Aphekom

Health impact assessment of air pollution

Excel tool – Long-term

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1. Objectives

The Aphekom HIA excel sheets were developed as tools to help performing standardized health impact assessment (HIA) of air pollution using the latest scientific evidence, within the Aphekom project. It requires routine health and air quality monitoring data. Guidelines for creating appropriate databases are part of the WP5 deliverables.

This document provides information on how to use the excel sheet. For further information on the HIA methods and data within Aphekom, you should refer to the detailed Aphekom report.

The present document provides information on how to use the Excel sheet for computing the long-term impacts of PM2.5 on total non-external mortality and cardiovascular mortality.

We advise you to go through this document before using the tool. Please take care not to modify the excel sheets as this is likely to disrupt all calculations.
If you encounter any problem with these Excel tools, please contact Magali Corso (m.corso@invs.sante.fr) or Mathilde Pascal (m.pascal@invs.sante.fr).

2. Methods

The excel tool includes a computation of the loss in life expectancy.

The period life expectancy at age 30 is calculated using standard actuarial methodology for 5-year age groups life tables as detailed below;

Y is the number of years used, here 3.

x is the starting age in each group
n is the duration interval of each age group
n_{ax} is the the average number of years lived by those who died during the interval [., .+*n*), which is estimated by *n*/2

${}_nN_x$ is the population in each age group.

${}_nD_x$ is the total number of deaths in each age group for years 2004, 2005 and 2006.

${}_nM_x$ is the mortality rate in each age group, computed as

$${}_nM_x = \frac{{}_nD_x}{{}_nN_x * Y}$$

${}_nq_x$ is the probability of dying in the age group, estimated as

$${}_nq_x = \frac{n \times {}_nM_x}{1 + (n - n_{ax}) \times {}_nM_x}$$

For the last age group, which is open, ${}_nq_x$ =1, since everybody will die.

l_x is the number of people lived in the age group. We start from a hypothetical cohort of 100 000 people being alive at 30. The number of people alive in the other age groups is computed as;

$$l_{x+n} = l_x(1 - {}_nq_x)$$

${}_n d_x$ is the number of people who died in the age group, computed as;

$$ {}_n d_x = l_x * {}_n q_x $$

${}_n L_x$ is the number of person-years alive in each age group, computed as;

$$ {}_n L_x = n * l_{x+n} + n_{ax} * {}_n d_x $$

For the last age-group,

$$ {}_n L_x = \frac{l_x}{{}_n M_x} $$

T_x is the number of person years that the hypothetical cohort lives after reaching age *x* and is calculated recursively from the ${}_n L_x$;

$$ T_x = T_{x+n} + {}_n L_x $$

e_{30} is the life expectancy at age 30, computed as

$$ e_{30} = \frac{T_{30}}{l_{30}} $$

The impacted life table is computed with the same method, except that ${}_n D_x$ is the total number of deaths in each age group for years 2004, 2005 and 2006 when the concentrations of the specific pollutant are decreased.

$$ {}_n D_x^{impacted} = {}_n D_x * e^{-\Delta x * \beta} $$

Δx is the modification of the concentration defined by the scenario
β is the concentration response functions.
RR per 10 µg/m^3 =exp(10* β)

For PM2.5, two scenarios are considered

- Scenario 1, where the PM2.5 yearly mean is decrease to 5 µg/m^3. In that case, Δx = 5 µg/m^3
- Scenario 2, where the PM2.5 yearly mean is decreased to 10 µg/m^3. In that case, Δx= ([PM2.5]$_{mean}$ – 10 µg/m^3).
  Δx = 0 if [PM2.5]$_{mean}$ <10

Scenarios and concentration-response functions (CRFs) are detailed below and in Table 1.

Final results are expressed as as reduction in the annual number of deaths per 100 000. For total mortality, results are also expressed as an average gain in life expectancy at 30 (e_{30}) and the gain in annual total life years (e_{30} multiplied by an estimation of the population aged 30). They are both summaries of the impact of the scenarios on the mortality experience of the study population.

Table 1- Scenarios and CRFs used in the excel sheet.

HIA	Air pollution metrics	Scenario 1	Scenario 2	Health outcome	Ages	RR per 10 µg/m^3	β	Ref
Long-term impacts of PM2.5	Annual average	Decrease by 5 µg/m^3	Decrease to 10 µg/m^3	All including non-external mortality	>30	1.06 [1.02-1.11]	0.0058269	Pope and al, 2002
	Annual average	Decrease by 5 µg/m^3	Decrease to 10 µg/m^3	All cardiovascular mortality	>30	1.12 [1.08-1.15]	0.0056664	Pope and al, 2004

3. How to use the Excel tools

The tools require macros to work correctly. In Excel, you can set the level of security that is applied to macro. We suggest that you set a medium level of security when you use the tools, and that you enable the macros.

To set the level of security, go to Tools -> options -> security -> macro security

3.1. Format

The Excel file comprises four sheets and uses a colour code:

Green = sheets that need your input; environmental data, health data and population data
Blue = sheets containing data that you do not need to input, but that will be used in the computations; hypothesis
Red = results

A similar code is applied to the cells.

3.2. Input data

Before using the tool, you must define your study areas, following WP5 Deliverable D5 - Guidelines for the definition of the study are, and collect the following data;
- Total population for the study area
- Environmental data for the study area. You should follow WP5 Deliverable D5 Exposure assessment: data availability, guidelines for the calculation of exposure indicators and the study of the influence of PM correction factors
- Health data for the study area. You should follow WP5 Deliverable D5 Health data: data availability and guidelines for their use in health impact assessment.

In the examples below, we use the data from Marseille.

3.3. Sheet "1-Environmental data"

<u>It is extremely important</u> <u>to respect the format</u> of this sheet when you input your data. Otherwise, the calculations may not work.

You must input your data column by column:

- Dates: column A, from cell A4

- PM2.5 concentrations: column B, from cell B4
- PM10 concentrations, if you don't have PM2.5 concentrations; column C, from cell C4

You may add correction factor for the PM measurement method.

If you wan to use PM10 to estimate PM2.5 concentrations, you can modify the conversion factor in the tool.

Conversion factor PM10/PM2,5	0.7
PM correction factor (summer)	1.0
PM correction factor (winter)	1.0

The sheets will automatically summarize the period available, the total number of days and the number of days with valid data (i.e. not empty and not text).

3.4. Sheet "2-Health data"

Again, it is extremely important to respect the format of this sheet when you input your data. Otherwise, the calculations may not work.

You must input the annual number of cases for each group and age-groups, and for years 2004 to 2006 as illustrated below. The total between 2004 and 2006 is automatically computed.

3.5. Sheet "3-Population data"

Don't forget, it is extremely important to respect the format of this sheet when you input your data. Otherwise, the calculations may not work. Fill the green cells as appropriate.

Total population of the study area	
30-34	63 741
35-39	66 215
40-44	66 161
45-49	62 875
50-54	60 041
55-59	57 183
60-64	46 607
65-69	40 160
70-74	40 826
75-79	37 366
80-84	29 838
85 and over	22 113

3.6. Sheet "4-Hypothesis"

This sheet is for information purpose only, and summarizes the scenarios applied, and the RR that will be used.

You may modify the parameters to change the scenarios or the years used in the HIA.

Scenarios		
PM2.5	**Description of scenario**	**Parameter**
Scenario 1	Annual mean decreased by 5	5
Scenario 2	Annual mean decreased to 10	10

Years used in HIA
2004
2005
2006

3.7. Sheet "Descriptive data"

The tool automatically gives an overview of the exposure data for the whole year and by season (winter = October - March, summer = April - September), for all the years and year by year.

Exposure data	PM2,5
Number of days	748
Minimum	3
Percentile 5	7
Percentile 25	11
Median	16
Percentile 75	23
Percentile 95	35
Maximum	77
daily mean	18
Standard deviation	10

You can check the number of days available each year, and the annual means of PM2.5 for these years.

	Number of data (N) and the % of available data by year and by pollutant					
	N_PM2,5	**% of available_PM2,5**	**Year used in the HIA**	**Total number of days used in the HIA**	**Annual mean of PM2,5 for years used in the HIA**	**Number of years of PM2.5**
2004	348	95.08%	Yes	348	17.45	
2005	313	85.75%	Yes	313	17.22	
2006	87	23.84%	No			
Total	748			661	17.34	3

The tool also gives you an overview of the data used in the HIA

	N_PM2,5	% of available _PM2,5	Year used in the HIA	Total number of days used in the HIA	Annual mean of PM2,5 for years used in the HIA	Number of years	~~Annual~~ ~~n~~Number of case total mortality	Number of years of mortalit y data	Annual number of cases CV mortality	Number of years of CV mortality data
2004	348	95.08%	Yes	348	17.45		8 182		2 398	
2005	313	85.75%	Yes	313	17.22		8 371		2 424	
2006	87	23.84%	No				8 126		2 397	
Total	748			661	17.34	3	24 679	3	7 219	3

3.8. Sheet "PM2.5-Results-Total-Mortality-S1"

You can check the scenario and the impact factor, computed as $impactfactor = e^{\Delta x * \beta}$. If you want to modify the scenario, please use the hypothesis sheet.

[Pm2.5]mean	20
Δ X	5

	All (including external) mortality		
	lower	**central**	**upper**
RR	1.02	**1.06**	1.11
β	0.001980263	**0.0058269**	0.010436
Impact factor	1.009950	**0.971286**	1.053565

The tool will automatically compute the period life table from the population and health data.

NB: For convenience, the period life table and the impacted life table are masked in the results sheets. You may display them by doing the following;

- select the two first lines, which correspond to line 3 and line 65
- right-click, and select "display"

Results are summarized as:

	lower	**central**	**upper**
Period life Expectancy	52,11	**52,11**	52,11
Impacted life Expectancy	52,23	**52,47**	52,77
Life Expectancy Gain	0,12	**0,37**	0,66
Life Years Gain	1585,9	**4684,0**	8427,7

	lower	**central**	**upper**
Current Annual Number of Deaths	8226,33	**8226,33**	8226,33

Impacted Annual Number of Deaths	8145,28	7990,12	7808,09
Reduction in the Annual Number of Deaths (number)	81,05	236,21	418,24
Reduction in the Annual Number of Deaths (rate per 100,000)	13,66	39,82	70,52

3.9. Sheet "PM2.5-Results-Total-Mortality-S2"

This sheet presents the results for PM2.5, total mortality scenario 2. See
The tool also gives you an overview of the data used in the HIA

	N_PM2,5	% of available _PM2,5	Year used in the HIA	Total number of days used in the HIA	Annual mean of PM2,5 for years used in the HIA	Number of years	~~Annual~~ ~~nNumber~~ of case total mortality	Number of years of mortalit y data	Annual number of cases CV mortality	Number of years of CV mortality data
2004	348	95.08%	Yes	348	17.45		8 182		2 398	
2005	313	85.75%	Yes	313	17.22		8 371		2 424	
2006	87	23.84%	No				8 126		2 397	
Total	748			661	17.34	3	24 679	3	7 219	3

3.8. Sheet "PM2.5-Results-Total-Mortality-S1" for more details.

3.10. Sheet "PM2.5-Results-Cardiovascular-S1"

This sheet presents the results for PM2.5, cardiovascular mortality scenario 1.

The life expectancy is not computed for cardiovascular mortality.

See
The tool also gives you an overview of the data used in the HIA

	N_PM2,5	% of available _PM2,5	Year used in the HIA	Total number of days used in the HIA	Annual mean of PM2,5 for years used in the HIA	Number of years	~~Annual~~ ~~nNumber~~ of case total mortality	Number of years of mortalit y data	Annual number of cases CV mortality	Number of years of CV mortality data
2004	348	95.08%	Yes	348	17.45		8 182		2 398	
2005	313	85.75%	Yes	313	17.22		8 371		2 424	
2006	87	23.84%	No				8 126		2 397	
Total	748			661	17.34	3	24 679	3	7 219	3

3.8. Sheet "PM2.5-Results-Total-Mortality-S1" for more details.

3.11. Sheet "PM2.5-Results-Cardiovascular-S2"

This sheet presents the results for PM2.5, cardiovascular mortality scenario 2. See
The tool also gives you an overview of the data used in the HIA

	N_PM2,5	% of available _PM2,5	Year used in the HIA	Total number of days used in the HIA	Annual mean of PM2,5 for years used in the HIA	Number of years	~~Annual~~ ~~nNumber~~ of case total mortality	Number of years of mortalit y data	Annual number of cases CV mortality	Number of years of CV mortality data
2004	348	95.08%	Yes	348	17.45		8 182		2 398	
2005	313	85.75%	Yes	313	17.22		8 371		2 424	
2006	87	23.84%	No				8 126		2 397	
Total	748			661	17.34	3	24 679	3	7 219	3

3.8. Sheet "PM2.5-Results-Total-Mortality-S1" for more details.

3.12. Graphs and summary tables

The tool produces graphs of the daily concentrations of PM2.5 (sheet Graph_PM2.5) and summary tables and graphs that can be used in the city report (sheet summary).

Please remember that you should not modify the excel sheets.

If you encounter any problem do not hesitate to contact Magali Corso (m.corso@invs.sante.fr) or Mathilde Pascal (m.pascal@invs.sante.fr).