HEALTH IMPACT ASSESSMENT OF AIR POLLUTION

ENHIS-1 PROJECT: WP5 HEALTH IMPACT ASSESSMENT

LOCAL CITY REPORT

Cracow

Summary of main findings for Cracow

In 2001 the PM_{10} annual mean (SD) was 42.2 (24) µg/m^3, much above the 1999/30/EC Directive limit value for 2010 (20 µg/m^3), and a bit above 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 concentration of ozone (O_3) were 62(24), 23 and 102 µg/m^3 , respectively.

Infant mortality in Cracow as 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 one total postneonatal death.

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 10 deaths per year in the general population in the study area, 8 from cardiovascular diseases, and 1 from respiratory causes.

Summary of HIA of outdoor air pollution in Cracow 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)	All ages	O_3 8h max	Summer[2]	Daily	1.0031 (1.0017-1.0052)	Gryparis et al 2004	10	
Cardiovascular mortality (ICD9 390-459 - ICD10 I00-I99)					1.0046 (1.0022-0.0073)		8	
Respiratory mortality (ICD9 460-519 - ICD10 J00-J99)					1.0113 (1.0074-1.0151)		1	
Total postneonatal mortality	1 month-1 year	Corrected PM_{10}[3]	Year	Annual	1.048 (1.022-1.075)	Lacasaña et al 2005		0.25
Postneonatal respiratory mortality (ICD9 460-519 - ICD10 J00-J99)					1.216 (1.102-1.342)			0.09
Postneonatal Sudden Infant Death Syndrom Mortality (ICD9 798.0 - ICD10 R95)					1.12 (1.07-1.17)	Woodruff 1997		0.16
Morbidity								
Emergency room visits for asthma (ICD-9 codes 493, ICD-10 codes J45, J46)	< 18 years	O_3 1h max	Year	Daily	1.0115 (1.0067-1.0163)	CARB 2004	not available	
Cough	< 18 years	Measured PM_{10}			1.0407 (1.0202-1.0511)	Ward and Ayres 2004		not available
Lower respiratory symptoms LRS	< 18 years	Measured PM_{10}			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)	Anderson et al 2004		not available
Hospital respiratory admissions (ICD9 460-519 - ICD10 J00-J99)	15 - 64 years	**O_3 8h max**	Summer		1.001 (0.991-1.012)		not available	
Hospital respiratory admissions (ICD9 460-519 - ICD10 J00-J99)	> 64 years				1.005 (0.998-1.012)		not available	

[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

Cracow, a historical city in the south of Poland with the population of almost 750 000 inhabitants is situated in the Vistula river valley. The topography favours atmospheric inversion with frequent trapping of moisture and fog. The beginnings of the city date back to the medieval times and its original lay out with very high-density housing and narrow streets in the city centre has been preserved. With the addition of big metallurgical factory and two power plants located nearby for a long time it has been known as a most polluted city within the country. In the recent years som e effort has been made on the local as well as on international level to improve the air quality in the city. As the result of international collaboration with the USA Environmental Protection Agency the automatic monitoring system was set up at the beginning of the nineties, and a lot of scientific research on air pollution health effects has started since then. One of the aims was to call attention of local authorities to the current situation in this subject.

According to the statistics almost 7000 people died in Cracow in 2001. Among them 49% were men and 74% were above 65 years of age. Cardiovascular diseases still remain the most common cause of death (50%) with malignant neoplasms in the second place. Cancer was responsible for 26% mortality in women and 29% in men. Injures and poisoning caused 6.5% deaths at all ages and they predominated in men. Diseases of respiratory system caused 3% of all deaths in 2001.

The health of children and young people is fundamental to their well-being and development. Different indicators, including birth outcome (low birth weight) and mortality rates, measure of children health.

Low-birth weight infants are at higher risk of death or long-term illness and disability than are infants of normal birth weight. The percentage of infants born with low birth weight was 5.8 in 2001 compared with the respective 5.5 in 2000. Infant mortality in 2001 in Cracow , defined as the death of an infant before her/his first birthday was 7.6 deaths per 1000 live births, and was higher than the respective 6.2 deaths recorded for 2000. About 75% of infant deaths occurred in the first month after birth and were mostly due to preterm delivery or birth defects.

The death rate for children ages 1-4 was 16.4 per 100 000 children. For older children, aged 5-14, the rate was 18 per 100 000. The leading cause of death for both age groups was injury, accounting for more than half of the deaths (51.7%), followed by birth defects (17.2%), and cancer (10.3%).

The results of the earlier health impact assessment (HIA) of air pollution done within the APHEIS project for the city of Cracow clearly demonstrated the benefits of reducing particulate matter exposure on a local scale. The investigations concentrated on the impact of exposure to different fractions of particulate matter on total and cause-specific mortality in general population in the very short, short, and long terms of observation .

It was shown that the reduction of the long-term PM pollution to the levels of PM2.5 of 15 mg/m^3 would reduce mortality in Cracow by 636 deaths in one year, and thus save 1.1 years of expected life for starting year of simulation. This estimate represents about 10% of the annual burden of mortality. In case of the short-term exposure, daily means of PM10 below 20 mg/m^3, would allow to avoid 50 premature deaths including 38 deaths from cardiovascular diseases.

The estimates of the 'preventable' deaths provided evidence for the meaningful effect of the particulate pollution on the total burden of mortality in Cracow.

Current report includes the results of the HIA of particulate matter pollution PM10 in infant and children subpopulation as well as estimates of additional deaths in adult population that could be attributed to photochemical ozone episodes in Cracow in 2001.

The study 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

Combustion of fossil fuel for heating and energy production as well as industrial processes are the major contributors to the suspended particulate matter in Cracow. With the quickly growing numbers of cars and traffic congestion problems within the city, road transport is becoming an increasingly important source of particles as well. However, there has been a steady decrease in particulate matter emissions in Cracow since the beginning of the 1990s. In particular, in 2001 particulate matter emission was 13% lower than the year before. Similar downward trend is observed in emissions of gaseous pollutants (i.e. SO_2, NOx and CO).

Despite the considerable decrease in emissions of particulate matter over the past decade, limit concentrations of PM in ambient air (annual mean and 24-hour concentrations) set by EU continue to be exceeded, in particular in winter months. Averaged concentrations of black smoke for the cold months are more than four times higher than those for the warm season. In the case of PM10, the corresponding difference is about 25%.

Tropospheric ozone, the most irritant of the common ambient air pollutants, is produced during summer time by the interaction of oxides of nitrogen and VOC in the presence of sunlight. Although very high ozone concentrations are not noted in Poland, almost every year, several episodes of increased ozone levels are recorded. In Cracow, after the high annual mean concentration value recorded in 1999 (63 µg/m^3), ozone level stabilised at the annual mean level of 38 µg/m^3 in 2000 and 37µg/m^3 in 2001. However, it should be borne in mind that ozone concentration patterns vary significantly from one year to another and it is highly depended not only on its precursors concentrations in ambient air but also on variations in weather conditions.

Exposure data

The exposure data consist of daily measurements of particulate matter fraction PM10 and ozone concentrations for the year 2001.

Apheis guidelines on exposure assessment were fulfilled for all monitoring stations operated in Cracow in 2001 with respect to the completeness criteria. All of them, but one, were located in different residential areas of the city and were not directly influenced by local sources of air pollution. The station measuring pollution from transport sources was excluded.

Data on daily (24-hour) concentrations of PM10 were obtained from 3 monitoring stations. The stations applied automatic PM10 measurements based on the ß-ray absorption method. The everyday readings were systematically corrected to compensate losses of volatile compounds so the correction factor has not been applied to the PM10 measurements data. PM_{10} daily exposure indicator has been calculated as the arithmetic mean of the daily concentrations of the all stations.

Ozone exposure data were obtained from one monitoring station located on the outskirts of the city. The daily maximum 1-hour concentration and the daily maximum 8-hour moving averages have served as an exposure indicators for current analysis. The latter one has been calculated for each day of the summer period (1st April to 30th September).

Air Pollution data description

The annual mean level (SD) of PM10 in Cracow was 42.2 (24.0) µg/m^3, and P5 and P95 of the daily mean values were, respectively, 15.5 µg/m^3 and 82.0 µg/m^3. The mean (SD) , P5 and P95 of the daily maximum 8-hour moving average concentrations of O_3 were, respectively, 62.1 (23.4), 27.5 and 102.5 µg/ m^3, and those of the daily maximum 1-hour concentrations 65.5 (27.4), 23.0 and 114.0 µg/m3 (Table 1).

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

	O3 8h - summer	**O3 1h max - year**	**PM10 - year**
Number	183	365	365
Minimum	7	10	11
Percentile 5	28	23	16
Percentile 25	44	47	27
Median	63	62	37
Percentile 75	78	83	50
Percentile 95	103	114	82
Percentile 98	109	130	103
Maximum	122	163	206
Daily mean	62	66	42
standard error	23	27	24
% missing values	0.00%	0.00%	0.00%

In 2001 the PM_{10} annual mean value was a bit above the 1999/30/EC Directive limit value for 2005 (40 µg/m^3), however daily limit value (50 µg/m^3) was exceeded for more than 90 days during that year, almost exclusively in winter months. For the summer period of the same year daily ozone concentrations remained under recommended limit of 120 µg/m^3, nevertheless in 11 days of 2001, the episodes of maximum 1-hour concentration of ozone above this limit were recorded.

Figures 1-3 present the distribution of daily concentrations of ozone and PM10 in Cracow in 2001.

Figure 1. Distribution of daily ozone 8h max in Cracow. Summer 2001.

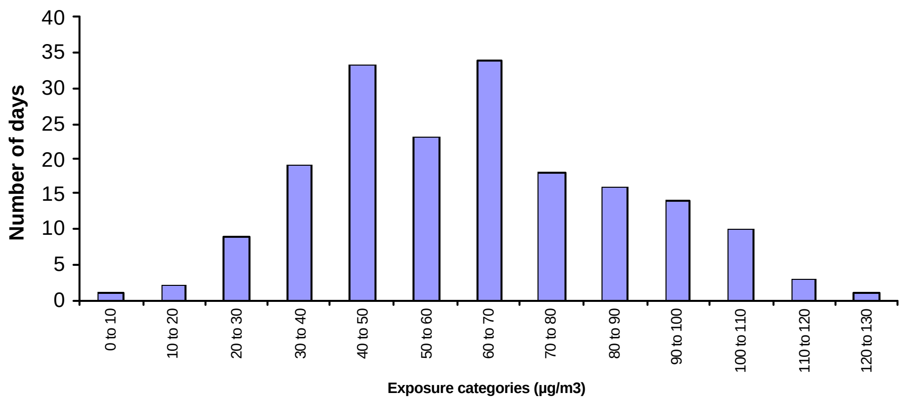


Figure 2. Distribution of daily ozone 1h max in Cracow, 2001.

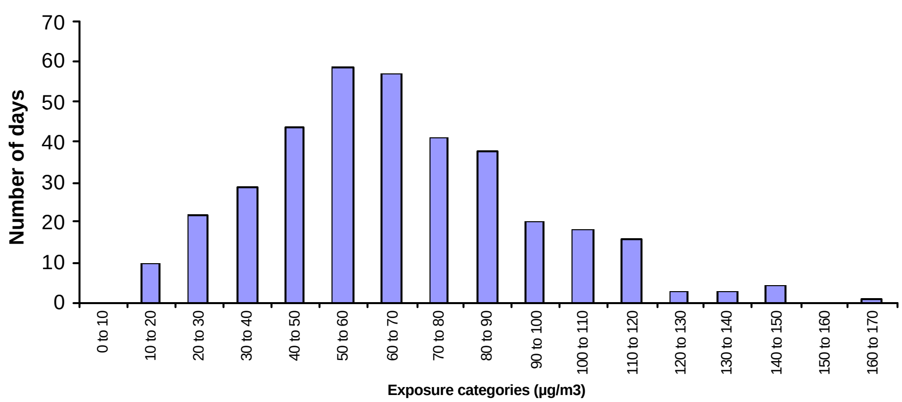
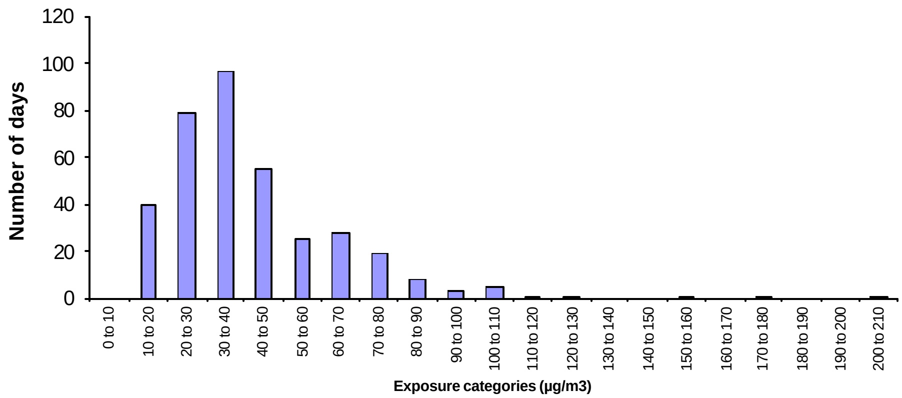


Figure 3. Distribution of daily PM10 in Cracow, 2001.



Health data

The health outcome consists of mortality data of Cracow inhabitants for the year 2001. The data on morbidity is still not readily available from health statistics and remains a domain of epidemiological studies only.

The daily counts of all and cause-specific deaths as well as detailed data on infant mortality were obtained from the local Medical Statistics Registration Office. Standard quality control program applied for collecting death certificates has resulted in the completeness of the data of 98.3%.

The total mortality, excluding external causes of death (ICD10: A00-R99), daily number of deaths from cardiovascular diseases (ICD10: I00-I99) and respiratory diseases (ICD10: J00-J99) were used as health indicators of general population. In addition, annual number of all postneonatal deaths as well as deaths from respiratory diseases and SIDS (ICD10: R95) have served as health indicators of infants.

6911 people died in Cracow in 2001. Among them 49% were men and 74% were above 65 years of age. There were 44 deaths among children below 1 year of age including 11 postneonatal deaths.

Table 2 summarises the ICD code categories used together with mean number of events per day and the number of cases per 100,000 in the population.

Table 2. Descriptive statistics for health outcomes in Cracow, 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	183.4			
Respiratory *ICD9 460-519 ICD10 J00-J99*	460-519	J00-J99	1	16.7			
Sudden infant death syndrome *ICD9 798.0 – ICD10 R95*	798.0	R95	3	50.1			
GENERAL POPULATION MORTALITY							

MORTALITY					
Total mortality all causes *ICD9 <800 ICD10 A00-R99*	<800	A00-R99	17.7 (5.0)	2.3	
Cardiovascular mortality *ICD9 390-459 ICD10 I00-I99*	390-459	I00-I99	9.5 (3.8)	1.3	
Respiratory mortality *ICD9 460-519 ICD10 J00-J99*	460-519	J00-J99	0.6 (0.9)	0.1	
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	not available	
Hospital respiratory admissions - Age < 15 years *ICD9 460-519 ICD10 J00-J99*	460-519	J00-J99			not available
Hospital respiratory admissions - Age 15 -64 years	460-519	J00-J99			not available
Hospital respiratory admissions - Age > 64 years	460-519	J00-J99			not available

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

[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.

	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.

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 **50 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 **20 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

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} levels higher than 20 ? g/m^3 was 1.07 (95%CI: 0.48 – 1.70), which is equivalent to an annual rate of 17.8 deaths per 100 000 (95%CI: 8-28.4).

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}.

	PM10 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)	4.2 (2.0-6.6)
	to 20 µg/m^3	1.07 (0.48-1.70)	17.9 (8.1-28.4)
	to 40 µg/m^3	0.10 (0.05-0.16)	1.7 (0.79-2.6)
Respiratory	by 5 µg/m^3	0.09 (0.04-0.14)	1.5 (0.7-2.4)
	to 20 µg/m^3	0.34 (0.15-0.58)	5.7 (2.5-9.7)
	to 40 µg/m^3	0.04 (0.02-0.06)	0.6 (0.3-1.0)
SIDS	by 5 µg/m^3	0.16 (0.10-0.23)	2.7 (1.6-3.9)
	to 20 µg/m^3	0.66 (0.37-0.96)	11.0 (6.2-16.0)
	to 40 µg/m^3	0.07 (0.04-0.09)	1.1 (0.7-1.6)
MORBIDITY	**Daily levels**		
Cough <18 y	by 5 µg/m^3		
	to 20 µg/m^3	not available	not available
	to 50 µg/m^3		
LRS <18 y	by 5 µg/m^3		
	to 20 µg/m^3	not available	not available
	to 50 µg/m^3		
Hospital respiratory admissions <15 y	by 5 µg/m^3		
	to 20 µg/m^3	not available	not available
	to 50 µg/m^3		

Regarding short-term effects of O_3, each reduction by 10 µg/m^3 of daily maximum 8-hour moving average concentrations would delay 9.9 (95%CI: 5.4 – 16.6) deaths per year in the study area, 7.8 (95%CI: 3.8 – 12.4) from cardiovascular diseases, and 1.2 (95%CI: 0.8 – 1.6) from respiratory causes.

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	9.9 (5.4-16.6)	1.3 (0.7-2.2)
	to 120 µg/m^3	NA	NA
Cardiovascular	by 10 µg/m^3	7.8 (3.8-12.4)	1.0 (0.5-1.6)
	to 120 µg/m^3	NA	NA
Respiratory	by 10 µg/m^3	1.2 (0.8-1.6)	0.2 (0.1-0.2)
	to 120 µg/m^3	NA	NA
MORBIDITY	**Daily 1-h max**		
Emergency room visits for asthma <18 y	by 10 µg/m^3 to 180 µg/m^3	not available	not available
	Daily 8-h max		
Hospital respiratory admissions 15-64 y	by 10 µg/m^3 to 120 µg/m^3	not available	not available
Hospital respiratory admissions > 64 y	by 10 µg/m^3 to 120 µg/m^3	not available	not available

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

Discussion

Exposure prevention is the most effective means of protecting people from environmental threats to health. Air pollution levels continue to fall in Cracow and it is anticipated that this trend will continue. In the last couple of years, certain measures to reduce air pollution have been taken in Cracow. The city authorities encourage citizens to use public transport rather than private cars and the ban on traffic in the city centre is already in place. However, improvement of the traffic-related air quality should not be expected in the short term because of the steady growing numbers of cars and local road infrastructure situation. The shifting from individual coal-fired furnaces to gas distribution networks and extended central heating distribution is of great significance for air quality in Cracow as well.

It is of vital importance to inform inhabitants of the city about air quality and its impact on public health. However, in Poland the need for HIA is still in its early stage and its meaning, methods and application remain to be established.

The results of the health impact assessment show the benefits of reducing particulate matter and ozone exposure on a local scale. Regarding children, infant mortality in Cracow as in Europe is quite low and consequently, the expected attributable number of deaths related to air pollution is also very low.

Conclusion

Within the process of the European Integration of Poland which among others, obliges all member states to implement measures for air quality improvement in order to protect human health the HIA findings should serve as a basis for policy-making in the future. As these assessments show, the small size of the risk from air pollution should not be underestimated in terms of its impact on public health.

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