NEPŘÍZNIVÝ VLIV ZNEČIŠTĚNÉHO OVZDUŠÍ NA CNS

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AIR POLLUTION 2010 – 2015

(CHMI)

Locality	PM10 µg/m³	PM2.5 µg/m³	B[a]P ng/m³
Ostrava-Poruba	39.9 ± 41.4 /29.1 ± 24.8	32.2 ± 37.0/22.7 ± 18.2	3.8 ± 6.2/ 2.6 ± 1.0
Ostrava -Bartovice	61.7 ± 45.6 /42.2 ± 37.4	46.7 ± 38.2/34.6 ± 29.3	7.2 ± 8.1/ 7.8 ± 4.5
Karvina	54.3 ± 50.0/36.6 ± 30.8	X/(33.1 ± 24.9)	6.3 ±8.8/ 3.5 ± 1.5)
Havirov	52.9 ± 58.2/36.2 ± 30.7	X	X
Prague-Smichov	37.9 ±20.1/29.1 ± 26.0	21.1 ± 14.2/16.1 ± 14.2	X
Prague -Libus	27.4 ± 16.9/21.5 ± 19.1	20.3 ± 13.1/(17.1 ±13.3)	0.9 ± 1.2/ 0.9 ± 0.4
Ceské Budejovice	25.2 ± 16.9/19.5 ± 16.8	X/16.9 ±14.3	1.5 ± 1.8/ 1.4 ± 0.6

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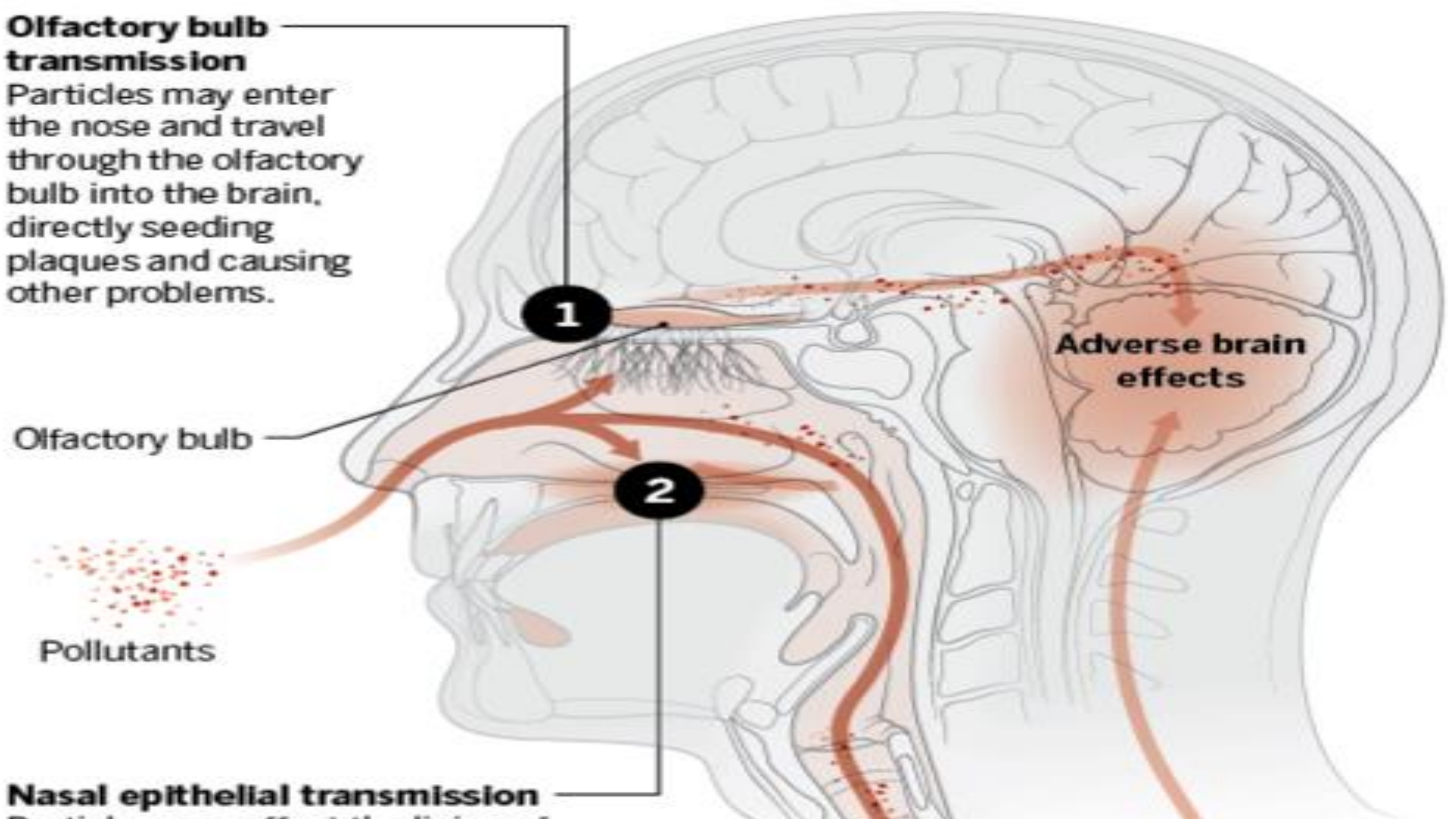
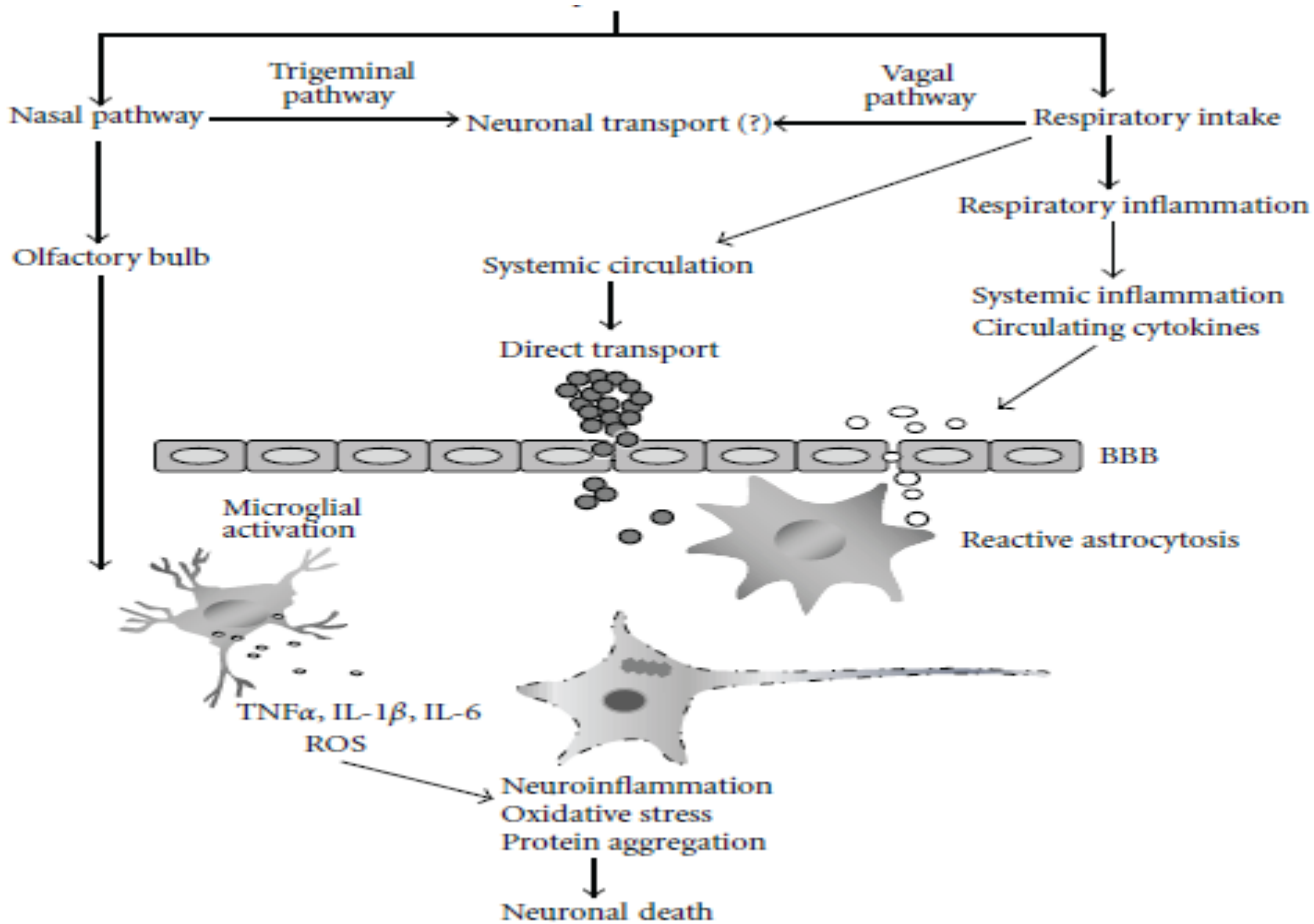
B[a]P

C.B.B. Guerreiro et al. “Benzo(a)pyrene in Europe: Ambient air concentrations, population exposure and health effects”, Environmental Pollution 214 (2016) 657-667

Acceptable risk level: 0.12 ng B[a]P/m^3

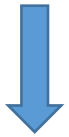
Increasing tendency in B[a]P emissions - implementation of climate mitigation policies promoting the use of biomass burning for domestic heating


Olfactory bulb transmission
Particles may enter the nose and travel through the olfactory bulb into the brain, directly seeding plaques and causing other problems.
1
Olfactory bulb
2
Pollutants
Adverse brain effects
Nasal epithelial transmission


Trigeminal pathway
Vagal pathway
Nasal pathway
Neuronal transport (?)
Respiratory intake
Respiratory inflammation
Olfactory bulb
Systemic circulation
Systemic inflammation
Circulating cytokines
Direct transport
BBB
Microglial activation
Reactive astrocytosis
TNFα, IL-1β, IL-6
ROS
Neuroinflammation
Oxidative stress
Protein aggregation
Neuronal death

N.D. Saenen et al.

In Utero Fine Particle Air Pollution and Placental Expression of Genes in the Brain-Derived Neurotrophic Factor Signaling Pathway: An ENVIR*ON*AGE Birth Cohort Study EHP 123:834-840 (2015)



PM2.5 15-19 $\mu g/m^3$

deregulation of genes *BDNF* and *SYN1* in placenta

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BDNF

1) Brain-derived neurotrophic factor ovlivňuje vývoj a funkci nervového systému
2) Zvýšení o 5 ug/m3 PM2.5 v prvním trimestru snižuje expresi genu *BNDF* v placentě o 16 %, synapsinu (*SYN1*) o 24 %
3) Koncentrace PM2.5 v prvním trimestru = 15.4 ug/m3

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PAHs & BDNF

D. Tang et al. Molecular and neurodevelopmental benefits to children of closure of a coal burning power plant in China. PlOS One 9(2014)e91966

PAH-DNA adducts were inversely correlated with BDNF ($r = -0.233$, $p<0.01$, $N=269$)

BDNF levels were positively associated with motor ($p=0.018$), social ($p=0.001$), and average ($p=0.017$) DQ scores (developmental quotient)

PM2.5 a autismus

1) Děti z LA, Kalifornie, s dg. AD ve věku 3-5 let v letech 1998-2009; 7603 dětí s AD, na 1 dítě s AD 10 kontrol
2) Zvýšení PM2.5 o 4.68 ug/m3 zvýšení o 15 % (OR=1.15; 95% CI: 1.06, 1.24)
3) Vliv dopravy, vzdělání matek, SES

B. Ritz et al. EHP 121 (2013) 380-386

MMR study

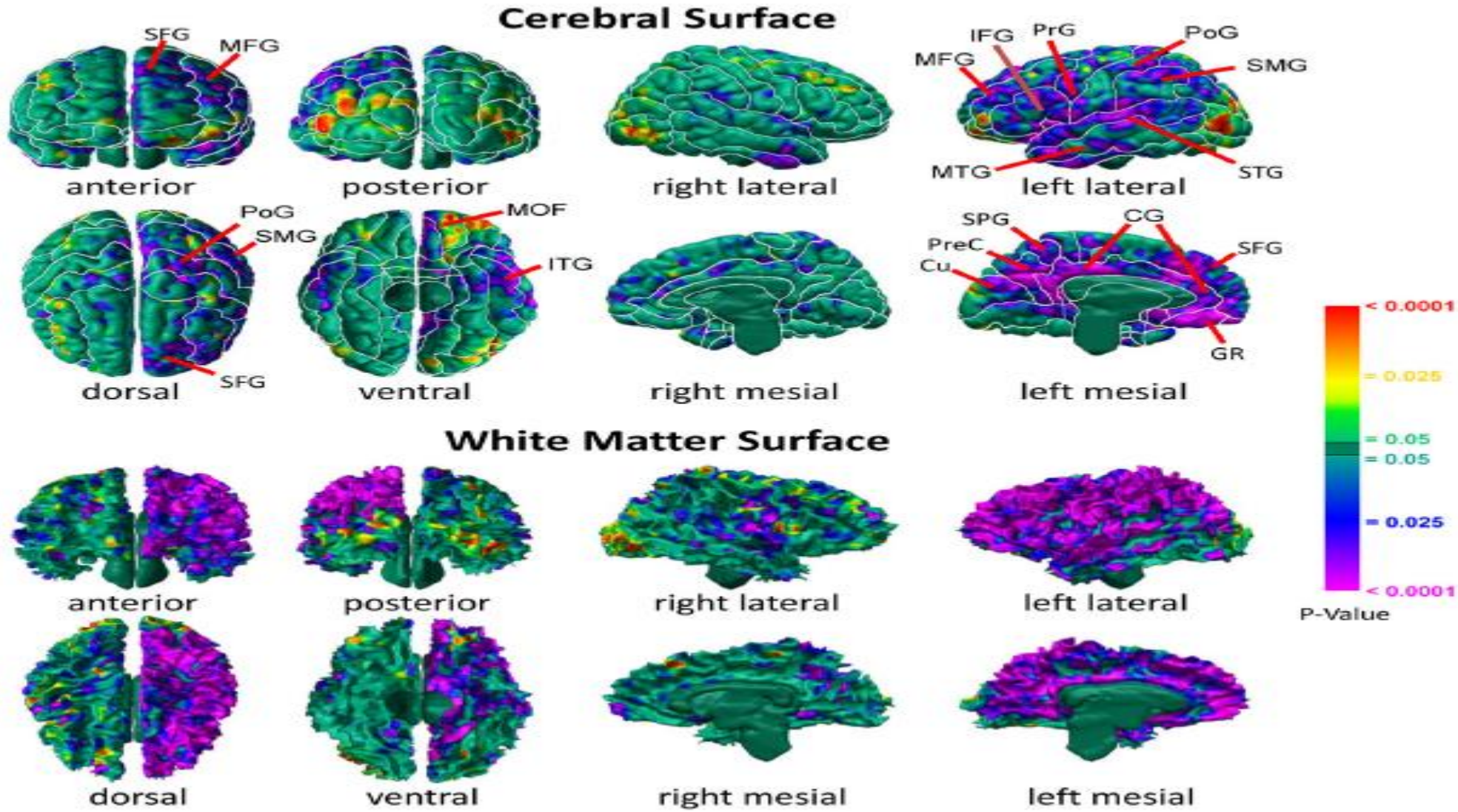
B. D. Peterson et al. Effects of prenatal exposure to air pollutants (PAHs) on development of brain white matter, cognition, and behavior in later childhood. JAMA Psychiatry 72 (2015) 531-540.

40 dětí ve věku 7-9 let

Etnicita matek: 72% dominikánská, 28 % afrikoamerická

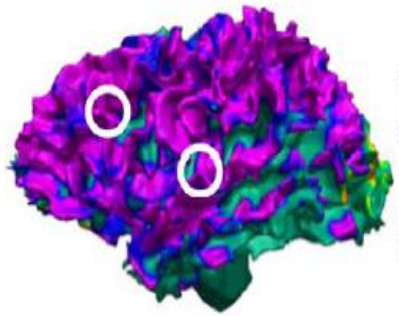
Prenatální expozice PAU 5.13±6.2 ng/m3

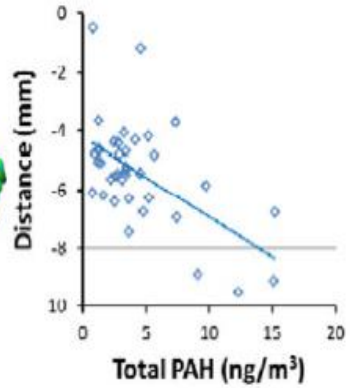
Median > 8.20±7.64 ng/m3, median < 2.06±0.91 ng/m3

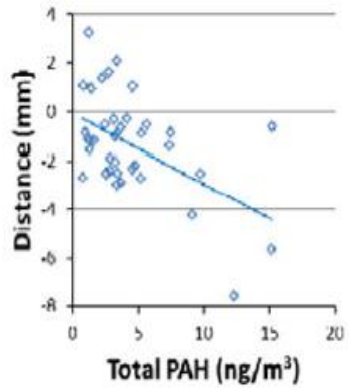

Cerebral Surface
SFG
MFG
anterior
posterior
right lateral
IFG
PrG
PoG
MFG
SMG
MTG
STG
left lateral
PoG
SMG
SFG
dorsal
MOF
ITG
ventral
right mesial
SPG
CG
PreC
SFG
Cu
GR
left mesial
White Matter Surface
anterior
posterior
right lateral
left lateral
dorsal
ventral
right mesial
left mesial
< 0.0001
= 0.025
= 0.05
= 0.05
= 0.025
< 0.0001
P-Value

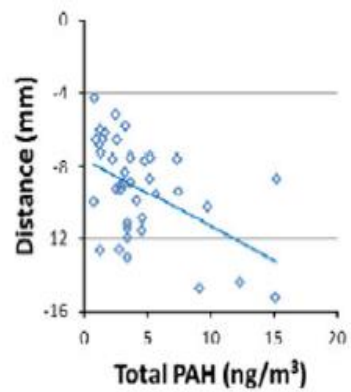
Correlations with Prenatal PAH Level

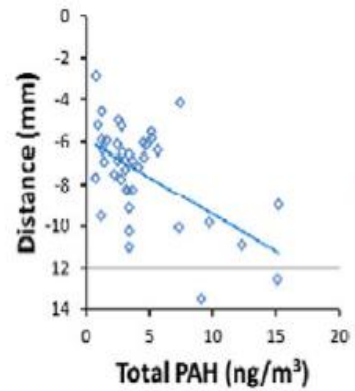
left lateral



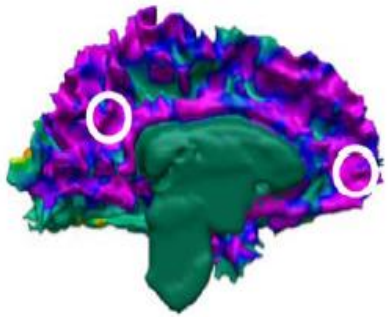






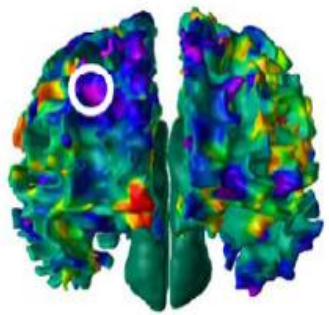


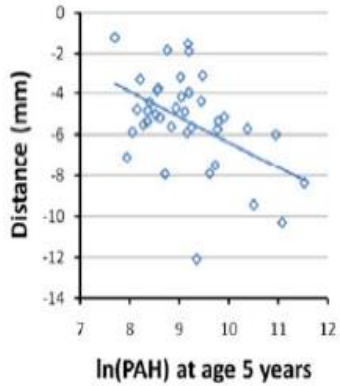
left mesial

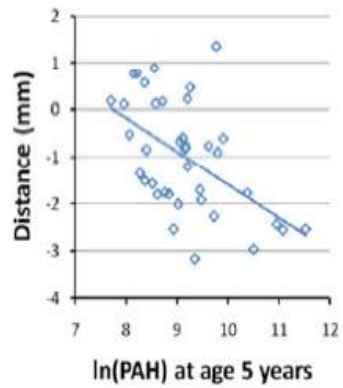


Correlations with Postnatal PAH Levels

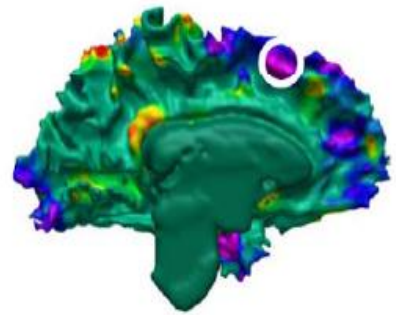
anterior







left mesial



MMR study

1) Increased prenatal exposure to PAHs reduced left hemisphere white matter
2) Reduced white matter measures of the left hemisphere were associated with significantly higher scores for externalizing problems of the CBCL (child behavior checklist), as well as externalizing symptoms that included ADHD symptoms and conduct disorder problems.
3) Higher prenatal PAH exposure was associated with reduced processing speed during intelligence testing

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MMR study

Impact of prenatal PAH exposure:

1) **Left hemisphere matter reduction**
2) **Attention problems and ADHD – cognitive abilities, including spatial learning, short-term memory**

Neurotoxic effect of PAHs:

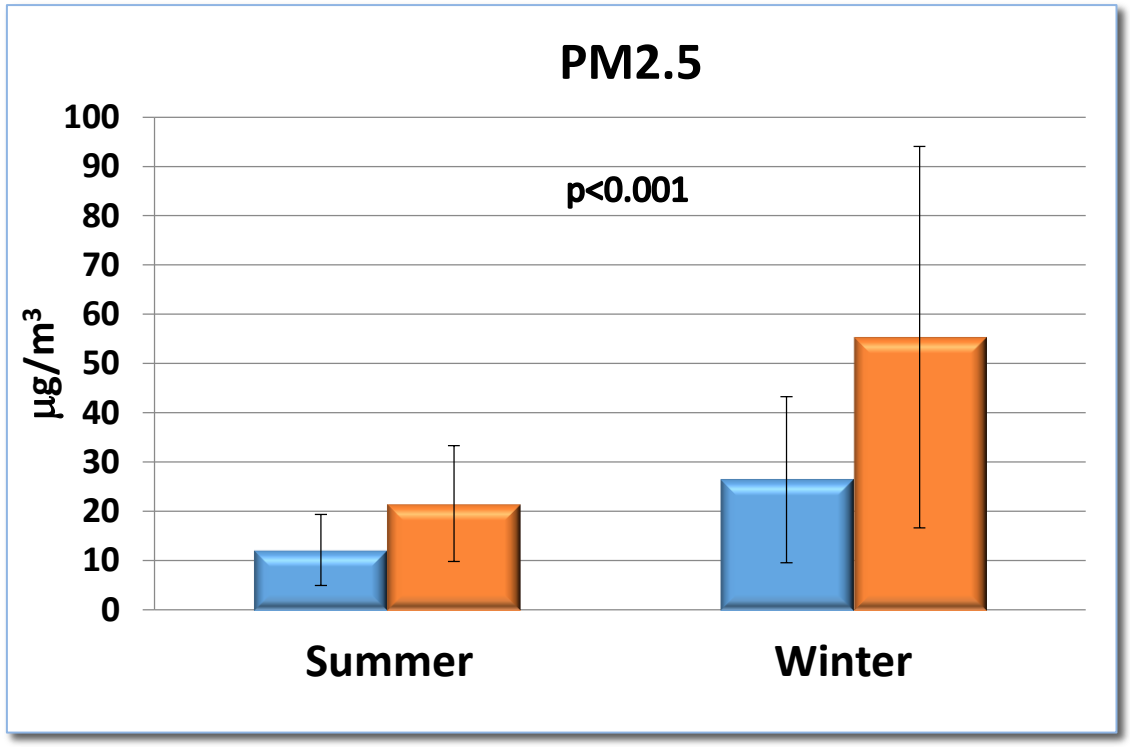
Microglial activation – B[a]P increases ROS in microglia, expression of nitric oxide synthetase – increase production of nitric oxide and proinflammatory cytokines in microglia – death of neurons, decresed production of myelin.

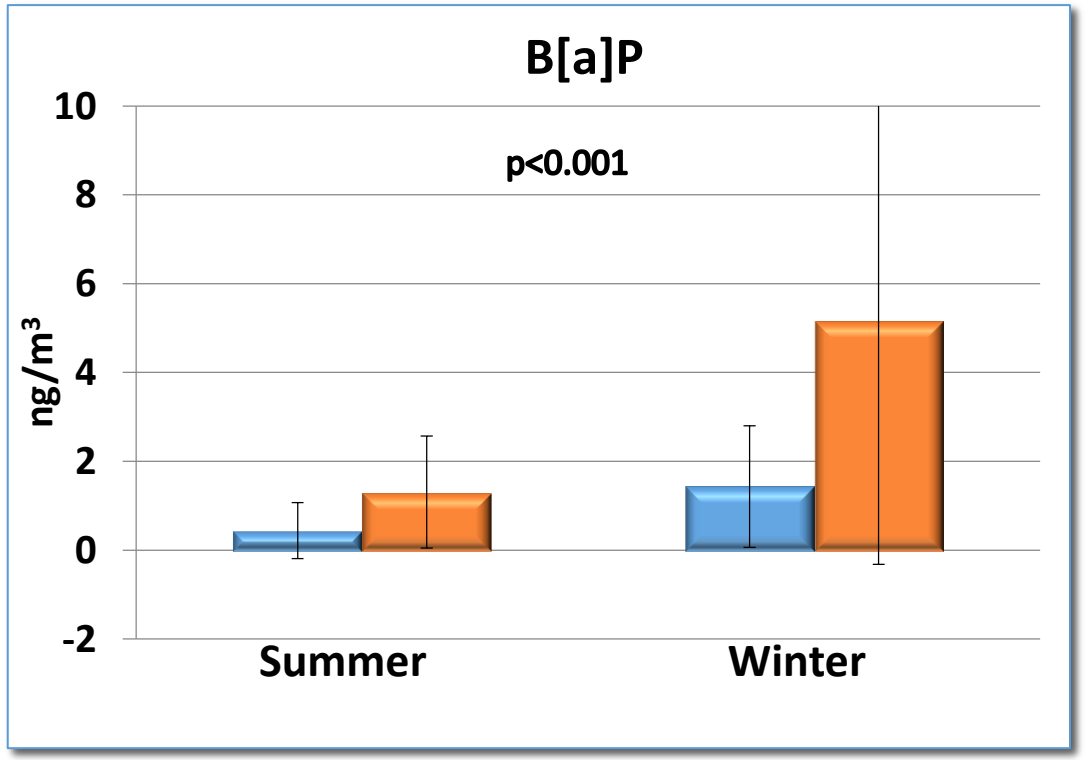
PAHs and cognitive functions

W.A.Jedrychowski et al. Prenatal exposure to polycyclic aromatic hydrocarbons and cognitive dysfunction in children. Environ Sci Pollut Res 22 (2015) 3631-3639

- 170 children in Cracow
- Exposure: PAH-DNA adducts, prenatal PAHs 43.0±55.3 ng/m3
- At age 7 ys Wechsler Inteligence Scale for Children
- Depressed verbal IQ index, cord blood adducts RR=3.0 (95%CI: 1.3, 6.8)
- Breast feeding 6 months – protective effect RR=0.3 (95%CI: 0.1, 0.9)
- Conclusion: PAHs are harmful to the developing fetal brain

EXPOSURE TO PM 2.5 AND B[a]P





Ceske Budejovice

Karvina

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The effect of prenatal exposure of air pollution to gene expression profile

Preliminary preview of the G-NEW study

K. Honkova[1], A. Rossnerova[1], P. Rossner, Jr.[1], J. Pavlikova[1], H. Gmuender[2], V. Svecova[1], J. Pulkrabova[3], J. Hajslova[3], M. Veleminsky[4] and R.J. Sram[1]

- We observed affected neurotrophin signalling pathway and primary imunodeficiency pathway for subjects from Karvina district and winter period.

ZNEČIŠTĚNÍ OVZDUŠÍ Z DOPRAVY

(Sunyer et al. 2017)

Změny pozornosti, ovlivnění neuropsychického vývoje

NO_2 33.50 μg/m3

EC 1.13 μg/m3

NO_2	Praha 2 Legerova	47.1±20.6 μg/m3
	Praha 4 Libuš	18.1±7.6 μg/m3
	Praha 5 Smíchov	41.6±17.3 μg/m3
	Praha 10 Průmyslová	31.2±12.2 μg/m3

PM2.5 and cognitive functions

J.A.Ailshire and E.M. Crimmins: Fine particulate matter air pollution and cognitive function among older US adults. Am J Epidemiol 180 (2014) 359-366

- Quartile annual mean PM2.5 exposure ug/m3: 8.9; 11.1; 13.0, 15.4
- Analytical sample: 13 996 men and women aged 50 years+
- Episodic memory, mental status
- Living in more polluted areas is associated with worse episodic memory as well as mental status
- Efforts to further reduce PM2.5 concentrations may have beneficial consequences for the cognitive health of the aging US population

PM2.5 & major depressive disorder

K-N. Kim et al. Long-term fine particulate matter exposure and major depressive disorder in a community-based urban cohort, EHP 124 (2016): 1547-1553

- 27 270 participants from Seul, 54% males, 46% females, aged mostly 40-69 years
- PM2.5 concentration in 2007 29.8 ug/m3, in 2010 24.9 ug/m3
- Risk increased with an increase of 10 ug/m3 PM2.5 in 2007 HR=1.44, (95% CI: 1.17, 1.78)
- When stratified for diabetes mellitus, HR=1.83 (95% CI: 1.26, 2.64); CVD HR=1.83 (95% CI: 1.19, 2.12); COPD HR=1.64 (95% CI: 1.17, 2.30)
- Long-term PM2.5 exposure increased the risk of MDD among the general population

AIR POLLUTION & DEMENTIA

A. Oudinet al. Traffic-related air pollution and dementia incidence in Northern Sweden: A longitudinal study. EHP 124 (2016) 306-312

- Umea, NOx, 1 806 participants, 191 dg. Alzheimer, 111 vascular dementia
- NOx Q4 > 26 ug/m3, age 55-85 ys.
- NOx 17-26 ug/m3 HR=1.49 (95%CI: 1.04, 2.14), > 26 ug/m3 HR=1.60 (95%CI: 1.02, 2.10) (adjusted for age, education, physical activity, smoking, sex, BMI, alcohol, diabetes, hypertension, and stroke)
- Conclusion: Air pollution from traffic might be an important risk factor for vascular dementia and Alzheimer disease

AIR POLLUTION & PARKINSON's DISEASE

B. Ritz et al. Traffic-related air pollution and Parkinson's disease in Denmark: A case control study. EHP 124 (2016) 351-356

- Copenhagen vs. rural area, NO2, 1 696 PD, 1 800 controls
- NOx = 21.0±13.0 ug/m3, NO2 Copenhagen 16.8±5.2 ug/m3, rural 12.1±1.8 ug/m3 (Prague-Smichov 35.2±24.8 ug/m3)
- Association with PD: Copenhagen OR 1.16 (95% CI: 1.08, 1.25), rural OR 0.93 (95% CI: 0.71, 1.22)
- Conclusion: Air pollution from traffic might be an important risk factor for Parkison's disease

ZÁVĚRY

Zvýšené koncentrace PM2.5 zvyšují výskyt:

- **autismu**
- **poruch kognitivních funkcí u dětí**
- **onemocnění depresí**
- **incidence demence**
- **Parkinsonovy choroby**
- **ovlivňují koncentraci proteinu BDNF**

ZÁVĚRY

Zvýšené koncentrace PAHs :

- **ovlivňují hladinu BDNF**
- **redukují bílou hmotu mozku**
- **snižují kognitivní funkce u dětí**
- **zvyšují výskyt ADHD**

ZÁVĚRY

Současné koncentrace PM2.5 a B[a]P v ČR nepříznivě ovlivňují vývoj CNS, zejména u dětské populace !

PODĚKOVÁNÍ

Podpořeno grantem Strategie AV21

Projekt QUALITAS

QUALITAS

Kvalitní život
ve zdraví i nemoci

Akademie věd
České republiky

Strategie AV21

Špičkový výzkum ve veřejném zájmu