

# Neurocognitieve prestaties en blootstelling aan luchtvervuiling

Saenen Nelly - UHasselt

# Fijn stof - translocatie

**Fijn stof**

**Koolstof**

Organische componenten  
Metalen  
Water oplosbare componenten

**Bovenste luchtwegen**  
Grove deeltjes  
2.5 – 10  $\mu\text{m}$

**Onderste luchtwegen**  
Fijne partikels  
0.1 – 2.5  $\mu\text{m}$

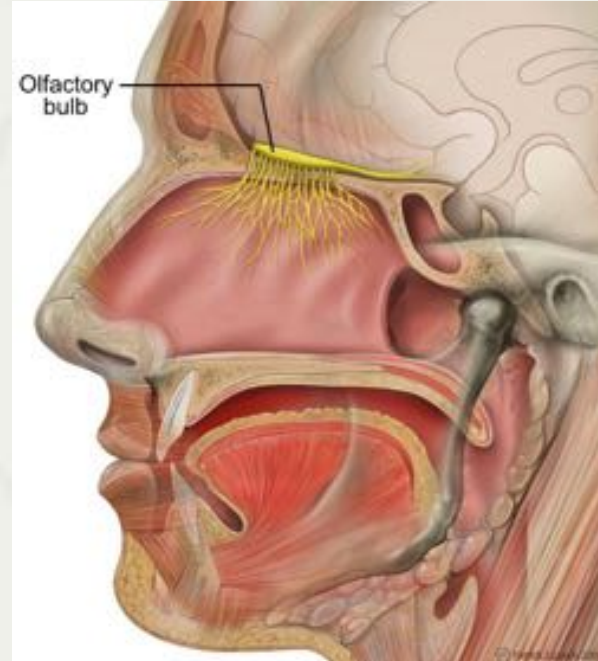
**Alveoli**  
Ultrafijne partikels  
<0.1  $\mu\text{m}$

Fijn stof

# Fijn stof - translocatie



Ultrafijne partikels ☼



# Gezondheidseffecten – gevoelige populaties

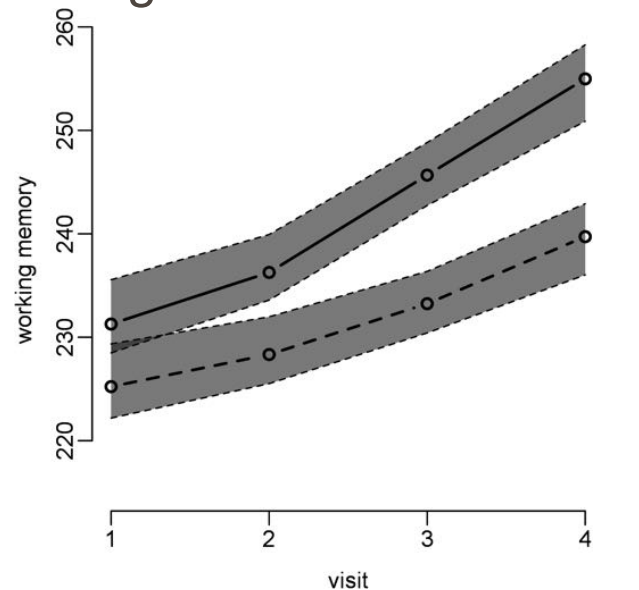
Cardiovasculaire – en respiratoire aandoeningen

Neurotoxisch?

- **Hogere blootstelling aan verkeer**

*Sunyer et al. PlosMed 2015*

→ Minder verbetering in cognitieve ontwikkeling



**Fig 2. Working memory development by high- or low-traffic-air-pollution school.**

Dashed line = high traffic air pollution; continuous line = low traffic air pollution; gray shading indicates 95% CIs.

Adjusted for age, sex, maternal education, residential neighborhood socioeconomic status, and air pollution exposure at home; school and individual as nested random effects in 2,715 children and 10,112 tests from 39 schools.

# Gezondheidseffecten – gevoelige populaties

Cardiovasculaire – en respiratoire aandoeningen

Neurotoxisch?

- **Chronische blootstelling aan PM<sub>2.5</sub>**

Saenen ND *et al.* Env Int 2016

→ gemiddelde PM<sub>2.5</sub> = 15.7 µg/m<sup>3</sup>

→ IQR = 1.16 µg/m<sup>3</sup>

→ Daling in aandacht

Attention						
	Continuous Performance Test			Stroop Test		
	msec	95% CI	p-value	msec	95% CI	p-value
<b>PM<sub>2.5</sub></b>	<b>9.45</b>	2.59 to 16.3	0.007	<b>59.9</b>	8.1 to 111.6	0.02

Adjusted for sex, age, familial socioeconomic position, out-of-school sport activities, and **residential traffic noise (day and night)**.

# Gezondheidseffecten – gevoelige populaties

Cardiovasculaire – en respiratoire aandoeningen

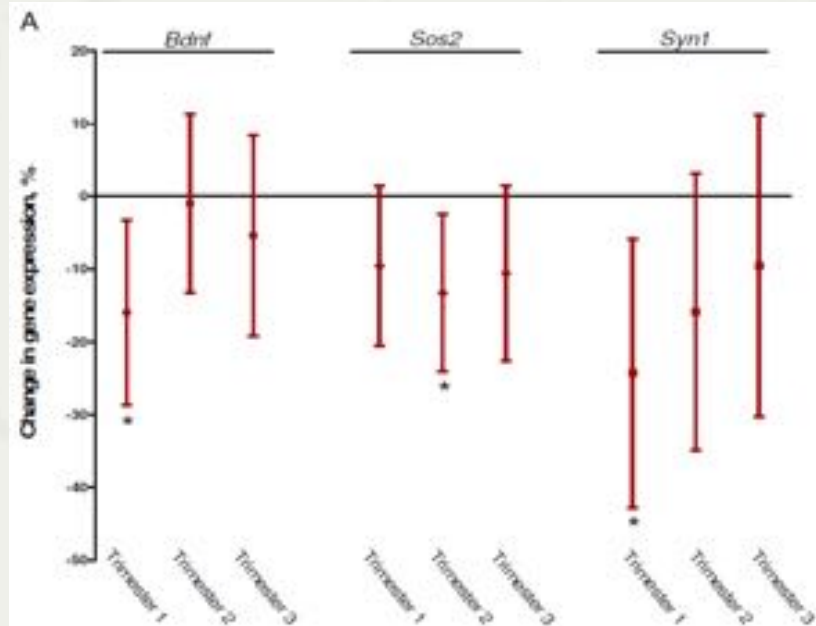
Neurotoxisch?

- **PM<sub>2.5</sub> tijdens zwangerschap**

Saenen ND *et al.* EHP 2015

→ 5  $\mu\text{g}/\text{m}^3$  stijging in PM<sub>2.5</sub>

→ daling in BDNF pathway genexpressie



Estimates were adjusted for newborn's sex, maternal age, maternal education, gestational age, cord blood insulin, placental sampling site, delivery date, season at birth, and NO<sub>2</sub> exposure. \* p < 0.05.

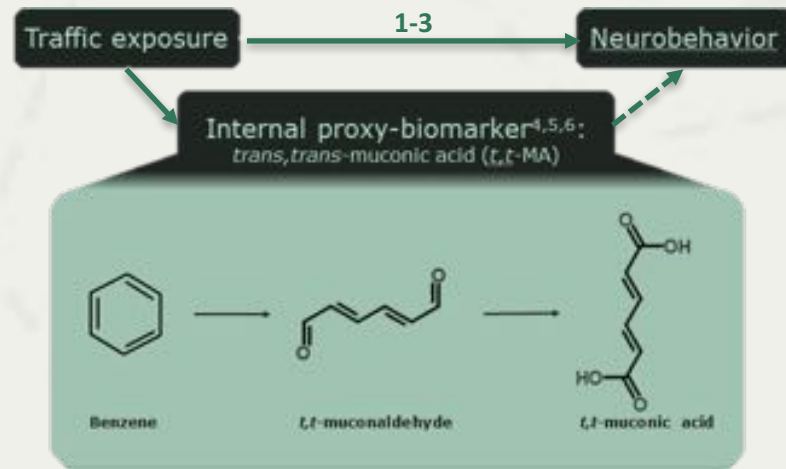
# Gezondheidseffecten – gevoelige populaties

Cardiovasculaire – en respiratoire aandoeningen

Neurotoxisch?

- ***Trans,trans* muconzuur als proxy-biomerker voor verkeersblootstelling**

Kicinski M, Saenen ND *et al.* Env Int 2016



1. Chiu Y. H. *et al.* 2013. Environ Health Perspect.  
2. Edwards S. C. *et al.* 2010. Environ Health Perspect.  
3. Kicinski M. *et al.* 2015. Environ Int.

4. Amodio-Cocchieri R. *et al.* 2001. J Toxicol Environ Health  
5. Arayasiri M. *et al.* 2010. Sci Total Environ.  
6. Fustinoni S. *et al.* 2005. Cancer Epidemiol Biomarkers Prev.

# *Trans,trans* muconzuur als proxy-biomarker voor verkeersblootstelling

895 non-smoking adolescents (14-15 years)

*t,t*-MA-U with ion-exchange chromatography  
Lead in blood (PbB) with ICP-MS

NO<sub>2</sub> – spatial temporal interpolation method/dispersion model  
Distance to major road – ArcGIS software

## Neurobehavioral evaluation system (NES3):

- Continuous Performance Test (Sustained attention)  
*(Mean reaction time/Errors of omission/Errors of commission)*
- Digit Span Test (Short-term memory)  
*(Maximum Span Forward/Maximum Span Backward)*

## Statistics

Individual cognitive tests: multiple regression analysis  
Combined cognitive tests: Mixed-effects models Z-scores





## ***Trans,trans* muconzuur als proxy-biomarker voor verkeersblootstelling**

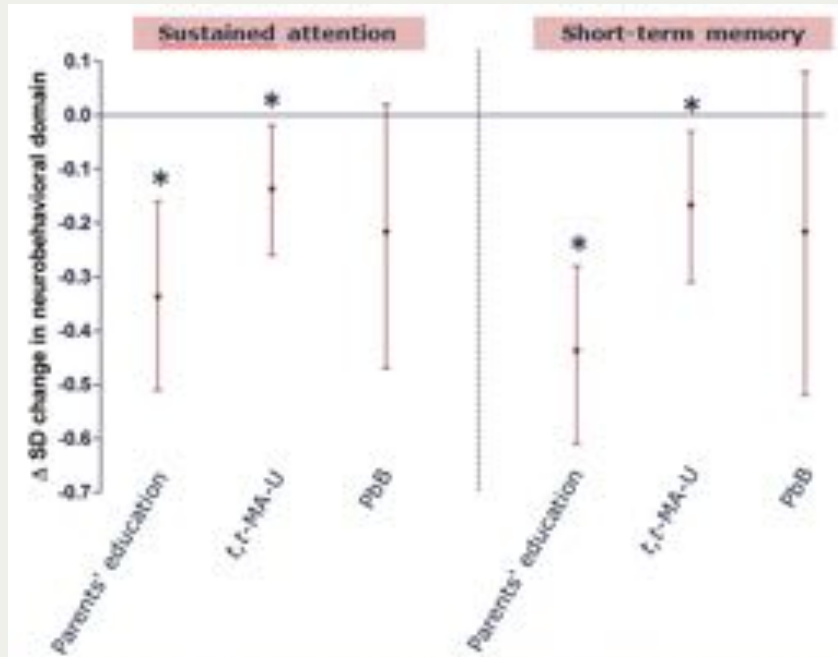
- 10  $\mu\text{g}/\text{m}^3$  stijging in recente  $\text{NO}_2$  blootstelling (72h)  $\rightarrow$  11.3% stijging in urinair *t,t*-MA
  - $\rightarrow$  Vergelijkbaar voor 1 week of 1 maand  $\text{NO}_2$  blootstelling
  - $\rightarrow$  Afstand tot weg niet geassocieerd met urinair *t,t*-MA

## *Trans,trans* muconzuur als proxy-biomarker voor verkeersblootstelling

	Parental education (low vs high)		t,t-MA-U		PbB	
	Effect size (95% CI)	p-value	Effect size (95% CI)	p-value	Effect size (95% CI)	p-value
<b>Continuous Performance Test</b>						
Mean reaction time, msec (N=832)	<b>12.2</b> <b>(3.17 to 20.9)</b>	<b>0.008</b>	<b>12.2</b> <b>(4.86 to 19.5)</b>	<b>0.001</b>	<b>19.1</b> <b>(2.43 to 35.8)</b>	<b>0.025</b>
Errors of omission, numbers (N=820)	<b>1.31</b> <b>(0.78 to 1.86)</b>	<b>&lt;0.0001</b>	<b>0.51</b> <b>(0.057 to 0.97)</b>	<b>0.028</b>	0.25 (-0.78 to 1.29)	0.63
Errors of commission, numbers (N=820)	<b>0.70</b> <b>(0.01 to 1.39)</b>	<b>0.05</b>	-0.22 (-0.79 to 0.35)	0.44	0.43 (-0.85 to 1.72)	0.51
<b>Digit Span Test</b>						
Max. span forward, digits	<b>-0.38</b> <b>(-0.60 to -0.17)</b>	<b>0.0004</b>	<b>-0.20</b> <b>(-0.38 to -0.026)</b>	<b>0.025</b>	-0.30 (-0.70 to 0.098)	0.14
Max. span backward, digits (N=881)	<b>-0.50</b> <b>(-0.70 to -0.13)</b>	<b>&lt;0.0001</b>	-0.15 (-0.32 to 0.022)	0.088	-0.14 (-0.53 to 0.25)	0.48

The effect size is shown for a ten-fold increase in the biomarkers of exposure as reflected by the level of t,t-MA-U and PbB. All models allowed for sex, age, passive smoking, parental education level, ethnicity, urinary creatinine, time of the day, day of the week, and study period. The models for t,t-MA-U were additionally adjusted for PbB and vice versa. The models for parental education were adjusted for the same covariates and the two biomarkers of exposures.

# *Trans,trans* muconzuur als proxy-biomarker voor verkeersblootstelling



Results are expressed as the **number of standard deviations change** in the neurobehavioral domains.

All models allowed for sex, age, passive smoking, parental education level, ethnicity, urinary creatinine, time of the day, day of the week, and study period.

\*p < 0.05.

## RELEVANTIE

### VOLKSGEZONDHEID:

***t,t*-MA-U** heft een effect-grootte vergelijkbaar met **±40%** van de effect-grootte van de **opleiding van de ouders** op langdurige aandacht en kortetermijn geheugen

# Conclusie

- Luchtvervuiling → neurocognitieve prestatievermogen
  - Aandacht en korte-termijn geheugen
- *t,t*-MA als proxy-biomarker van verkeers-gerelateerde blootstelling
- Relevantie volksgezondheid/beleid:
  - Effect van luchtvervuiling op cognitie ↔ socio-economische achtergrond
  - Effect luchtvervuiling ± 1/3<sup>de</sup> van socio-economische achtergrond

