How serious are health impacts in one of the most polluted regions of Central Europe?

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INTRODUCTION

Upper Silesian basin is **one of the most air polluted regions of Central Europe**. Differences between long-term (over the decades) air concentrations in residential areas in the Czech Republic for polluted (Silesia region) and unpolluted region (South Bohemia) are about 20 μg/m^3 for PM_{10}, 15 μg/m^3 for $PM_{2,5}$, 7 μg/m^3 for NO_2, 25 μg/m^3 for SO_2, 2 μg/m^3 for benzene, 4 ng/m^3 for B(a)P. Assessed health risks show that polluted areas such as Silesian region, could have significantly increased population mortality and some respiratory morbidity up to tens of percent in comparison with unpolluted areas, in dependence on disease type, on time period and on age of population group.

The objective of here presented research was to compare calculated health risks and the actual state of health of the population and to find some other possible association between pollution exposures and responses of population in the cleanest and the most polluted parts of the Czech Republic.

METHODS

Air pollution

There were collected concentrations of PM_{10}, $PM_{2,5}$, NO_2, SO_2, benzene (BZN) and benzo(a)pyrene (BaP) in polluted (Moravian-Silesian Region - MSR) and unpolluted area (South Bohemian Region - SBR). These data are based on the measurement five-year period, the pollution modeling territory without measuring stations and the calculations of weighted concentrations according to population.

Health risks

Mortality and morbidity was calculated from dose-response relations published by the WHO, Regional Office for Europe (HRAPIE, REVIHAAP, IHME project WHO 2013).

Health outcomes

The actual data of mortality and morbidity was obtained from reports of medical facilities and physicians in the relevant region over the same five years as for air pollutants. Health data include the entire population of selected regions, ie. MSR (polluted) 1,249,323 and SBR (unpolluted) 631,387 inhabitants.

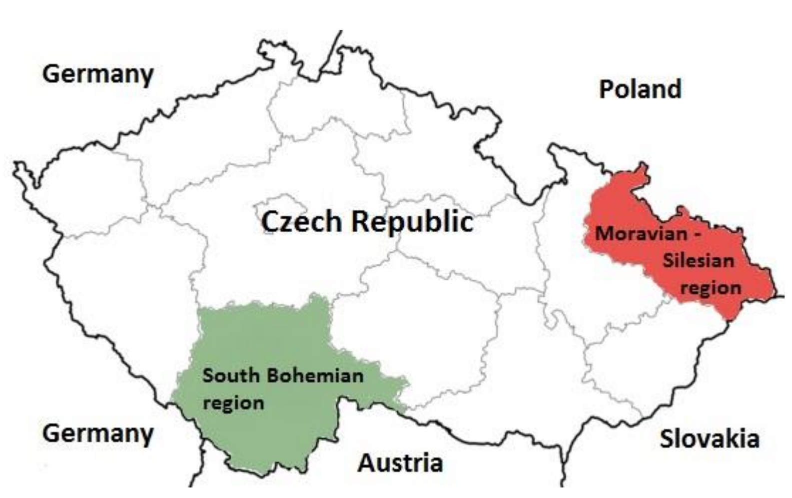
Statistical analysis

To examine the association between air pollution and health outcomes the logistic regression for odds ratio with interval of confidence and the extended Mantel-Haenszel Chi-Square for linear trend with a p-value for one degree of freedom was used.

RESULTS

Air pollution

The one of the most polluted area of Central Europe (Upper Silesian basin) can be find on the border of the Czech Republic and Poland (Fig. 1), while very clean (unpolluted) area of the South Bohemian Region.



Concentrations of pollutants are calculated from measurements, software modelling and statistic population-weighting over five year period. Results are in the table 1.

Tab 1 – Five year population-weighted average concentration of pollutants

Five-year population-weighted average concentration of pollutants						
Region	PM_{10} [μg.m-3]	$PM_{2,5}$ [μg.m-3]	NO_2 [μg.m-3]	SO_2 [μg.m-3]	BZN [μg.m-3]	BaP [ng.m-3]
Unpolluted	17.23	13.69	11.03	14.07	0.69	0.63
Polluted	36.54	29.19	18.68	39.12	2.75	4.75

Health risks

Probabilities of some health outcomes was calculated as relative risks for non-cancer effects, individual and population cancer risks for the unpolluted and polluted region. (Tab 2, Tab 3).

Tab 2 – Calculated relative risks (RR) and confidence interval (CImin-CImax) for few health outcomes according to WHO.

Risks	M-all($PM_{2.5}$)	CD,IHD,COPD($PM_{2.5}$)	LC($PM_{2.5}$)	PIM(PM_{10})	PB(PM_{10})	ICB(PM_{10})
RR	1.0961	1.1182	1.1820	1.0772	1.1545	1.2259
CImin	1.0813	1.0413	1.0636	1.0487	0.9513	1.0973
CImax	1.1420	1.2009	1.3137	1.1879	1.5100	1.5073

M-all - Mortality – all causes. age 30+ years, CD - cerebrovascular disease (includes stroke), IHD - ischemic heart disease, COPD - chronic obstructive pulmonary disease, , age 30+ years, LC - mortality, trachea, bronchus and lung cancer, age 30+ years, PIM - Postneonatal (age 1–12 months) infant mortality, all-cause, PB - Prevalence of bronchitis in children, age 6–12 (or 6–18) years, ICB - Incidence of chronic bronchitis in adults (age 18+ years)

Tab 3 – Cancer risks of exposures to benzene (BZN) and benzo(a)pyrene (BaP) for unpolluted and polluted regions comparing approaches the WHO and US EPA.

Risks		Cancer(BZN)		Cancer(BaP)	
		WHO	US EPA	WHO	US EPA
	UCR[μg/m^3]$^{-1}$	6.00E-06	7.80E-06	9.00E-02	1.10E-03
Unpolluted	LICR	4.14E-06	5.38E-06	5.67E-05	6.93E-07
	APCR	0.04	0.05	0.51	0.01
Polluted	LICR	1.65E-05	2.15E-05	4.28E-04	5.23E-06
	APCR	0.29	0.38	7.63	0.09

UCR-unit cancer risk, LICR-lifetime individual cancer risk, APCR-annual population cancer risk

Health outcomes

The obtained health data was related to the exposure levels of the population. Population structure is similar in both of these regions, varies to some socio-economic status and the environmental conditions.

Tab 4 – odds ratios (OR) of prevalence for unpolluted and polluted regions and significance of linear trend for dose-response associations.

Prevalence	J44	J45	D80	D83
OR	1.954	1.868	1.779	1.149
CI	1.836-2.080	1.760-1.982	1.374-2.304	0.777-1.699
χ2 (PM_{10})	409.38	425.63	16.53	0.71
p	<0.0001	<0.0001	<0.0001	0.3979
χ2 ($PM_{2.5}$)	177.44	401.06	61.88	3.92
p	<0.0001	<0.0001	<0.0001	0.04781
χ2 (NO_2)	522.60	366.78	30.72	5.33
p	<0.0001	<0.0001	<0.0001	0.02098
χ2 (SO_2)	609.77	172.90	65.40	34.13
p	<0.0001	<0.0001	<0.0001	<0.0001

Tab 5 – odds ratios (OR) of incidence for unpolluted and polluted regions and significance of linear trend for dose-response associations.

Incidence	J44	J45	D80	D83
OR	2.105	1.697	1.526	0.700
CI	1.730-2.563	1.407-2.048	0.856-2.722	0.267-1.839
χ2 (PM_{10})	64.56	23.96	2.48	0.38
p	<0.0001	<0.0001	0.115	0.5396
χ2 ($PM_{2.5}$)	16.88	19.35	0.28	0.86
p	<0.0001	<0.0001	0.5968	0.3548
χ2 (NO_2)	54.25	37.53	2.28	0.46
p	<0.0001	<0.0001	0.1311	0.4988
χ2 (SO_2)	155.56	12.33	8.89	1.35
p	<0.0001	0.0004454	0.002868	0.2453

Dg. J44-chronic obstructive pulmonary disease, dg. J45-asthma bronchiale, dg. D80-immunodeficiency with predominantly antibody defects, dg. D83-common variable immunodeficiency, CI--confidence interval, χ2 - extended Mantel-Haenszel Chi-Square for linear trend, p-value for one degree of freedom

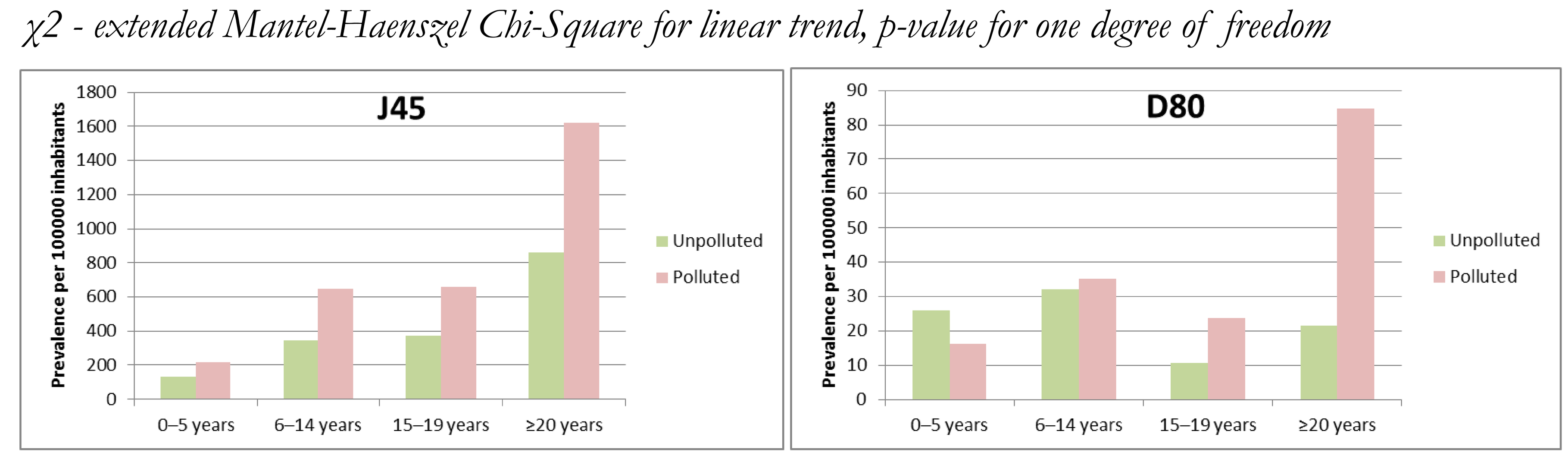


Fig. 2 – Dg. J45-asthma bronchiale and D80-immunodeficiency by age groups in the unpolluted and polluted region.

Tab 6 - Relative risks (RR) of mortality for unpolluted and polluted regions

Mortality	J44	J45	Stroke	Cancer
RR	0.935	2.667	0.973	1.013
CI	0.603-1.451	0.256-27.84	0.774-1.224	0.754-1.362

Dg. J44-chronic obstructive pulmonary disease and other chronic lung disease, dg. J45-asthma bronchiale, Stroke-cerebrovascular events, Cancer- trachea, bronchus and lung cancer.

CONCLUSIONS

Our research has confirmed the similarity theoretically calculated risk of long-term exposure to air pollutants with health impacts for diseases of the respiratory system, including asthma. Any association not confirmed between these exposures and increased cardiopulmonary mortality and mortality from cerebrovascular disease and lung cancer. To make comparisons of the disputed approach WHO and US EPA to evaluate carcinogenic risks associated with environmental conditions could not be retrieved enough data, but were found another interesting association, eg. between long-term exposures to almost all major air pollutants and immunodeficiencies associated mainly with disorders of antibody formation. Worth mentioning also some differences by age group.

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