# HEALTH IMPACT ASSESSMENT OF AIR POLLUTION

ENHIS-1 PROJECT: WP5 HEALTH IMPACT ASSESSMENT

**LOCAL CITY REPORT**

**LJUBLJANA**

# Summary of main findings for Ljubljana

*In 2001 the $PM_{10}$ annual mean (SD) was 29,5 (16,9) 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 concentration of ozone ($O_3$) were 219,8 (35,8), 27,2 and 129,3 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 0,20 total postneonatal deaths. Reducing $PM_{10}$ daily mean values to 20 µg/$m^3$ would prevent 8,71 hospital respiratory admissions.*

*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 3,83 deaths per year in the general population in the study area, 2,31 from cardiovascular diseases, and 2,32 from respiratory causes. In terms of hospital admissions, this would represent 0,36 respiratory admissions in the adult population and 1,70 in the population over 64 years*.

## *Summary of HIA of outdoor air pollution in Ljubljana in ENHIS-1*

| Health outcome | Population | Pollutant | Period | Mean type | RR (for 10 $\mu g.m^3$ increase) | References | Number of attributable cases by scenario1 | |
|---|---|---|---|---|---|---|---|---|
| **Mortality** | | | | | | | **Ozone: Reduction by 10 µg.m3** | **PM10: Reduction by 5 µg/m3** |
| 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 | 3,83 | |
| Cardiovascular mortality (ICD9 390-459 - ICD10 I00-I99) | | | | | 1.0046 (1.0022-0.0073) | | 2,31 | |
| Respiratory mortality (ICD9 460-519 - ICD10 J00-J99) | | | | | 1.0113 (1.0074-1.0151) | | 2,32 | |
| Total postneonatal mortality | 1 month-1 year | Corrected $PM_{10}$[3] | Year | Annual | 1.048 (1.022-1.075) | Lacasaña et al 2005 | | 0,11 |
| Postneonatal respiratory mortality (ICD9 460-519 - ICD10 J00-J99) | | | | | 1.216 (1.102-1.342) | | | 0,00 |
| Postneonatal Sudden Infant Death Syndrom Mortality (ICD9 798.0 - ICD10 R95) | | | | | 1.12 (1.07-1.17) | Woodruff 1997 | | 0,00 |
| **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 | | 3,64 |
| Hospital respiratory admissions (ICD9 460-519 - ICD10 J00-J99) | 15 - 64 years | **$O_3$ 8h max** | Summer | | 1.001 (0.991-1.012) | | 0,36 | |
| Hospital respiratory admissions (ICD9 460-519 - ICD10 J00-J99) | > 64 years | | | | 1.005 (0.998-1.012) | | 1,70 | |

[1] For ozone: absolute reduction by 10 $\mu g/m^3$. For $PM_{10}$ absolute reduction by 5 $\mu g/m^3$.

[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 Ljubljana metropolitan area had a population of 270 032 on $30^{th}$ June 2001. The number of people over 65 years was 41 131 (15,2 %). Ljubljana's climate is transition between continental and alpine, with prevailing weak local winds, influenced by urban heat island. Ljubljana is located in basin with regular temperature inversions. Such meteorological conditions can dramatically contribute to build up pollution. The average daily air temperature was 11,4 °C. In 2001 there was 17 days with maximum air temperature below 0 ºC and 29 days with maximum air temperature above 30 ºC. In 2001 total sunshine duration was 1993 hours which makes 110% of the 1981-90 period average. There was 1328 mm of precipitation and 59 days with wind speed over 6 Beaufort in 2001.

Air pollution levels generally continue to fall in Ljubljana. BS and $PM_{10}$ were used to estimate the exposure for Ljubljana to air pollution in the past APHEIS study. The annual daily mean level of BS has been decreasing for at least 10 years; from 1999 to 2000 it has decreased for another 20 % and has reached the bottom level (15 µg/m3). The annual daily mean level of PM10 is also decreasing in last few years; it was 35,7 $\mu g/m^3$ in 1999, 31,5 $\mu g/m^3$ in 2000 and 29,5 $\mu g/m^3$ in 2001.

Main causes of mortality in Ljubljana are cardiovascular diseases, cancer and accidents - injuries in the falling order. Age mortality rate is 778,7 per 100 000 including violent deaths, using the European population for 2000 year (United Nations, 2001).

For children three main causes are accidents – injuries, cancer and complication of congenital malformations. The third category of mortality for children keeps changing from year to year as population is small and consequently the numbers of cases are small. Independent research institutions predict a slight decrease in number of births, but it also depends on number of newly come immigrants.

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

Principal sources of air pollution were described in detail in the previous Apheis city reports (www.apheis.org).

Traffic is the main source of air pollution in Ljubljana (70%). Another source is heating (30%). Central heating plant was much bigger pollutant in the past, but significantly lost it's impact due to the use of high quality coal and introduction of sophisticated cleaning system. Same parts of city still use poor quality coal for heating. We do not expect any major changes refer to sources of pollution in incoming years. However, new traffic policy and steady increase in use of natural gas are making a difference.

At local level a network of cycling paths had extended. Ministry of Health went for a big health promotion campaign, promoting healthy living, healthy eating and physical activity with emphasize on physical transport. The main finding of the APHEIS study was also given to city council and on to services that usually do planning and development and to general public, since the air pollution continues to pose a significant threat to public health in the city.

## Exposure data

The chosen pollution indicators, i.e. particles less than 10 µm (PM10), ozone ($O_3$), are monitored by Agency for Environment. Measurements from two urban background stations were selected: Figovec and the station at Agency for Environment. This two stations are geographically representative for the study area and not directly influenced by local sources of air pollution.

Calculation of indicators:

- $PM_{10}$: daily exposure indicator has been calculated as the arithmetic mean of the daily concentrations of the stations. For purpose of long-term health impact assessment we used conversion factor 1,3.
- Ozone: The daily maximum 1-hour 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).

For each pollutant, a series consisting of the arithmetic mean of daily values of both monitoring stations was constructed. For days with missing values in both used monitoring stations, we used the average of the value of the pollutant of the previous day (to the one with the missing value) and the next day, if these are not missing as well. In case there are consecutive days with missing values they were filled in. Before filling in there were 9,6% missing values for $PM_{10}$, 0,8% for $O_3$ 1h max and 3,6% for $O_3$ 8h max.

The annual mean level (SD) of $PM_{10}$ in Ljubljana was 29,5 (16,9) µg/m$^3$, and P5 and P95 of the daily mean values were, respectively, 6,9 µg/m$^3$ and 65,3 µg/m$^3$. The mean (SD), P5 and P95 of the daily maximum 8-hour moving average concentrations of $O_3$ were, respectively, 219,8 (35,8), 27,2 and 129,3 µg/ m$^3$, and those of the daily maximum 1-hour concentrations 269,5 (46,6), 8,6 and 158,0 µg/m3 (Table 1 and figures 1-3).

In 2001 the $PM_{10}$ annual mean (29,5 µg/m$^3$) was above the 1999/30/EC Directive limit value for 2010 (20 µg/m$^3$), and below that established for 2005 (40 µg/m$^3$).

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

| | O3 8h - summer | O3 1h max - year | O3 1h max - summer | PM10 - year |
|---|---|---|---|---|
| **Number** | 173 | 363 | 181 | 336 |
| **Minimum** | 9 | 2 | 18 | 2 |
| **Percentile 5** | 27 | 9 | 45 | 7 |
| **Percentile 25** | 53 | 42 | 81 | 19 |
| **Median** | 76 | 71 | 106 | 27 |
| **Percentile 75** | 94 | 106 | 129 | 37 |
| **Percentile 95** | 129 | 158 | 173 | 65 |
| **Percentile 98** | 184 | 182 | 210 | 73 |
| **Maximum** | 220 | 270 | 270 | 118 |
| **Daily mean** | 78 | 77 | 108 | 30 |
| **standard error** | 36 | 47 | 41 | 17 |
| **%missing values** | 5,5% | 0,5% | 1,1% | 7,9% |

**Fig 1. Distribution of daily $O_3$ 8h max in Ljubljana area, summer 2001.**

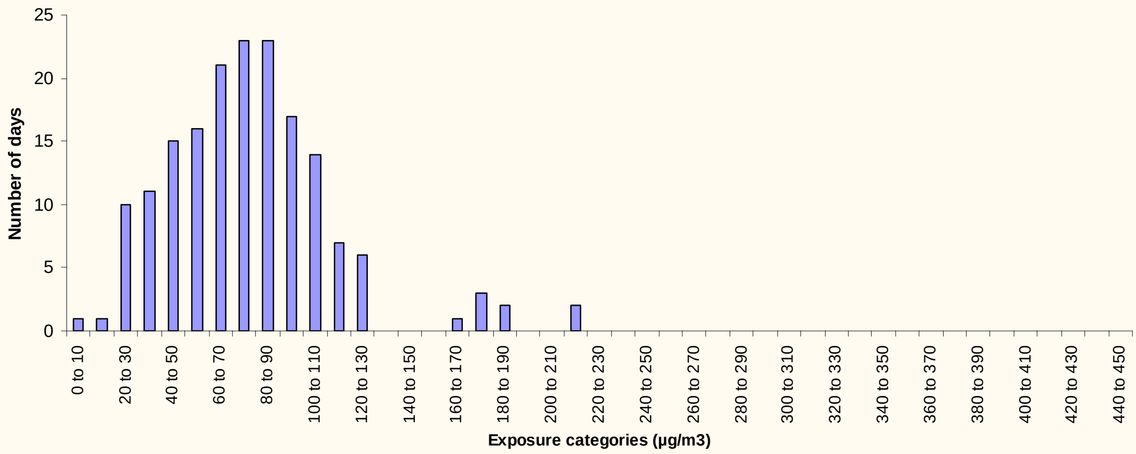


Fig 2. Distribution of daily $O_3$ 1h max in Ljubljana area, 2001.

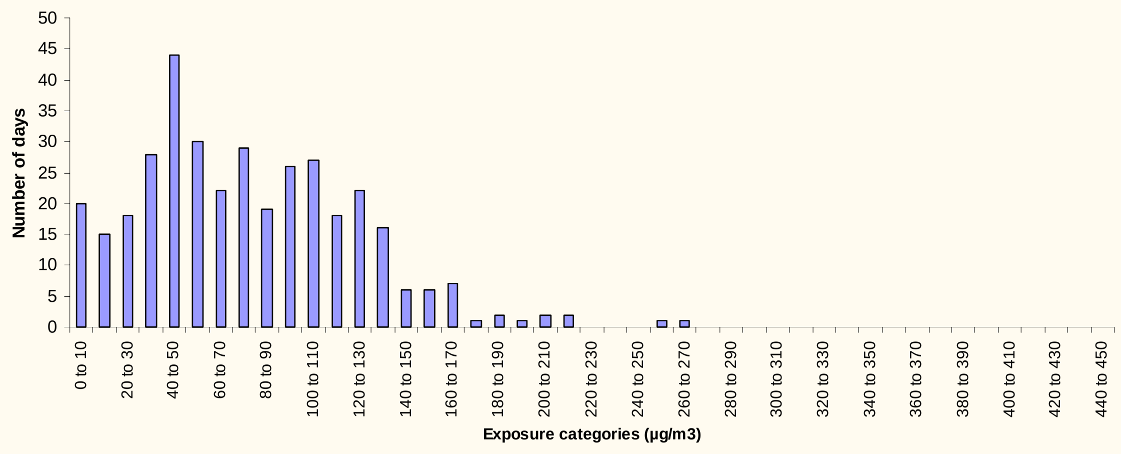
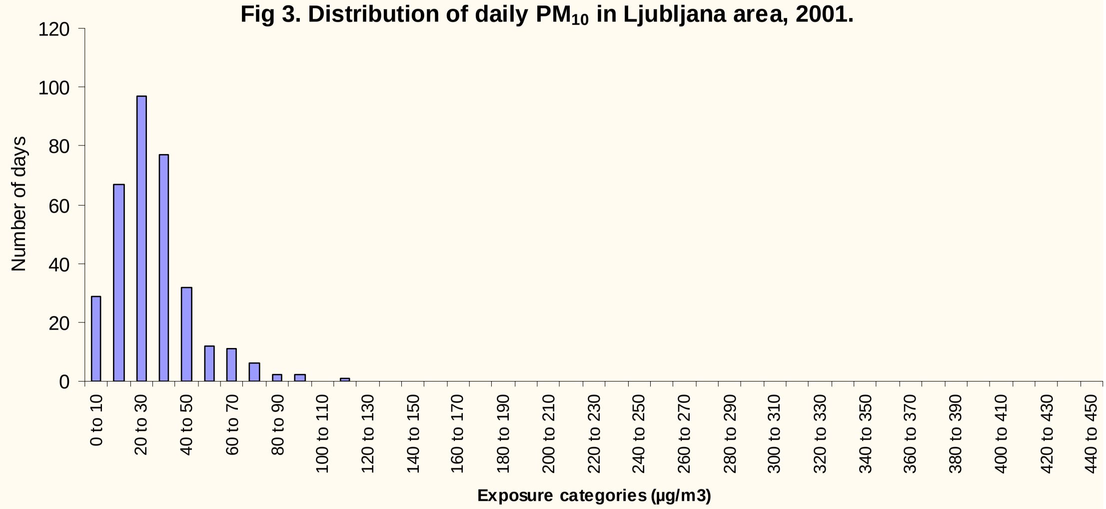



Fig 3. Distribution of daily $PM_{10}$ in Ljubljana area, 2001.



## Health data

National Institute of Public Health provides mortality and hospital admission data. All data included are for year 2001.

Daily rate of total mortality in Ljubljana was 7,3 per 100 000 and annual rate of postneonatal mortality was 221,9 per 100 000 in 2001.

**Table 2**. Descriptive statistics for health outcomes in Ljubljana, 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 | | | 5 | 221,9 | | | |
| Respiratory *ICD9 460-519 ICD10 J00-J99* | 460-519 | J00-J99 | 0 | 0 | | | |
| Sudden infant death syndrome *ICD9 798.0 – ICD10 R95* | 798.0 | R95 | 0 | 0 | | | |
| ***GENERAL POPULATION MORTALITY*** | | | | | | | |
| Total mortality all causes *ICD9 <800 ICD10 A00-R99* | <800 | A00-R99 | | | 7,3 (2,8) | 2,7 | |
| Cardiovascular mortality *ICD9 390-459 ICD10 I00-I99* | 390-459 | I00-I99 | | | 3,0 (1,6) | 1,1 | |
| Respiratory mortality *ICD9 460-519 ICD10 J00-J99* | 460-519 | J00-J99 | | | 1,3 (0,6) | 0,5 | |
| ***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 | | | | | 813 |
| Hospital respiratory admissions - Age 15 -64 years | 460-519 | J00-J99 | | | | | 773 |
| Hospital respiratory admissions - Age > 64 years | 460-519 | J00-J99 | | | | | 742 |

### 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) |

[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.

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 μg/m$^3$ was 0,20 (95%CI: 0,09 – 0,31), which is equivalent to an annual rate of 8,93 deaths per 100 000 (95%CI: 4,10 – 14,0).

**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$^3$ | 0,11 (0,05-0,17) | 4,73 (2,18-7,35) |
| | to 20 μg/m$^3$ | 0,20 (0,09-0,31) | 8,93 (4,10-14,0) |
| | to 40 μg/m$^3$ | 0,00 (0,00-0,00) | 0,00 (0,00-0,00) |
| Respiratory | by 5 μg/m$^3$ | 0,00 (0,00-0,00) | 0,00 (0,00-0,00) |
| | to 20 μg/m$^3$ | 0,00 (0,00-0,00) | 0,00 (0,00-0,00) |
| | to 40 μg/m$^3$ | 0,00 (0,00-0,00) | 0,00 (0,00-0,00) |
| SIDS | by 5 μg/m$^3$ | 0,00 (0,00-0,00) | 0,00 (0,00-0,00) |
| | to 20 μg/m$^3$ | 0,00 (0,00-0,00) | 0,00 (0,00-0,00) |
| | to 40 μg/m$^3$ | 0,00 (0,00-0,00) | 0,00 (0,00-0,00) |
| ***MORBIDITY*** | ***Daily levels*** | | |
| Cough <18 y | by 5 μg/m$^3$ | not available | not available |
| | to 20 μg/m$^3$ | not available | not available |
| | to 50 μg/m$^3$ | not available | not available |
| LRS <18 y | by 5 μg/m$^3$ | not available | not available |
| | to 20 μg/m$^3$ | not available | not available |
| | to 50 μg/m$^3$ | not available | not available |
| Hospital respiratory admissions <15 y | by 5 μg/m$^3$ | 3,64 (-0,73-7,63) | 9,66 (-1,94-20,2) |
| | to 20 μg/m$^3$ | 8,71 (-1,72-81,5) | 23,1 (-4,57-49,1) |
| | to 50 μg/m$^3$ | 1,30 (-0,26-2,76) | 3,44 (-0,68-7,31) |

Regarding short-term effects of $O_3$, each reduction by 10 µg/m$^3$ of daily maximum 8-hour moving average concentrations would delay 3,83 (95%CI: 2,10 - 6,42) deaths per year in the study area, 2,31 (95%CI: 1,10 – 3,66) from cardiovascular diseases, and 2,32 (95%CI: 1,52 – 3,10) 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 | by 10 µg/m$^3$ | 3,83 (2,10- 6,42) | 1,42 (0,78-2,38) |
| causes | to 120 µg/m$^3$ | 1,34 (0,73-2,26) | 0,50 (0,27-0,84) |
| Cardiovascular | by 10 µg/m$^3$ | 2,31 (1,10-3,66) | 0,85 (0,41-1,36) |
| | to 120 µg/m$^3$ | 0,82 (0,39-1,32) | 0,30 (0,14-0,49) |
| Respiratory | by 10 µg/m$^3$ | 2,32 (1,52-3,10) | 0,86 (0,56-1,15) |
| | to 120 µg/m$^3$ | 0,91 (0,59-1,23) | 0,34 (0,22-0,45) |
| ***MORBIDITY*** | ***Daily 1-h max*** | | |
| Emergency room visits for | by 10 µg/m$^3$ | not available | not available |
| asthma <18 y | to 180 µg/m$^3$ | not available | not available |
| | ***Daily 8-h max*** | | |
| Hospital respiratory | by 10 µg/m$^3$ | 0,36 (-3,28-4,37) | 0,19 (-1,71-2,28) |
| admissions 15-64 y | to 120 µg/m$^3$ | 0,12 (-1,08-1,53) | 0,06 (-0,56-0,80) |
| Hospital respiratory | by 10 µg/m$^3$ | 1,70 (-0,68-4,08) | 4,13 (-1,65-9,92) |
| admissions > 64 y | to 120 µg/m$^3$ | 0,61 (-0,24-1,49) | 1,48 (-0,58-3,63) |

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

## Discussion

Traffic is the main source of air pollution in Ljubljana (70%), which continues to pose a significant threat to public health in the city. We are expecting that extended network of cycling paths and health promotion campaign organized by Ministry of Health will reduce the air pollution in the long run, as people will travel by personal cars more rationally. Ministry of transport put all the responsibility to local government, which is responsible for local transport and urban planning.

In the Apheis city report for Ljubljana for year 2000 it was found out that, if the daily means of PM10 would be kept less than 20 $\mu g/m^3$, 8 deaths and 50 hospital admissions could have been avoided. Different scenarios were used to evaluate short and long-term exposure to particulate pollution.  In the city of Ljubljana, these scenarios were built for three indicators of this particulate pollution: BS, PM10 and PM2,5. Different tools and different estimates were used for evaluating the short- and long-term impacts of this particulate pollution on health.

## Conclusion

Reducing air pollution would impact on population's health and mortality. The annual number of postneonatal deaths attributable to $PM_{10}$ levels higher than 20 $\mu g/m^3$ was 8,93 deaths per 100 000. Regarding short-term effects of $O_3$, each reduction by 10 $\mu g/m^3$ of daily maximum 8-hour moving average concentrations would delay 3,83 deaths per year in the study area, 2,31 from cardiovascular diseases, and 2,32 from respiratory causes.

## References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