Toxicological background for measured substances list

(updated information)

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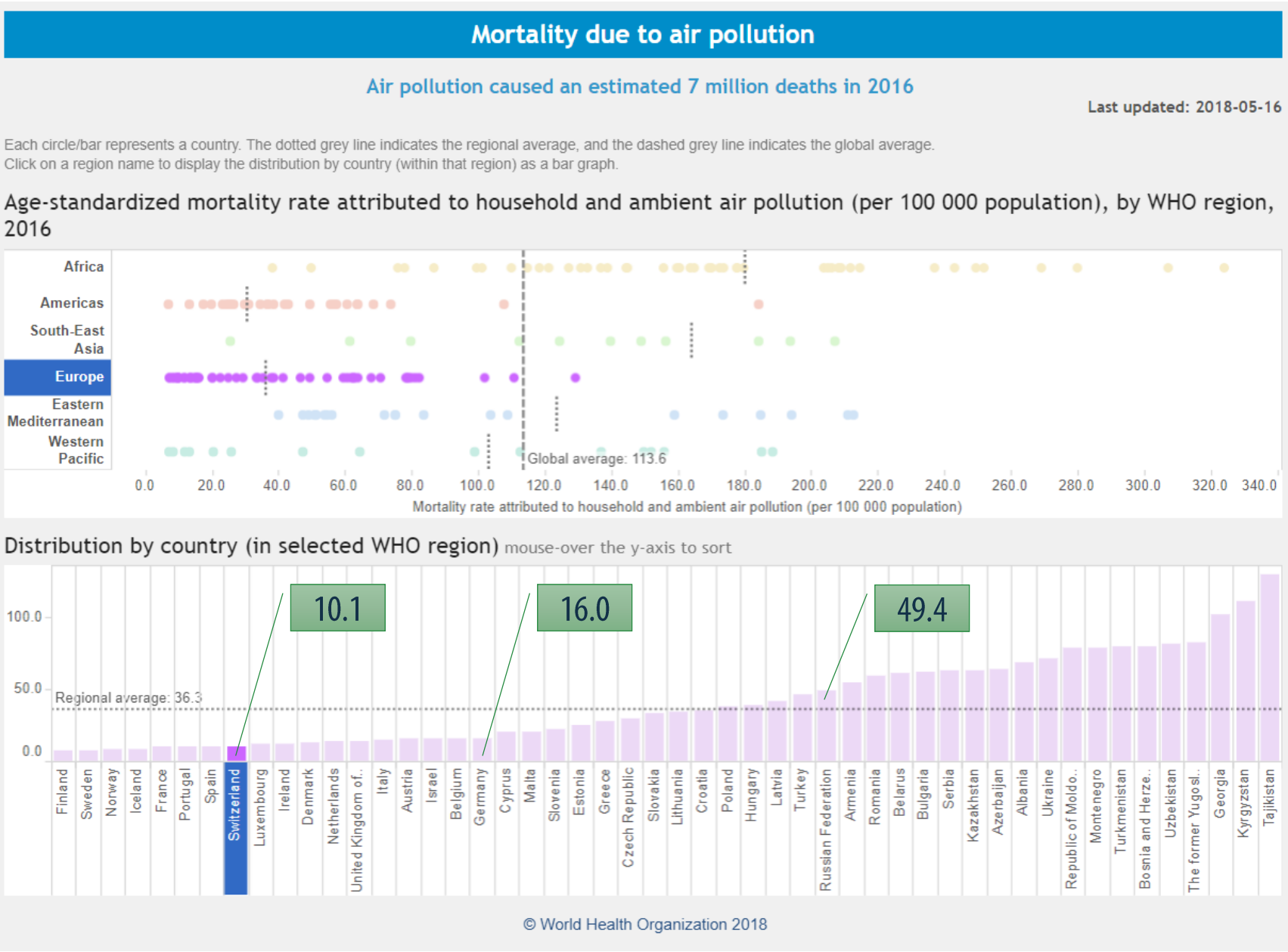
Ambient (outdoor) air quality and health

WHO data



Air pollution is a major environmental risk to health. By reducing air pollution levels, countries can reduce the burden of disease from stroke, heart disease, lung cancer, and both chronic and acute respiratory diseases, including asthma. (WHO)

Toxicity Index

for air pollutants

Toxicity index for i-th substance:

$$A_i = a_i \cdot \alpha_i \cdot \delta_i \cdot \lambda_i \cdot \beta_i$$

Where:

a_i – an indicator of the relative toxicity of the presence of a pollutant in the air inhaled by a person (see next slide);

α_i – correction factor, taking into account the probability of accumulation of initial or secondary pollutants in the components of the environment and in food chains, as well as the intake of pollutant into the human body by non-inhalation means (is equal 1…5);

δ_i – correction factor which takes into account the effect on different recipients, in addition to a people (is equal 1…2), if an assessment of the toxic effect only on people is carried out, is taken equal to 1;

λ_i – correction factor for the probability of secondary transfer of pollutants to the atmosphere after their pecipitating on surfaces (introduced for dust and particles) (is equal 1…1.2);

β_i – correction factor for the probability of formation with the participation of initial pollutants going into the atmosphere, other (secondary) pollutants, more dangerous than the initial pollutants (introduced for light hydrocarbons) (is equal 1…5).

Toxicity Index (continuation)

for air pollutants

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Indicator of the relative toxicity for i-th substance:

$$a_i = \left(\frac{\mathrm{MAC}_{\mathrm{CO\ amb}} \times \mathrm{MAC}_{\mathrm{CO\ w.zone}}}{\mathrm{MAC}_{\mathrm{i\ amb}} \times \mathrm{MAC}_{\mathrm{i\ w.zone}}} \right)^{\frac{1}{2}} = \sqrt{\frac{60}{\left(\mathrm{MAC}_{\mathrm{i\ amb}} \times \mathrm{MAC}_{\mathrm{i\ w.zone}}\right)}}$$

Where:

MAC – maximum allowable concentration of pollutant in ambient air (index – amb) or in air of working zone (index – w.zone) for substance i in comparison to carbon monoxide (CO).

Temporary methodology for determining prevented environmental damage / L.Vershkov, V.L.Groshev, V.V. Gavrilov and others - M., 1999. - 68 p.

Toxicity Index (calculation example)

for air pollutants

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Indicator of the relative toxicity for NO_2:

$$a_i = \sqrt{\frac{60}{\left(\mathrm{MAC}_{\text{i amb}} \times \mathrm{MAC}_{\text{i w.zone}}\right)}} = \sqrt{\frac{60}{0.04 \times 2}} = 27.4$$

Toxicity index for NO_2:

$$A_i = a_i \cdot \alpha_i \cdot \delta_i \cdot \lambda_i \cdot \beta_i = 27.4 \cdot 1 \cdot 1.5 \cdot 1 \cdot 1 = 41.1$$

Toxicity Index (calculation summary)

for air pollutants

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Substance	MAC_{amb}	$MAC_{w.zone}$	$MAC_{sh.t}$*	a	α	δ	λ	β	Toxicity Index
CO	3	20	5	1	1	1	1	1	1
NO	0.06	-	0.4	25	1	1.5	1	1	37.5
NO_2	0.04	2	0.2	27.4	1	1.5	1	1	41.1
HCHO	0.01	0.5	0.05	109.5	1	1.2	1	1	131.5
$PM_{2.5}$	0.035	-	0.16	51.8	2	1	1.2	1	124.2
PM_{10}	0.06	-	0.3	28.9	2	1	1.2	1	69.3
O_3	0.03	0.1	0.16	141.4	1	1.5	1	1	212.1

* $MAC_{sh.t}$ - maximum allowable short-term concentration

Carbon Monoxide

CO

Symptoms
headache, tachypnea, nausea, lassitude (weakness, exhaustion), dizziness, confusion, hallucinations; cyanosis; depressed S-T segment of electrocardiogram, angina, syncope

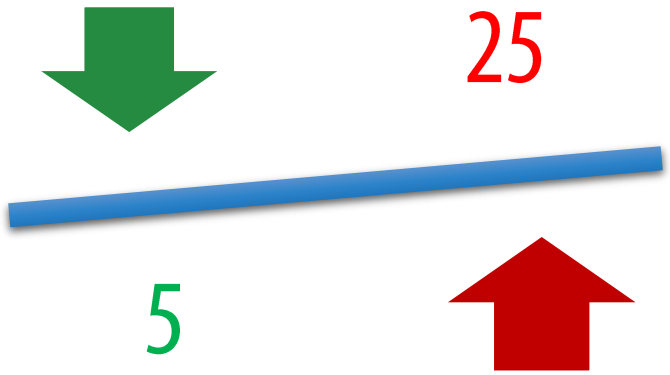
Target Organs
cardiovascular system, lungs, blood, central nervous system

Toxicity Index

1

MAC, mg/m³	Russia	WHO	Europe	USA	Korea
1 year					
24 hours	3				
8 hours			10	11	11
1 hour				44	31
30 minutes	5				
Work zone	20			40	

In vehicle concentration, mg/m³



In vehicle air

Nitrogen Monoxide

NO

Symptoms
irritation eyes, wet skin, nose, throat; drowsiness, unconsciousness; methemoglobinemia

Target Organs
Eyes, skin, respiratory system, blood, central nervous system

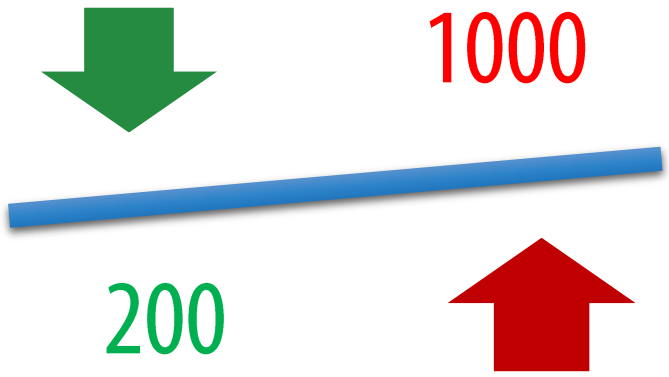
Toxicity Index

37.5

MAC, μg/m³	Russia	WHO	Europe	USA	Korea
1 year					
24 hours	60				
8 hours					
1 hour					
30 minutes	400				
Work zone				30000	

In vehicle air

In vehicle concentration, μg/m³



Nitrogen Dioxide

NO_2

Symptoms

irritation eyes, nose, throat; cough, mucoid frothy sputum, decreased pulmonary function, chronic bronchitis, dyspnea (breathing difficulty); chest pain; pulmonary edema, cyanosis, tachypnea, tachycardia

Target Organs

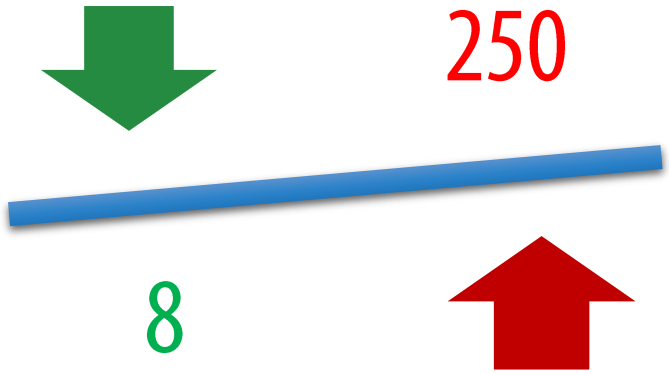
Eyes, respiratory system, cardiovascular system

Toxicity Index

41.1

MAC, μg/m³	Russia	WHO	Europe	USA	Korea
1 year		40	40	109	62
24 hours	40				123
8 hours					
1 hour		200	200	205	205
30 minutes	200				
Work zone	2000			1800	

In vehicle concentration, μg/m³



In vehicle air

Formaldehyde

HCHO

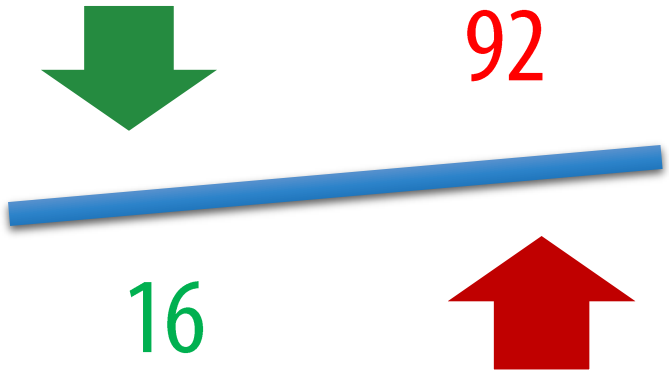
Symptoms
irritation eyes, nose, throat, respiratory system; lacrimation (discharge of tears); cough; wheezing; [potential occupational carcinogen]
Target Organs
Eyes, respiratory system

Toxicity Index
131.5

MAC, μg/m³	Russia	WHO	Europe	USA	Korea
1 year					
24 hours	10				
8 hours					
1 hour					
30 minutes	50				
Work zone	500			100	

In vehicle air

In vehicle concentration, μg/m³



Particulate matter less than 2.5 μm

$PM_{2.5}$

Symptoms

Nonfatal heart attacks, irregular heartbeat, aggravated asthma, decreased lung function, increased respiratory symptoms, such as irritation of the airways, coughing or difficulty breathing, premature death in people with heart or lung disease

Target Organs

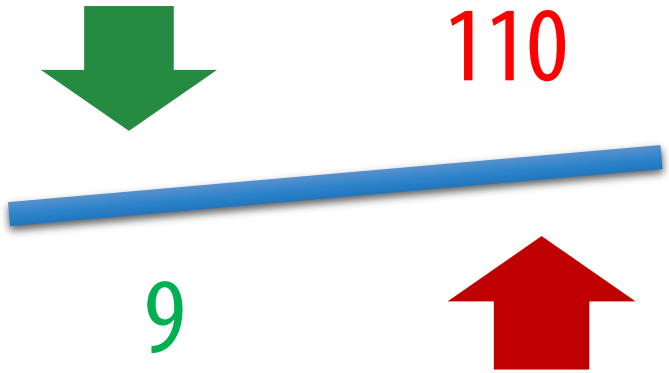
Respiratory system, cardiovascular system

Toxicity Index

124.2

MAC, μg/m³	Russia	WHO	Europe	USA	Korea
1 year		10	25	12	25
24 hours	35	25		35	50
8 hours					
1 hour					
30 minutes	160				
Work zone					

In vehicle concentration, μg/m³



In vehicle air

Particulate matter less than 10 μm

PM_{10}

Symptoms

Nonfatal heart attacks, irregular heartbeat, aggravated asthma, decreased lung function, increased respiratory symptoms, such as irritation of the airways, coughing or difficulty breathing, premature death in people with heart or lung disease

Target Organs

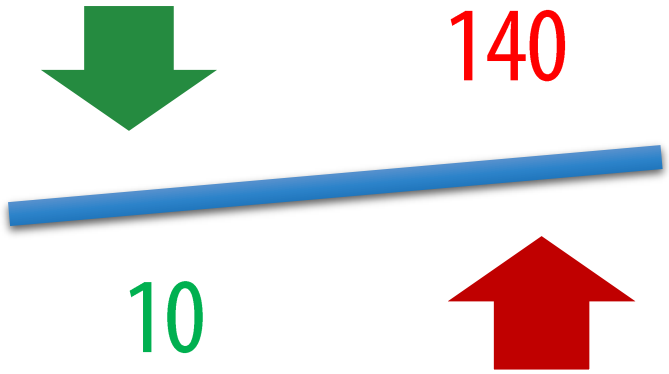
Respiratory system, cardiovascular system

Toxicity Index

69.3

MAC, μg/m³	Russia	WHO	Europe	USA	Korea
1 year		20	40		50
24 hours	60	50	50	150	100
8 hours					
1 hour					
30 minutes	300				
Work zone					

In vehicle concentration, μg/m³



In vehicle air

Ozone

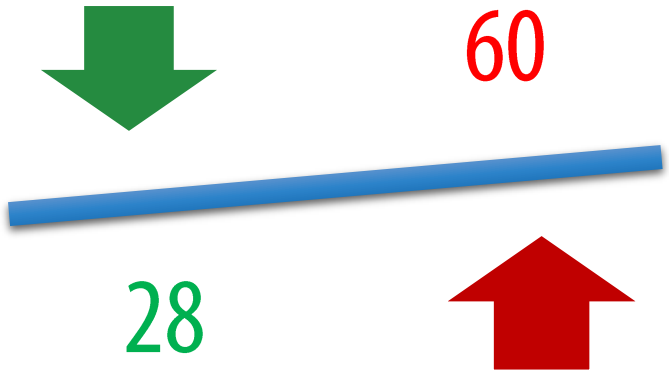
O_3

Symptoms
irritation eyes, mucous membrane; pulmonary edema; chronic respiratory disease
Target Organs
Eyes, respiratory system

Toxicity Index
212.1

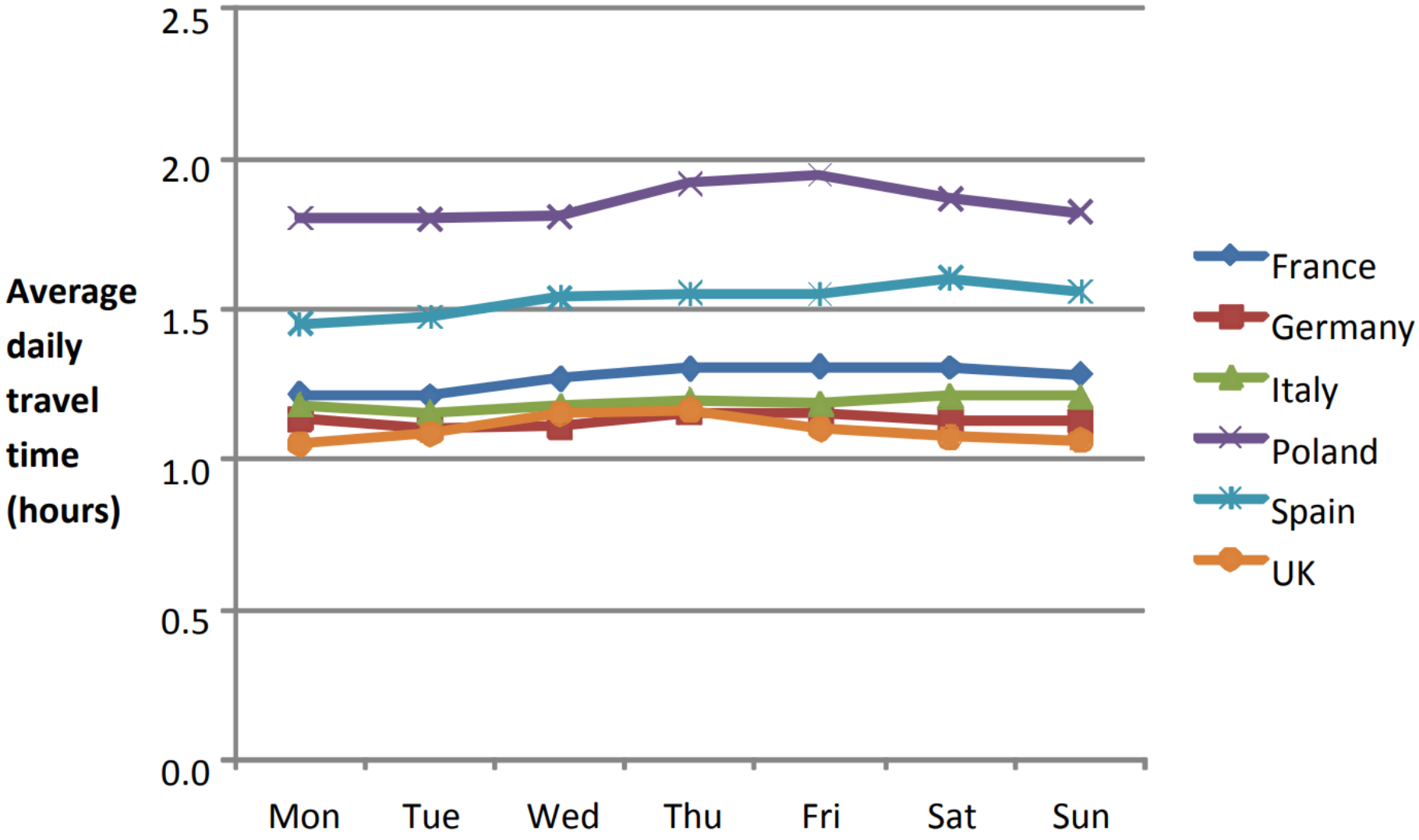
MAC, μg/m³	Russia	WHO	Europe	USA	Korea
1 year					
24 hours	30				
8 hours		100	120	141	121
1 hour					
30 minutes	160				
Work zone				200	202

In vehicle concentration, μg/m³



In vehicle air

Average daily travel time (hours) by day of the week in Europe



European Commission, Joint Research Centre, Institute for Institute for Energy and Transport, 2012
doi:10.2790/7028

Exposure and toxic effect calculation

for in-vehicle air

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Aspirated air volume per year: 1 hour * 700 l/hour * 365 days = 255,5 m^3/year

or 2 hour * 700 l/hour * 365 days = 511,0 m^3/year

Doze of aspirated toxicant (NO) per year:

minimal: 255,5 m^3/year * 0,2 mg/m^3 = 0,051 g/year

maximal: 511,0 m^3/year * 1,0 mg/m^3 = 0,511 g/year

Relative toxic effect of NO:

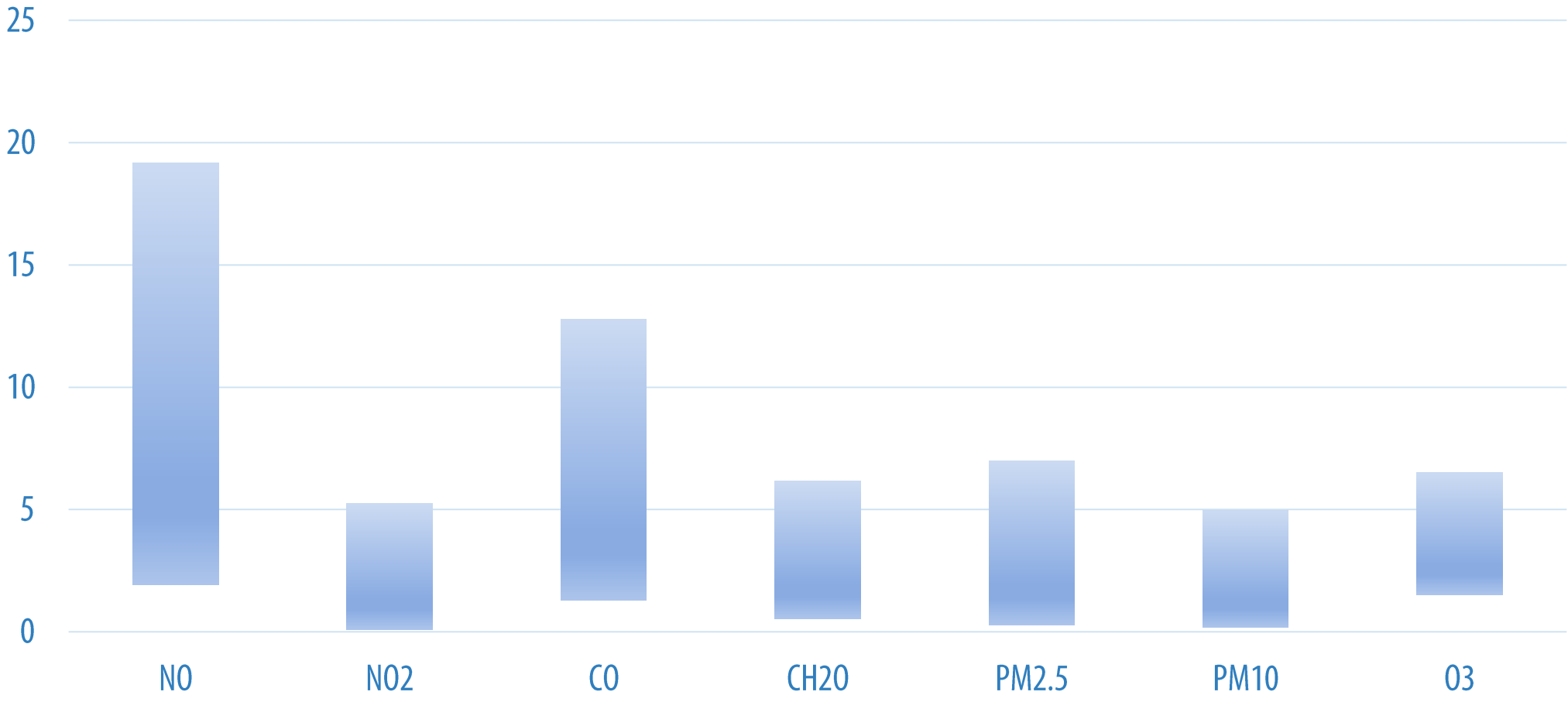
minimal: 0,051 g/year * 37,5 = 1,92 rel.g/year

maximal: 0,511 g/year * 37,5 = 19,2 rel.g/year

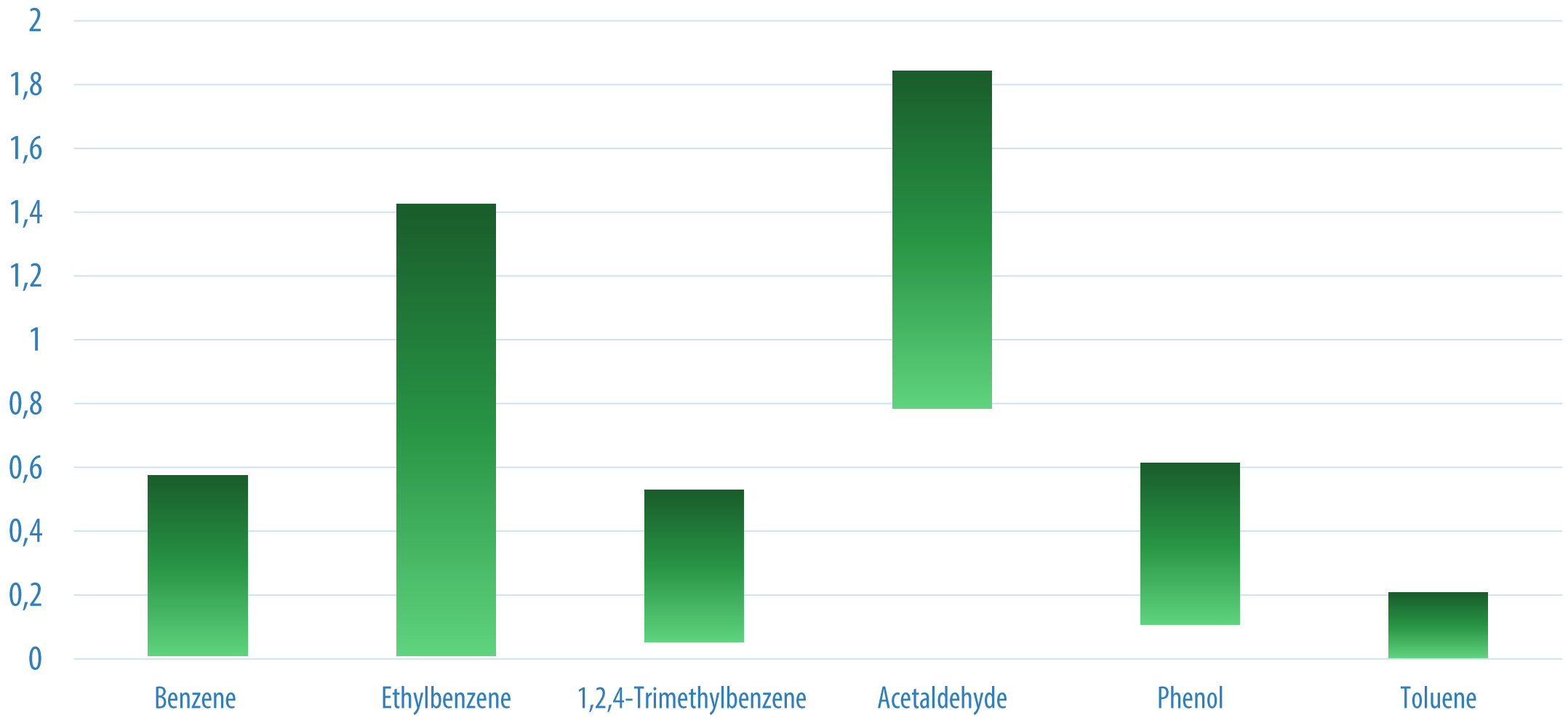
Toxicity index

Toxic effect relative to CO

Relative toxic effect of main pollutants



Relative toxic effect of hydrocarbons



Conclusions

1. The assessment of relative toxic effect of main pollutants in vehicle interior air showed that most aggressive components are NO and CO, but formaldehyde and particles also have strong negative potential effect on human health.
2. Relative toxic effect of other hydrocarbons is small in comparison to effect of main pollutants.
3. It is advisable to include to scope of VIAQ IWG particulate matters with dimensions less then 2.5 and 10 μm.
4. It is important to collect and analyze the information about fine particles in vehicle interior, because they have very strong negative effect on human health.

Thank you for your attention!

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