HEALTH IMPACT ASSESSMENT OF AIR POLLUTION

ENHIS-1 PROJECT: WP5 HEALTH IMPACT ASSESSMENT

LOCAL CITY REPORT

Prague

Summary of main findings for Prague

In 2001 the PM_{10} annual mean (SD) was 34 (16) µg/m^3, above the 1999/30/EC Directive limit value for 2010 (20 µg/m^3), and below that established for 2005 (40 µg/m^3). For the summer period of the same year, the mean (SD), P5 (5th percentile) and P95 of the maximum daily 8-hour moving average concentrations of ozone (O_3) were 87 (26), 49 and 134 µg/m^3.

Regarding children, infant mortality in Europe is quite low and consequently, the expected attributable number of deaths related to air pollution is also very low. All other things being equal, the reduction of the annual average levels of PM_{10} to 20 µg/m^3 would prevent 0.71 cases of total postneonatal deaths. Reducing PM_{10} daily mean values to 20 µg/m^3 would prevent 70.77 hospital respiratory admissions in children.

As far as short-term effects of O_3 in summer are concerned, all other things being equal, each reduction by 10 µg/m^3 of the daily maximum 8-hour moving average concentrations would delay 18.84 deaths per year in the general population in Prague, 15.93 cases from cardiovascular diseases, and 3.04 cases from respiratory causes. In terms of hospital admissions, this would prevent 2.55 respiratory admissions in the adult population and 8.83 cases in the population over 64 years.

Summary of HIA of outdoor air pollution in Prague in ENHIS-1

Health outcome	Population	Pollutant	Period	Mean type	RR (for 10 µg.m[3] increase)	*References*	Number of attributable cases by scenario[1]	
Mortality							**Ozone: Reduction by 10 µg.m[3]**	**PM10: Reduction by 5 µg/m[3]**
Total mortality excluding external causes (ICD9 < 800 - ICD10 A00 - R99)					1.0031 (1.0017-1.0052)		18.84	
Cardiovascular mortality (ICD9 390-459 - ICD10 I00-I99)	All ages	O_3 8h max	Summer[2]	Daily	1.0046 (1.0022-0.0073)	Gryparis et al 2004	15.93	
Respiratory mortality (ICD9 460-519 - ICD10 J00-J99)					1.0113 (1.0074-1.0151)		30 4	
Total postneonatal mortality					1.048 (1.022-1.075)	Lacasaña et al 2005		0.25
Postneonatal respiratory mortality (ICD9 460-519 - ICD10 J00-J99)	1 month-1 year	Corrected PM_{10}[3]	Year	Annual	1.216 (1.102-1.342)			0.28
Postneonatal Sudden Infant Death Syndrom Mortality (ICD9 798.0 - ICD10 R95)					1.12 (1.07-1.17)	Woodruff 1997		0
Morbidity								
Emergency room visits for asthma (ICD-9 codes 493, ICD-10 codes J45, J46)	< 18 years	O_3 1h max			1.0115 (1.0067-1.0163)	CARB 2004	not available	
Cough	< 18 years	Measured PM_{10}	Year		1.0407 (1.0202-1.0511)	Ward and Ayres 2004		not available
Lower respiratory symptoms LRS	< 18 years	Measured PM_{10}		Daily	1.0407 (1.0202 -1.617)	Ward and Ayres 2004		not available
Hospital respiratory admissions (ICD9 460-519 - ICD10 J00-J99)	< 15 years	Measured PM_{10}			1.010 (0.998-1.021)			2318
Hospital respiratory admissions (ICD9 460-519 - ICD10 J00-J99)	15 - 64 years	O_3 8h max	Summer		1.001 (0.991-1.012)	Anderson et al 2004	255	
Hospital respiratory admissions (ICD9 460-519 - ICD10 J00-J99)	> 64 years				1.005 (0.998-1.012)		88 3	

[1] For ozone : absolute reduction by 10 µg/m[3] . For PM_{10} absolute reduction by 5 µg/m[3].

[2] Definition of summer period : 01 April – 30 September

[3] PM_{10} reference papers for HIA on postneonatal mortality use gravimetric methods to measure PM_{10}. If the local air quality network uses automatic methods (TEOM or other) a correction factor is required to compensate for loss of volatile compounds: if available, a local correction factor recommended by the air quality network or, by default, the European factor 1.3.

Introduction

The city of Prague belongs to the highest polluted localities in the Czech Republic. In spite of that the total amount of emissions has considerably decreased in the past few years, the air quality remains one of the greatest environmental problems. Considering the high density of the population the important health risk exists by broad as well as by local excess of the limit values. The greatest share on the air pollution have the mobile sources (automobile traffic) treated to be hardly controllable.

The capital of Prague has a different situation compared to other regions due to number of special medical facilities but also the oldest age structure, the highest employment rate etc. All these factors influence the health indicators. The most frequent death cause are the circulatory system diseases (47.0 % in males and 57.5 % in females), of them most ischemic heart disease. The second cause of death are malignant neoplasms (29.9 % in males, 24.3 % in females). In both genders the MN incidence has an increasing trend. In 2001, 661.5 new cases per 100,000 in males (268 per 100,000 , European standard) and 677.1 cases per 100,000 in females (177 per 100,000, European standard) were notified. There were three diagnoses with highest number of new cases in Prague in comparison with other regions in 2001: MN of prostate in males, MN of breast and MN of lung and bronchus in females.

The infant mortality was 2.5 per thousand of living births, the total number in Czechia is 3.9 per thousand. The most frequent causes were some conditions arose in perinatal period (64 % of cases).

The numbers of followed-up (dispenzarized) children has been increasing in Prague, it was 47,633 (32,0 % of child population) in 2003. The number of dispenzarized adolescents amounted to about 20,000 (30,6 % persons 15 - 19 years of age).The respiratory diseases are most frequent in children and adolescents; 9,383 dispenzarized diseases per 100,000 children and 7 206 per 100,000 adolescents in 2003. On the second place therewere diseases of skin and hypodermic ligament, in adolescents there were diseases of nervous system and sensory organs. The number of dispenzarized children for asthma bronchiale was 3 878, for asthma of allergic origin it was 4 463,6 per 100,000 children 0-14 years of age. This rates are double in comparison with the republic average. On the other hand, the number of congenital malformations in Prague are under the national average value.

As the short term of air pollution effects by ground ozone there are presented the numbers of preventable cases of total, cardiovascular and respiratory mortality in the general population, and hospital respiratory admissions in children, adults and seniors when reduction to/by certain concentration value would be achieved. In case of PM_{10} air pollution as short term effects the preventable cases of hospital respiratory admissions in children are assessed; as the long-term effects the total and respiratory postneonatal mortality were considered.

This work has been carried out within the framework of work package WP5 on health impact assessment of ENHIS-1 project (www.enhis.net).

Sources of air pollution

Sources generating atmospheric pollutants are monitored within the so-called Air Pollution Sources Register. Large pollution sources are distributed unevenly across the territory of Prague. The step up increase in the number between the years 1985 and 1992 was mostly caused by the construction of block heating stations on new Prague housing estates. On the other hand, the decrease in the number of large pollution sources in 1998 to 2002 is a result of the implementation of the largest co-generation project in the whole Europe – the interconnection of heating systems of Melník and Prague. The number of mid-sized sources has been stagnating in recent years. The highest numbers of mid-sized sources are located in older buildings in the City centre.

There has occur the long-term emission reduction in particulate matter, sulphur dioxide, and nitrogen oxides from stationary sources. This favourable trend results partly from the decrease in fuel consumption (higher utilisation of heat from the heat supply mains Melník - Praha, heat savings at end consumers, decrease in industrial production output after 1990, etc.), and partly from the change in fired fuel structure (replacing solid fuels by gaseous fuels) and efficient operations (reconstruction and modernisation of boilers). Furthermore, other reason is the pressure of economic and legislative measures aimed at emission reduction from these sources. Due to high stacks of large emission sources their contribution to air pollution is manifested over much larger territory than that of mid-sized sources and small ones, which exert pollution load to their very surroundings. The main share of emissions is accounted, apart from the Radotín Cement Plant and the Malešice Incineration Plant, and several industrial sources generating smaller emission volume, to the plants of the Prague Heat Utility Company. The largest stationary emission source located on the territory of the City of Prague is the Prague Heat Utility Company – the Malešice Co-Generation Plant. Its dominant share in total emissions has been maintained despite the fact that two low-rank coal boilers were retrofitted to be able to burn a high quality, low-sulphur hard coal in 1997–1999, including the installation of new electric precipitators and a covered fuel stock and so the volume of SO_2 emissions as well as particulate matter emissions were substantially reduced.

At present the automotive traffic is the most important source of air pollution on the territory of Prague. Traffic emissions were calculated within the regular update of the project "Model air quality assessment on the territory of the City of Prague".

Since autumn 1997 the Smog regulation system has been performed. In the last several years no smog episode was recorded.

Air pollution with particulate matter remains one of the great problem in Prague in light of the legislative requirements. Till 1999, the decreasing trend in PM_{10} air pollution was performed. After the year 2000 this trend stopped and gradual growing of conc entrations on the most of stations took place. In 2001 a part of the centre of the City of Prague was, similarly as in the past years, with regard to the level of SPM concentration values measured and to the current limit values exceeded at two Public Health Service stations, the most affected area in the Czech Republic. On the other hand, the other parts of Prague, and namely the outskirts, recorded relatively low levels (below one half of the annual limit value). Two stations, Svornosti in Prague 5 and Sokolovská in Prague 8, registered a significant exceeding of the annual limit value again. These stations are situated at severely exposed localities where there is direct impact of traffic. In 2000 and 2001 the SPM air pollution in Prague was quite comparable, slight decrease in PM_{10} concentrations was recorded at certain stations.

In 2001 the maximum 8hour concentration fell between the highest value of 151 $\mu g.m^{-3}$ recorded at the Station Vysocany, Prague 9 on 27 June 2001 and the lowest value of 122 $\mu g.m^{-3}$ recorded on 25 August at the Station Kobylisy, Prague 8.

Exposure data

The ground-level pollution of air has been monitored by the measurement network operated by Czech Hydrometeorological Institute (CHMI) through the Air Quality Information System of the Czech Republic (ISKO). The station registration update including the update of types of measurements at the registered stations is carried out every year. The air pollution data stem from the database of ISKO.

Measurement techniques applied for PM10 determination is radiometry – beta ray absorption, for ground ozone UV absorption photometry. The quality assurance of air pollution measurements by means of automated methods and their calibration and the subsequent quality control of the obtained data are in charge of the Central air pollution laboratories by CHMI . The quality of the measured data is assured at all levels. Air pollution data submitted to ISKO are checked in compliance with the operational rules of ISKO air pollution data administration. The measured data are checked twice: first, monthly control is in charge of the regional network administrator. The second control is implemented by ISKO, namely for each quarter of the year. Both procedures are based on control of formal and logic parameters aimed at the detection and elimination of gross errors which could affect the statistical characteristics of the data file.

Ground-level ozone has been monitored in the monitoring network since 1992. In 2001 , the total number of six monitoring stations were under operation in Prague. All of them has been operated by the Czech Hydrometeorological Institute.

The daily maximum 1-hour ozone indicator has been calculated as the arithmetic mean of the 1-hour maximum of the stations. The daily maximum 8-hour moving average of each day have been calculated as the arithmetic mean of the maximum 8 hour moving averages of the stations for the summer period (1st April to 30th September). The mean (SD) , P5 and P95 of the daily maximum 8hour moving average concentrations of O_3 w ere, respectively, 87 (26), 49 and 134 $\mu g/m^3$, and those of the daily maximum 1-hour concentrations 74 (32), 31 and 133 $\mu g/m^3$ (Table 1 and figures 1-2). The value of legislative requirement according to the Government Order No. 350/2002 (har monized with EU directives), 120 $\mu g/m^3$ 25x in a 3-years average, were in case of max 8h moving average – summer- not exceeded. The most frequent concentration interval was 100 – 110 with the frequency of 28 days. For 1-h mean O_3 concentration there exists no limit value, the most of days were in the concentration limit of 60 – 70 $\mu g/m^3$ - 53 days.

Suspended particulate matter PM10 had been monitored at 12 measuring stations in 2001, operated by Czech Hydrometeorological Institute. Daily PM_{10} exposure indicator has been calculated as the arithmetic mean of the daily concentrations of the stations. In 2001, the annual mean level (SD) of PM_{10} in Prague was 34 (16) $\mu g/m^3$, and P5 and P95 of the daily mean values were, respectively, 17 $\mu g/m^3$ and 61 $\mu g/m^3$. For more statistic characteristics, see Table 1.

The annual average concentration of PM_{10} from all the measuring stations in Prague did not exceed the limit according to the EU legislative requirements. Nevertheless, the average value of daily levels exceeded the 24-h limit 56 times, that is more than the requirement of the maximum of 35 exceeding cases. On the particular highly polluted stations the situation can be worse, namely in the central City districts of Prague 2, 5 and 10.

In 2001, the average 24-h concentrations of PM_{10} in Prague ranged in interval of 11 to 123 µg/m^3, the maximum frequency of days ranged in the interval from 20 to 30 µg/m^3 (123 days). The distribution of daily concentrations levels is shown on Fig. 3.

Table 1. Descriptive statistics for ozone and PM_{10} levels in Prague in 2001

	O3 8h - summer	O3 1h max - year	PM10 - year
Number	183	365	365
Minimum	31	6	11
Percentile 5	49	31	17
Percentile 25	67	50	23
Median	85	69	30
Percentile 75	104	91	44
Percentile 95	134	133	61
Percentile 98	145	158	79
Maximum	153	172	123
Daily mean	87	74	34
standard error	26	32	16
% missing values	0,00%	0,00%	0,00%

Fig 1. Distribution of daily O_3 8h max in Prague. Summer 2001

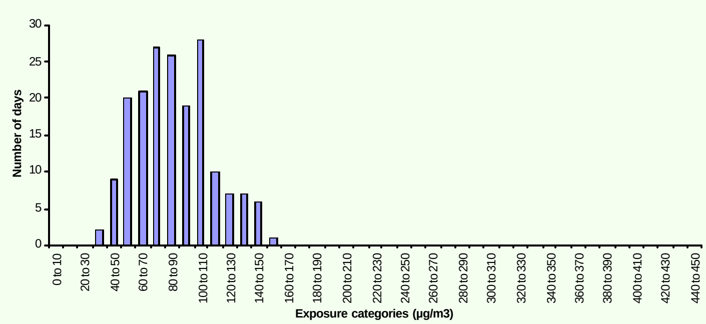


Fig 2. Distribution of daily O3 1h max in Prague.
Summer 2001

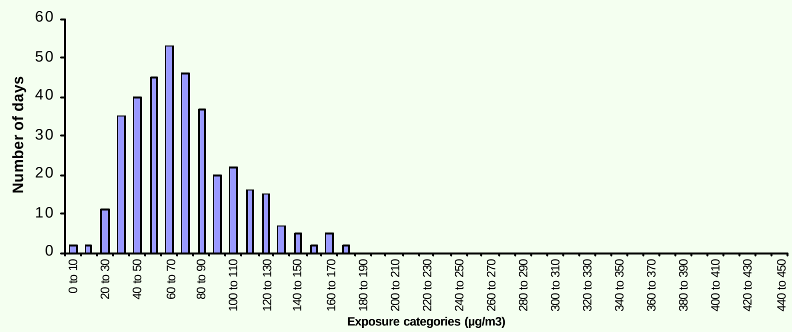
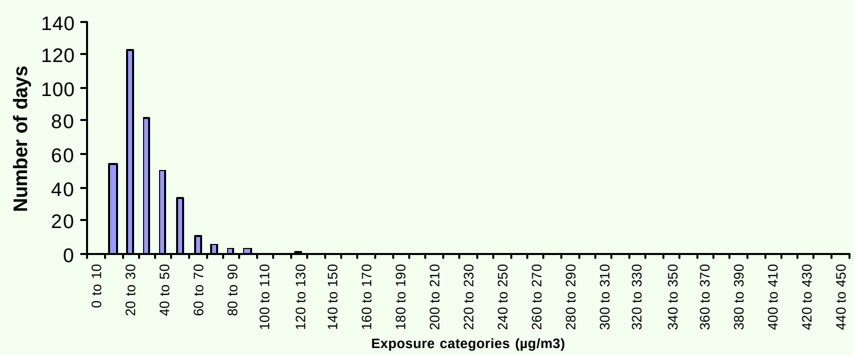


Fig 3. Distribution of PM_{10} in Prague.
2001



Health data

The data on mortality stem from the Czech Statistical Office (CSO) - Register of deaths. The 100% data complexity is assumed as there is legislatively stipulated a notification duty of each death. The data are processed only for persons with permanent residence in Czechia. Czech Statistical Office maintained checking of mortality data on Registry Office data. CSO is manually coding and than processing only the primary death cause according to the WHO rules. The used data stem form the year 2001 , pursuant to the air pollution data.

The morbidity (hospital data) stem from the National Health Information System, component part of which are National health registers, in case of used data the Register on hospitalizations. It is realized as obligatry notification on the base of finished cases of hospitalization in particular hospital sections. The data are from the year 2001. The checking for data completness is made according to the particular departments of hospitals. On the central level, the checking linkages of diagnoses and age/gender has been performed.

Data on cough and lower respiratory syndroms as well as data on emergency room visits are not processed in this paper as there is no reporting prescribed.

The numbers of postneonatal death in Prague is relatively low (see Table 2), that's also why lowering the pollutant concentrations does not bring such a marked effect in this point. There was no case of reported Sudden Death Syndrome in 2001 in Prague.

In Prague the standardized mortality is lower than in other regions in Czechia (daily rate 2.9), namely in case of cardiovascular mortality. The daily rate per 100,000 population amounted to 1.67 in Prague, it represents more than one half of all death cases. Standardized rates of respiratory mortality are in comparison to other Czech regions in the middle position. The daily mean of cases in Prague are presented in Table 2.

The situation in number of hospitalized persons cannot be compared with data from other regions as in Prague operate a number of attraction medical facilities for surrounding territory or even the whole republic.

Table 2. Descriptive statistics for health outcomes in Prague in 2001

Health outcome	ICD9	ICD10	Annual deaths	Annual rate (per 100 000)	Daily mean (SD)	Daily rate (per 100 000)	Annual incidence rate (per 100 000)
POSTNEONATAL MORTALITY							
Total			11	113.6	0.0301	0.311	
Respiratory *ICD9 460-519 ICD10 J00-J99*	460-519	J00-J99	3	31	0.0082	0.0849	
Sudden infant death syndrome *ICD9 798.0 –ICD10 R95*	798.0	R95	0	0	0	0	
GENERAL POPULATION MORTALITY							
Total mortality all causes *ICD9 <800 ICD10 A00-R99*	<800	A00-R99			34 (6.043)	2.9	12410
Cardiovascular mortality *ICD9 390-459 ICD10 I00-I99*	390-459	I00-I99			19.6 (4.703)	1.67	7154
Respiratory mortality *ICD9 460-519 ICD10 J00-J99*	460-519	J00-J99			1.6 (1.332)	0.13	584
MORBIDITY							
Cough					not available		
Lower respiratory symptoms LRS					not available		
Emergency room visits for asthma - Age < 18 years *ICD9 493, ICD10 J45 J46*	493	J45-J46			not available		
Hospital respiratory admissions - Age < 15 years *ICD9 460-519 ICD10 J00-J99*	460-519	J00-J99			13.11	8.490	2996.40
Hospital respiratory admissions - Age 15 - 64 years	460-519	J00-J99			14.03	1.697	619.51
Hospital respiratory admissions - Age > 64 years	460-519	J00-J99			10.03	5.205	1899.99

Health Impact Assessment

Methodology

Health impact of air pollution (AP) has been calculated as the annual number of health events attributable to AP in the target population. A causal relationship between AP and the effects is assumed, and therefore HIA can only be performed for those outcomes with sufficient evidence of causality. Once the effects with sufficient evidence of causal relationship with AP have been determined, the next step is to find the best exposure-response functions (ERFs) for each of the selected outcomes. Table 3 shows the result of a systematic review on these issues carried out by the Bilbao Apheis team[1] for WP5 of ENHIS-1. This table summarizes the health outcomes and ERFs deemed suitable for HIA according to the criteria established by WP5 with the advice of the air pollution experts of WP5[2].

Table 3. Health outcomes and Exposure-response functions (ERFs) selected for health impact assessment

	OUTCOME	POLLUTANT	ERFs	ORIGINAL SOURCE
CHILDREN - PARTICLES				
	Total postneonatal mortality (1 month-1 year)	PM_{10} Annual Mean	RR=1.048 (1.022-1.075) ?10µg/m^3	Lacasaña et al 2005
	Postneonatal respiratory mortality ICD9 460-519 ICD10 J00-J99	PM_{10} Annual Mean	RR=1.216 (1.102-1.342) ?10µg/m^3	Lacasaña et al 2005
	Postneonatal Sudden Infant Death Syndrome (SIDS) mortality (normal birth weight=2500g) ICD9 798.0 –ICD10 R95	PM_{10} Annual Mean	Adjusted Odds Ratio AOR=1.12 (1.07-1.17) ?10µg/m^3	Woodruff et al. 1997
	Cough	PM_{10} Daily Mean	OR=1.041 (1.020-1.062) ?10µg/m^3	Ward & Ayres 2004
	Lower respiratory symptoms LRS	PM_{10} Daily Mean	OR=1.041 (1.020-1.051) ?10µg/m^3	Ward & Ayres 2004
CHILDREN – OZONE				
	Emergency room visits for asthma <18 Y ICD9 493, ICD10 J45 J46	Ozone Maximum 1 h	RR=1.0116 (1.0067-1.0165) ?10µg/m^3	CARB 2004
ADULTS/GENERAL POPULATION				
	Total mortality all causes ICD9 <800 ICD10 A00-R99	Ozone Maximum 8 h Summer	RR= 1.0031 (1.0017-1.0052) ?10µg/m^3	Gryparis et al 2004 (APHEA 2)
	Respiratory mortality ICD9 460-519 ICD10 J00-J99	Ozone Maximum 8 h Summer	RR= 1.0113 (1.0074-1.0151) ?10µg/m^3	Gryparis et al 2004 (APHEA 2)
	Cardiovascular mortality ICD9 390-459 ICD10 I00-I99	Ozone Maximum 8 h Summer	RR= 1.0046 (1.0022-1.0073) ?10µg/m^3	Gryparis et al 2004 (APHEA 2)

To be coherent with mortality findings, it was decided, with the experts' advice, to include RRs of hospital admissions in the health impact assessment calculations, even if they were not statistically significant. More concretely, it was decided that if there was not any new RR published by the time of making the calculations, the RRs for respiratory hospital admissions from Anderson's meta-analysis could be used, although they were not statistically significant (see Table 2). The rationale for that is that if there is sufficient evidence to accept a causal relationship between air pollution and respiratory mortality -both in children-PM and adults-O_3- we should easily accept that there will also be an impact on hospital admissions.

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1 Cambra K, Alonso E, Cirarda FB, Martínez-Rueda T. Bilbao APHEIS group. Selection of outcomes and exposure response functions for health impact assessment of particles and ozone. Review of the evidence. ENHIS project. WORK PACKAGE 5. Bilbao, February 2005. Http:

2 Ferran Ballester: Valencian School of Health Studies, Valencia, Spain; Sylvie Cassadou: National Institute of Public Health Surveillance, InVS, Toulouse, France; Fintan Hurley: Institute of Occupational Medicine, Edinburgh, Scotland, UK; Nino Künzli: University of Southern California, Division of Occupational and Environmental Health, Los Angeles, CA, USA; Odile Meckel: Institute of Public Health NRW (LOEGD), Bielfeld, Germany; Hans-Guido Mücke: WHO Collaborating Center (Air)-Federal Environmental Agency, Berlin, Germany; Nikolaos Stilianakis: Institute for Environment and Sustainability, European Commission – JRC, Ispra, Italy.

Table 4. Complementary Exposure-response functions (ERFs) for health impact assesment on respiratory hospital admissions for children (particles) and adults (ozone)

	OUTCOME	POLLUTANT	RR	SOURCE
CHILDREN - PARTICLES				
	Respiratory hospital admissions 0-14 Y ICD9 460-519 ICD10 J00-J99	*PM_{10}* Daily Mean	*RR= 1.010 (0.998-1.021) ?10µg/m^3*	*Anderson 2004*
ADULTS/GENERAL POPULATION				
	Hospital respiratory admissions 15-64 Y ICD9 460-519 ICD10 J00-J99	*Ozone Maximum 8 h*	*RR=1.001 (0.991-1.012) ?10µg/m^3*	*Anderson et al 2004*
	Hospital respiratory admissions >64 Y ICD9 460-519 ICD10 J00-J99	*Ozone Maximum 8 h*	*RR=1.005 (0.998-1.012) ?10µg/m^3*	*Anderson et al 2004*

Finally, HIA needs defining the evaluation scenarios, i.e. the hypothetical scenario with which we want to compare the current air pollution situation. We calculate the impact on health of the (current) air pollution levels in the city that are above the pollution level of the evaluation scenario. In other words, the attributable number of health events (deaths, hospital admissions…) calculated for each scenario represents the number of events that would be prevented if, all other things being equal, air pollution levels were reduced to the evaluation scenario level. These evaluation scenarios are based on the objectives and limits established in 1999/30/CE, and 2002/3/CE Directives.

HIA scenarios

1 - HIA scenarios for PM_{10}

1.1.- Scenarios for HIA on **short-term** effects of PM_{10} and **cough, lower respiratory symptoms** in people under 18 year (<18), and **hospital respiratory admissions** in people under 15 year (<15)

1.1.1 Reduction of PM_{10} levels to a 24-hour value of **20 µg/m^3** in all days exceeding this value (Limit of 1999/30/CE Directive)

1.1.2. Reduction of PM_{10} levels to a 24-hour value of **50 µg/m^3** in all days exceeding this value

1.1.3 Reduction **by 5 µg/m^3** of all the 24-hour values

1.2.- Scenarios for HIA on **long-term** effects of PM_{10} and **postneonatal mortality** (total, respiratory and sudden infant death syndrome-SIDS)

1.2.1 Reduction of the annual mean value of PM_{10} to a level of **40 µg/m^3** (Limit of 1999/30/CE Directive for 2005)

1.2.2 Reduction of the annual mean value of PM_{10} to a level of **20 µg/m^3** (Limit of 1999/30/CE Directive for 2010)

1.2.3 Reduction **by 5 µg/m^3** of the annual mean value of PM_{10}

2.- HIA scenarios on short-term effects of Ozone

1.2.1 Daily maximum 1-hour concentration and **emergency room visits for asthma** in people under 18 year (< 18)

1.2.1.1 Reduction of O_3 daily maximum 1-hour concentrations to a level of **180 µg/m^3** in all days exceeding this value (Information threshold of 2002/3/CE Directive)

1.2.1.2 Reduction **by 10 µg/m^3** of the daily maximum 1-hour concentrations

1.2.2 Daily maximum 8-hour moving average concentration and **mortality** in general population and **hospital respiratory admissions** in adults and elderly.

1.2.2.1 Reduction of O_3 daily maximum 8-hour moving average concentrations to **120 µg/m^3** in all days exceeding this value (Limit for health protection of 2002/3/CE Directive)

1.2.2.2 Reduction **by 10 µg/m^3** in the daily maximum 8-hour moving average concentrations.

Findings

The annual number of postneonatal deaths attributable to PM_{10} annual levels higher than 20 ?g/m^3 was 0.71 (95%CI: 0.33-1.12), which is equivalent to an annual rate of 7.40 deaths per 100 000 (95%CI: 3.37-11.63). The number of preventable respiratory admissions, rated as short-term health effect, could be in children to 15 years of age about 10 cases by reducing all daily concentrations to the level of 50 µg/m^3 and about 70 cases by reducing the daily levels to 20 µg/m^3. The numbers of attributable cases for PM_{10} air pollution are shown in Table 5.

Table 5. Potential benefits of reducing PM_{10} levels. Absolute numbers and rates (per 100 000 children) (95% confidence limits) attributable to the health effects of PM_{10}.

	PM_{10} reduction	**Number of attributable cases per year**	**Annual rates (per 100.000)**
POSTNEONATAL MORTALITY	**Annual mean levels**		
Total	by 5 µg/m^3	0.25 (0,12-0,39)	2.63 (1.21-4.08)
	to 20 µg/m^3	0.71 (0,33-1.12)	7.40 (3.37-11.63)
	to 40 µg/m^3	NA	NA
Respiratory	by 5 µg/m^3	0.28 (0.14-0.43)	2.89 (1.40-4.46)
	to 20 µg/m^3	0.73 (0.34-1.19)	7.61 (3.51-12.33)
	to 40 µg/m^3	NA	NA
SIDS	by 5 µg/m^3	no case reported	-
	to 20 µg/m^3	-	-
	to 40 µg/m^3	-	-
MORBIDITY	**Daily levels**		
Cough <18 y	by 5 µg/m^3	not available	
	to 20 µg/m^3		
	to 50 µg/m^3		
LRS <18 y	by 5 µg/m^3	not available	
	to 20 µg/m^3		
	to 50 µg/m^3		
Hospital respiratory admissions <15 y	by 5 µg/m^3	23.18 (-4.65-48.54)	15.01 (-3.01-31.44)
	to 20 µg/m^3	70.77 (-13.98-150.37)	45.83 (-9.05-97.38)
	to 50 µg/m^3	9.84 (-1.95-20.88)	6.37 (-1.26-13.52)

Regarding short-term effects of ground ozone, each reduction by 10 µg/m^3 of daily maximum 8-hour moving average concentrations would delay 18.84 (95%CI: 10.33-31.60) deaths per year in Prague, 15.93 (95%CI: 7.62-25.28) from cardiovascular diseases, and 3.04 (95%CI: 1.99-4.06) from respiratory causes.

As regards the hospital respiratory admissions, the decrease of daily 8-h max ozone levels by 10 µg/m^3 could prevent 2.55 cases in adults and 8.83 cases in elderly. The detailed results are described in Table 6.

Table 6. Potential benefits of reducing ozone daily levels. Absolute numbers and rates (per 100 000 inhabitants) (95% confidence limits) attributable to the health effects of ozone.

	OZONE reduction	**Number of attributable cases per year**	**Annual rates (per 100.000)**
MORTALITY	**Daily 8-h max**		
Total (excluding external causes)	by 10 µg/m^3	18.84 (10.33-31.60)	1.61 (0.88-2.69)
	to 120 µg/m^3	3.27 (1.79-5.49)	0.28 (0.15-0.47)
Cardiovascular	by 10 µg/m^3	15.93 (7.62-25.28)	1.36 (0.65-2.15)
	to 120 µg/m^3	2.81 (1.34-4.47)	0.24 (0.11-0.38)
Respiratory	by 10 µg/m^3	3.04 (1.99-4.06)	0.25 (0.16-0.33)
	to 120 µg/m^3	0.58 (0.38-0.77)	0.05 (0.03-0.06)
MORBIDITY	**Daily 1-h max**		
Emergency room visits for asthma <18 y	by 10 µg/m^3	not available	not available
	to 180 µg/m^3		
	Daily 8-h max		
Hospital respiratory admissions 15-64 y	by 10 µg/m^3	2.55 (-22.93-30.57)	0.31 (-2.77-3.70)
	to 120 µg/m^3	0.43 (-3.87-5.21)	0.05 (-0.47-0.63)
Hospital respiratory admissions > 64 y	by 10 µg/m^3	8.83 (-3.53-21.20)	4.58 (-1.83-11.00)
	to 120 µg/m^3	1.57 (-0.62-3.77)	0.81 (-0.32-1.96)

NA: Not applicable - if air pollution levels are lower than the scenario level

Discussion

The basic concept documents for reducing air pollution in Prague are Long-term plan of air protection in capital city of Prague which represents a strategic material for preparing program documents. Recently is handled the Integrated regional program of emissions reduction and the Integrated regional program of improving outdoor air quality in Prague. These programs content the analysis of current situation, model of next air pollution development and the tools and measures of various kinds to improve the air quality and so reduce the burden from air pollution in Prague. Also the National Environmental Health Action Plan set a number of actions middle term as well as long-term to improve outdoor air quality generally, e.g. to focus on lowering emissions from small-scale stationary sources, or to limit the effects of traffic on air quality through planning and organization, particularly in residential areas. The national program document Health 21 in the goal 10 formulates the objective to ensure safer environment where the pollutant concentrations will not exceed the internationally declared limits till 2015.

In the HIA there is missing some processed health outcomes although the correlations of dose (potential exposure from outdoor air) and response were confirmed. Cough and lower respiratory symptoms are not a matter of regular reporting within the dispenzarized diagnoses. Such data have been collected within various health questionnaire surveys, e.g. in the frame of Environmental Health Monitoring System, but such data are not available in Prague so far. A similar situation is concerning emergency room visits.

The data on the number of hospitalizations can be somewhat overestimated concerning Prague residents, as in Prague operate a number of attraction medical facilities for surrounding territory or even the whole republic, and the data on hospitalizations stem from notifications of the particular hospital departments according to their quarters.

Conclusion

Health impact of air pollution in the city of Prague was estimated by means of the annual number of health events attributable to air pollution. Such health outcomes were took into account, for w hich sufficient evidence of causality w as proved and the exposure-response functions w ere recommended by the expert group of the international project ENHIS – WG5. The long-term health effects, such as postneonatal mortality, total and respiratory, and the short–term effects, such as mortality (total, cardiovascular and respiratory) and the hospital admissions for respiratory diseases were considered to HIA.

Owing to the relatively low postneonatal mortality, the effect of reducing air-born particulate matter PM_{10} annual concentrations to the level of 20 µg/m^3 on this health outcome would be relatively slight, less than 1 case of the total as well as of the respiratory postneonatal mortality. The number of preventable cases of hospital respiratory admissions in children is estimated to about 10 cases per year in case of decrease of daily PM_{10} concentrations on 50 µg/m^3 .Relatively high effect on reduction of hospital respiratory admissions in children has a potential decrease of all daily PM_{10} concentrations to the level of 20 µg/m^3, expressed in numbers it is about 70 cases.

Ground ozone daily 8-h maximum concentrations reduction by 10 µg/m^3 could prevent relatively marked number of deaths cases, total as well as from cardiovascular diseases. Number of preventable hospital respiratory admissions is remarkable namely in elderly (over 64 years of age), namely 8.83 cases.

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