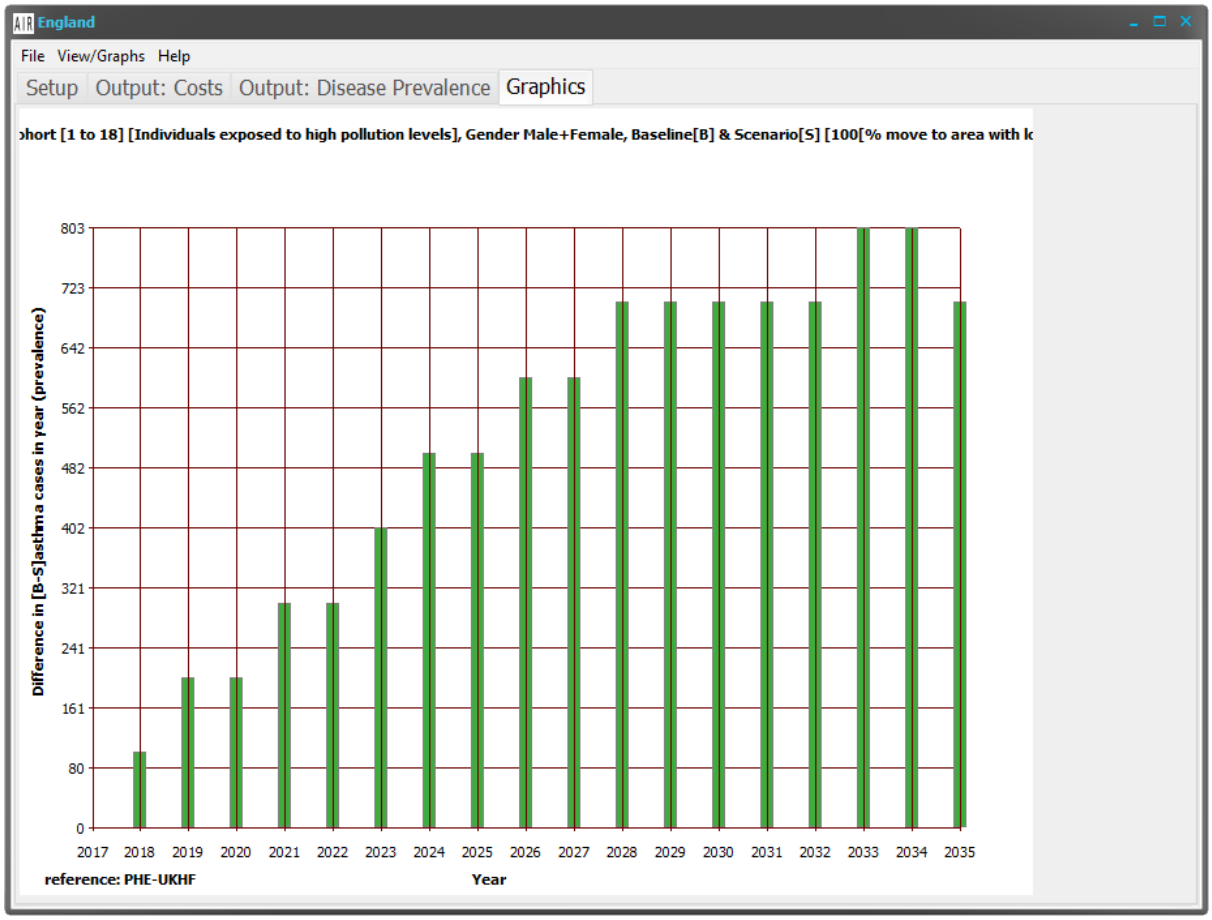


Figure 23 Asthma prevalence cases avoided as a result of moving 100% of the children from an area of high exposure to low exposure

NO_2

For NO_2 relative risks were available for both adults and children. Again, the scenario '100% move to an area of low exposure' was run.

Example 1. 18+ cohort, all exposure groups, England

There are peaks and troughs of asthma cases avoided when comparing all exposure groups to a cohort where 100% of people have moved to an area of low exposure. A similar pattern is observed with individuals in the high exposure group. Again, impact from other diseases are important to consider here, making the trends unstable, since individuals may die from other air pollution related causes in the high exposure area, so there are fewer people to contract asthma in the high exposure group (Figure 24).

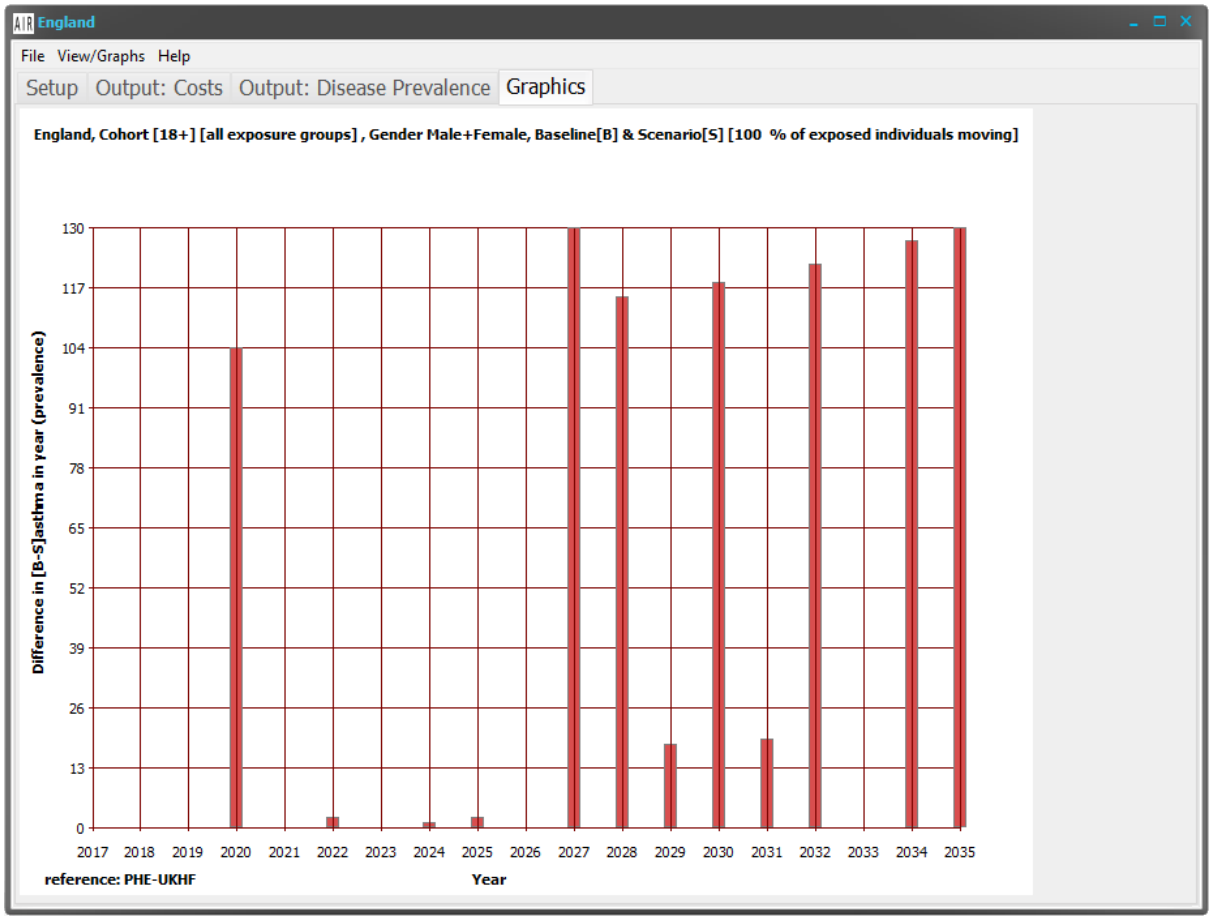


Figure 24 Asthma prevalence cases avoided as a result of moving 100% from an area of high exposure to low exposure (only asthma in the tool)

Similarly with adults exposed to high exposure, there are dips in cases avoided (Figure 25).

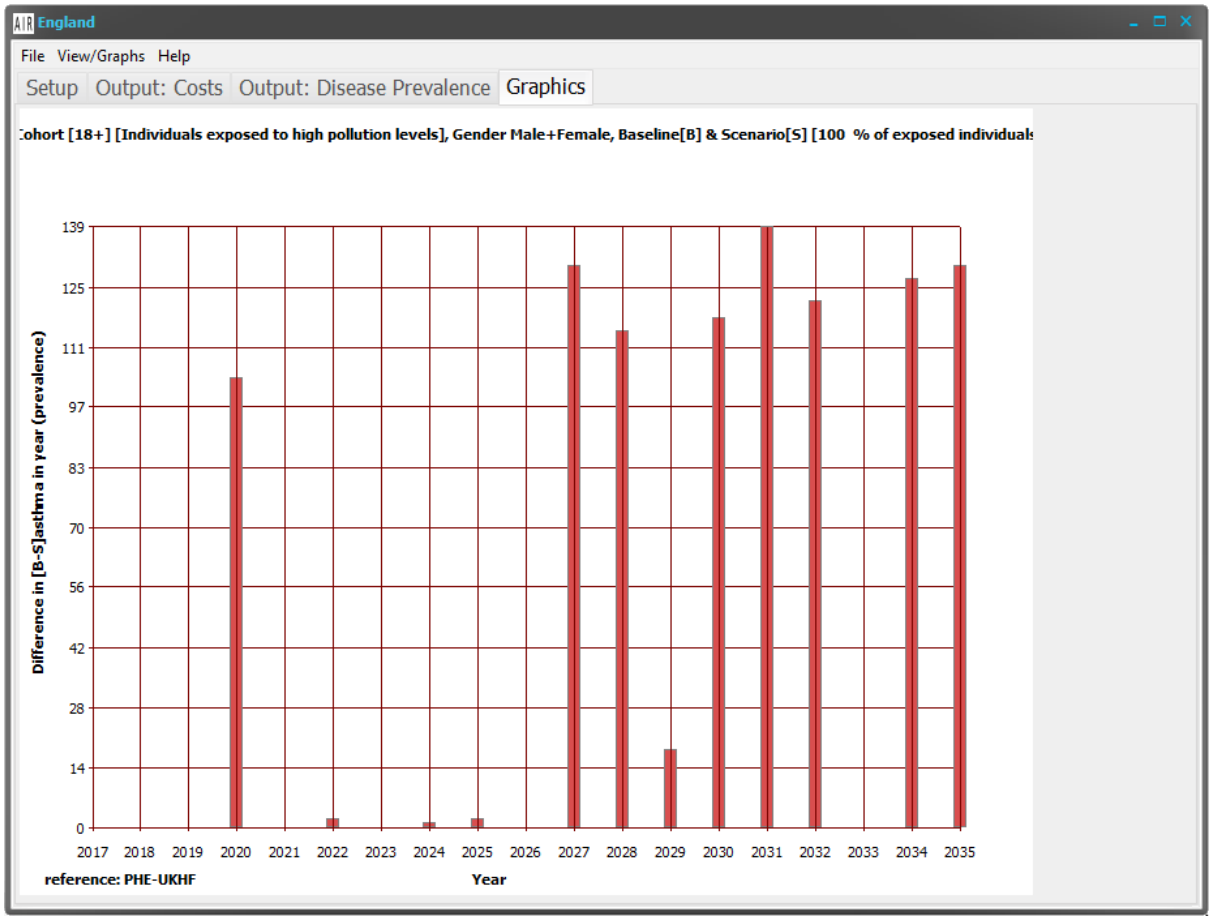


Figure 25 Asthma prevalence cases avoided as a result of moving 100% from an area of high exposure to low exposure

Example 2: Child cohort (1-18 years), high pollution area, England

In children in the high exposure group there are peaks and troughs in the cases avoided when '100% of individuals move from an area of high exposure to low exposure'. Since we include two RRs for children <6 yrs and >=6 years, then this as children age and move onto a different RR beyond age 6, we see more abrupt/stepped changes which may be due to the RRs and the exposure levels for these two different age groups (Figure 26).

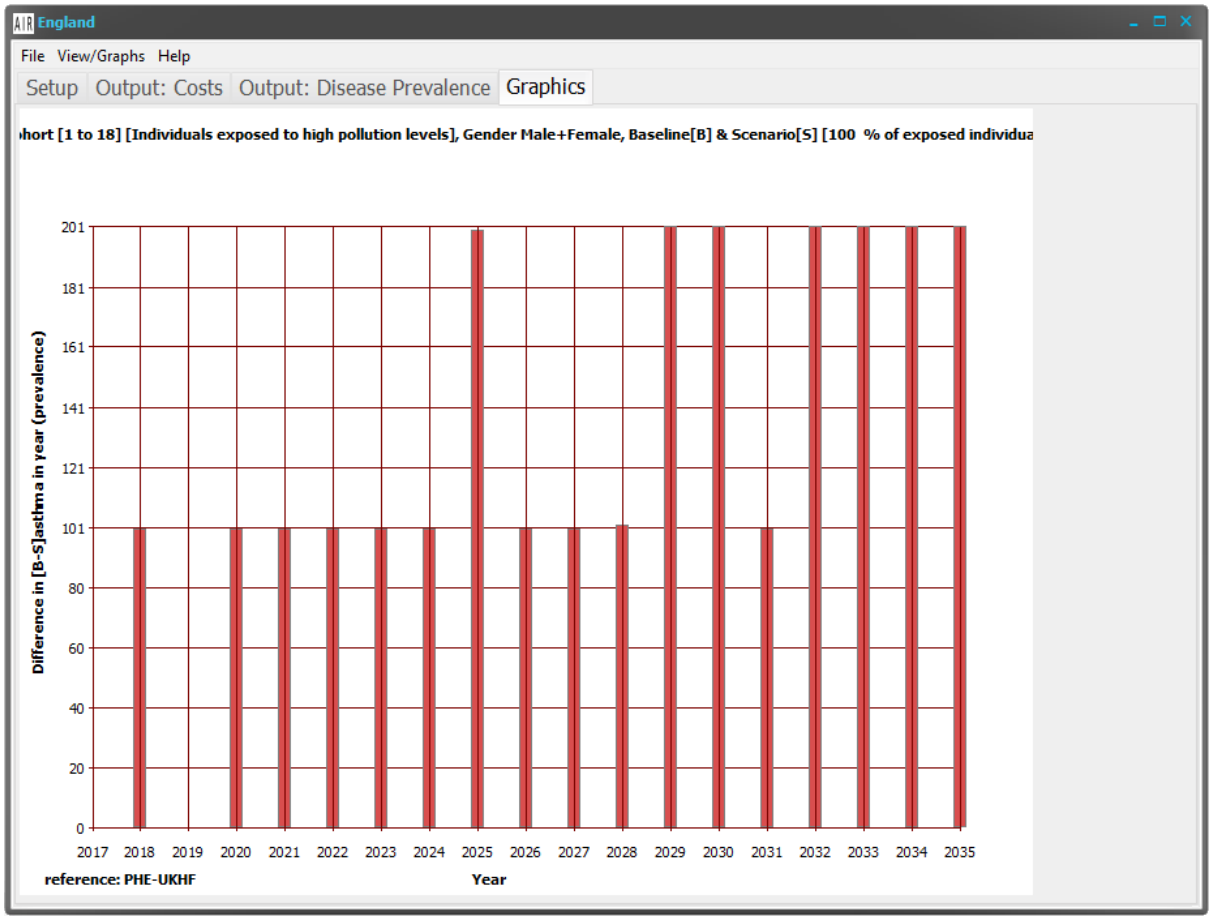


Figure 26 Asthma prevalence cases avoided as a result of moving 100% from an area of high exposure to low exposure

A similar pattern is observed in children of all exposure groups (Figure 27).

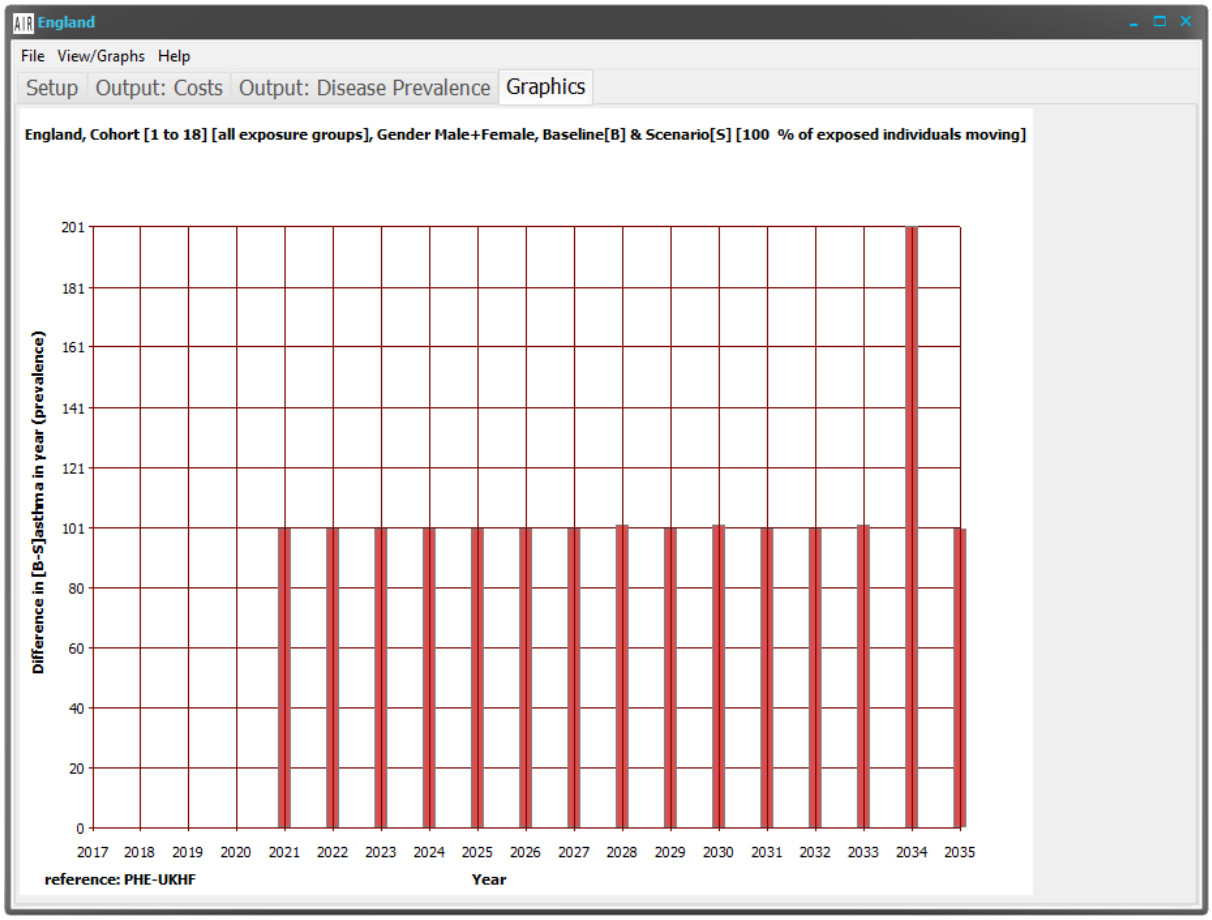


Figure 27 Asthma prevalence cases avoided as a result of moving 100% from an area of high exposure to low exposure

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