

WETENSCHAPPELIJK INSTITUUT VOLKSGEZONDHEID

INSTITUT SCIENTIFIQUE DE SANTÉ PUBLIQUE



### Air pollution and public health

A. Van Nieuwenhuyse

CORDEX meeting, September 25, 2017

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#### Air pollution and health



#### Short-term (hours - days) and long-term exposure to air pollution (PM, NO<sub>2</sub>, etc)



autonomic, hemostatic, inflammatory, vascular endothelial disturbances



#### Cardiovascular morbidity and mortality

Myocardial infarction, arrhythmias, heart failure, stroke, etc.

#### Respiratory morbidity and lung function

Poor asthma control, decline in lung function, childhood infections.

#### Neurological effects

Delayed psychomotor development (children), cognitive function decline (elderly).



In 2015, ambient PM2.5 was the fifth-ranked risk factor for global deaths among the risk factors included in the GBD.

1990 rank	2015 rank
1 High systolic blood pressure	1 High systolic blood pressure
2 Smoking	2 Smoking
3 Childhood undernutrition	3 High fasting plasma glucose
4 Ambient particulate matter pollution	4 High total cholesterol
5 Household air pollution from solid fuels	5 Ambient particulate matter pollution
6 High total cholesterol	6 Diet high in sodium
7 High fasting plasma glucose	7 High body-mass index
8 Diet high in sodium	8 Diet low in whole grains
9 High body-mass index	9 Diet low in fruits
10 Unsafe water source	10 Household air pollution from solid fuels
11 Diet low in whole grains	11 Impaired kidney function
12 Diet low in fruits	12 Alcohol use
13 Alcohol use	13 Diet low in nuts and seeds
14 Unsafe sanitation	14 Diet low in vegetables
15 No handwashing with soap	15 Low physical activity
16 Diet low in vegetables	16 Diet low in seafood omega3 fatty acids
17 Impaired kidney function	17 Unsafe sex
18 Diet low in nuts and seeds	18 Childhood undernutrition
19 Suboptimal breastfeeding	19 Unsafe water source
20 Low physical activity	20 No handwashing with soap
21 Diet low in seafood omega3 fatty acids	21 Second-hand smoke
22 Second-hand smoke	22 Unsafe sanitation
23 Unsafe sex	23 Diet high in processed meat
24 Diet high in processed meat	24 Suboptimal breastfeeding



# Global Burden of Disease (GBD 2015)

In 2015,

ambient PM2.5 was the sixth-ranked risk factor for DALYs (disability-adjusted life years) among the risk factors included in the GBD.

1 Childhood undernutrition	1 High systolic blood pressure
2 Unsafe water source	2 Smoking
3 High systolic blood pressure	3 High fasting plasma glucose
4 Household air pollution from solid fuels	4 High body-mass index
5 Smoking	5 Childhood undernutrition
6 Ambient particulate matter pollution	6 Ambient particulate matter pollution
7 Unsafe sanitation	7 High total cholesterol
8 Suboptimal breastfeeding	8 Household air pollution from solid fuels
9 No handwashing with soap	9 Alcohol use
10 High fasting plasma glucose	10 Diet high in sodium
11 Alcohol use	11 Diet low in whole grains
12 High total cholesterol	12 Unsafe sex
13 High body-mass index	13 Diet low in fruits
14 Diet high in sodium	14 Unsafe water source
15 Diet low in whole grains	15 Impaired kidney function
16 Diet low in fruits	16 Iron deficiency
17 Iron deficiency	17 Diet low in nuts and seeds
18 Second-hand smoke	18 No handwashing with soap
19 Vitamin A deficiency	19 Unsafe sanitation
20 Unsafe sex	20 Diet low in vegetables
21 Impaired kidney function	21 Low physical activity
22 Diet low in vegetables	22 Suboptimal breastfeeding
23 Diet low in nuts and seeds	23 Second-hand smoke
24 Low physical activity	24 Vitamin A deficiency



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# Respiratory medication sales and air pollution in Brussels (2005 to 2011)

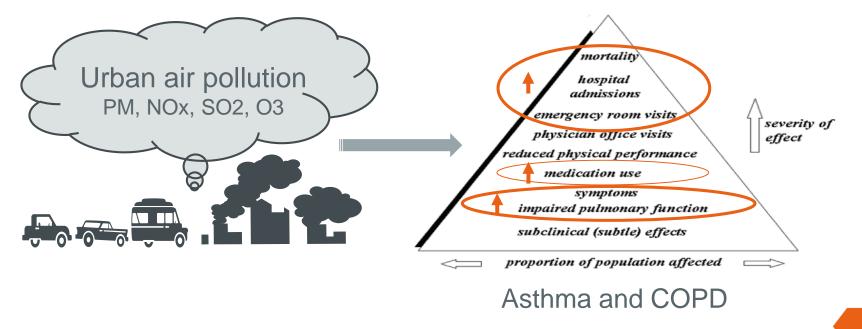
A. Van Nieuwenhuyse, K. Simons, T. Nawrot, O. Brasseur, P. Declerk, R. Buyl, D. Coomans, B. Nemery & L. Casas

CORDEX meeting, September 25, 2017

# Background



#### Air pollution, asthma and COPD



Atkinson et al. 2014. Thorax; Pitard et al. 2004. Environ. Res.; Zeghnoun et al. 1999. Environ. Res. Vegni et al. 2005. Eur J Epidemiology; Gent et al. 2009. EHP .be





We investigated the association between air pollution ( $PM_{10}$  and  $NO_2$ ) and reimbursement data of prescribed asthma and COPD medication in the Brussels-Capital Region (2005 to 2011).



Where? Brussels Capital region

When? 01/01/2005 to 31/12/2011

Who? All registered inhabitants

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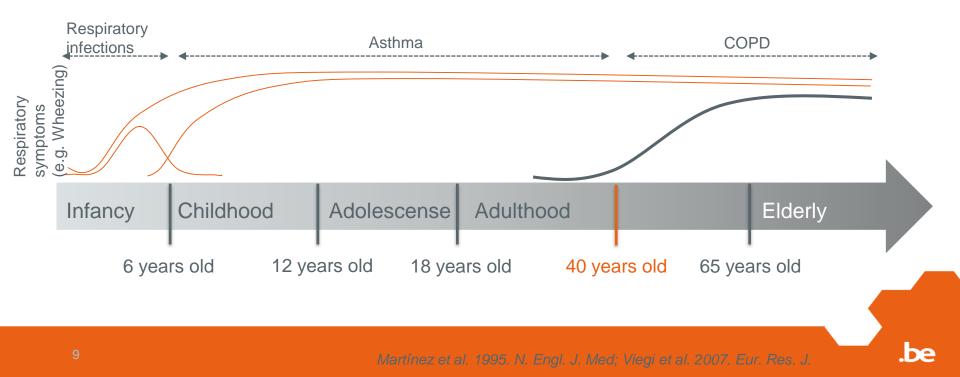


#### 7 age groups

Infancy	Childhood	Adolescense	Adulthood		Elderly	
6 yea	rs old 12 ye	ars old 18 yea	ars old 40 yea	ars old 65 yea	l ars old 85 yea	ars old



#### Evolution of chronic respiratory conditions: Asthma and COPD



Data

**Methods** 

#### Asthma and COPD medication: reimbursment.

Database with records of sales of prescribed drugs that are reimbursed for every person covered by the social security.

#### ATC code R03: Asthma and COPD medication.

- All medication.
- Short acting.

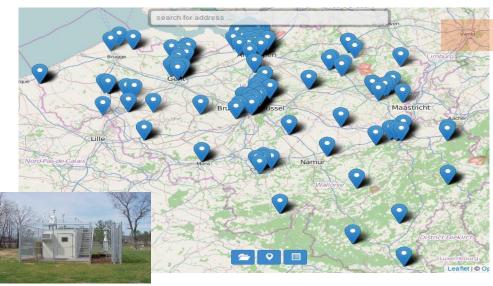




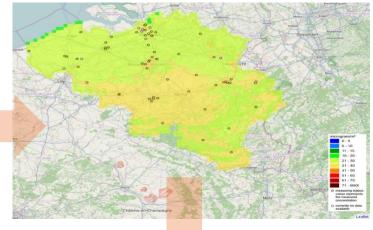
# Methods

Data

#### Air pollution: PM<sub>10</sub> and NO<sub>2</sub> Monitoring stations



Air pollutant model (4x4km resolution): source, meteorology, physico-chemical SP characteristics, transport.



Daily average concentrations in the Brussels Capital Region





Additional data: confounders, effect modifiers, etc.

- Age and sex: IMA-AIM database
- Daily meteorological conditions: temperature and relative humidity (from the Belgian Royal Meteorological Institute).
- Weekly influenza-like infections: Binary indicator defined by an epidemic threshold of 140 visits per 100,000 inhabitants per week during two consecutive weeks.



<u>Table 1:</u> Description of the concentrations ( $\mu$ g/m<sup>3</sup>) of PM<sub>10</sub> and NO<sub>2</sub>, and the average relative humidity (RH, %), and minimum temperatures (t<sub>min</sub>, ° C) in Brussels-Capital Region (Belgium).

	PM <sub>10</sub>	NO <sub>2</sub>	RH	tmin
Minimum	6.0	8.2	31,9	-8.1
P25	(0,D	20.4	68.5	3.4
Median	25.0	38.0	77.6	8,1
Mean	29.0	39.6	75.6	7.6
P75	35.7	48,9	84.2	12.4
Maximum	119.5	124.8	99,8	21,9
WHO recommendations	20	40	-	-
(annual means)				
European Community recommendations	40	40	-	-
(annual means)				



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<u>Fig 1:</u> Time-series plot of concentrations of  $PM_{10}$  and  $NO_2$  (µg/m<sup>3</sup>), in Brussels-Capital Region (Belgium).

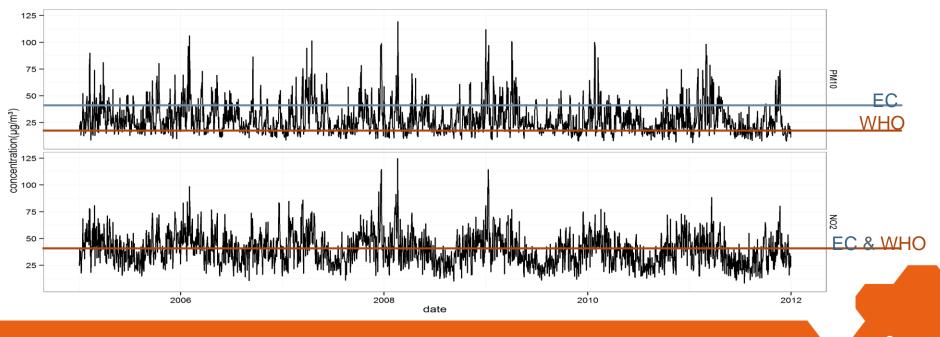
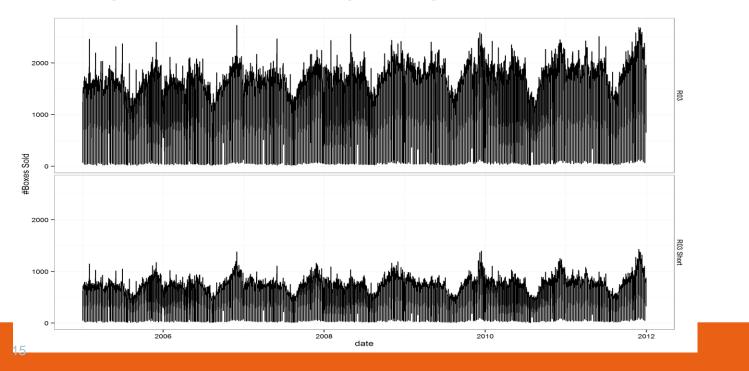




Fig 2: Time-series plot of daily sales of **asthma and COPD medication** (all and short-acting) in Brussels-Capital Region (Belgium).





<u>Fig 3:</u> Estimated **cumulative relative risks (RR)**\* and their 95% confidence intervals of sales of asthma and COPD medication per IQR ( $17.1\mu g/m3$ ) increase in the concentration of **PM10**, by age group.

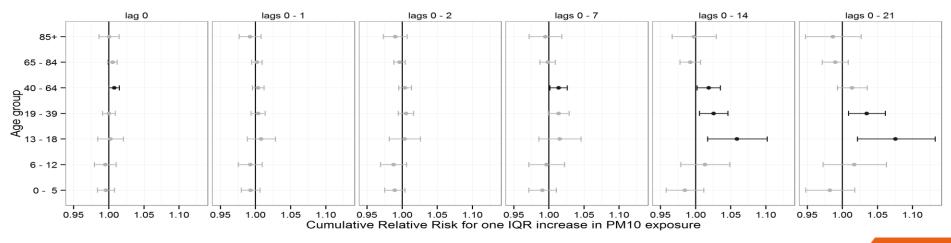




Fig 3 (ct'd): Estimated cumulative relative risks (RR)\* and their 95% confidence intervals of sales of asthma and COPD medication per IQR ( $17.1\mu g/m3$ ) increase in the concentration of PM10, by age group.

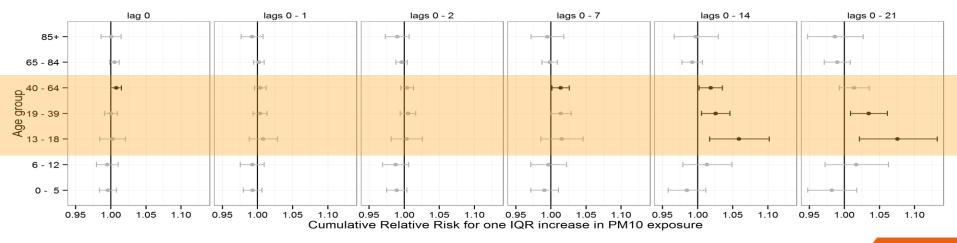
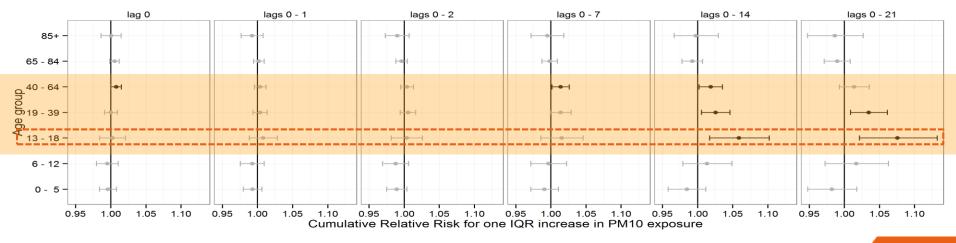


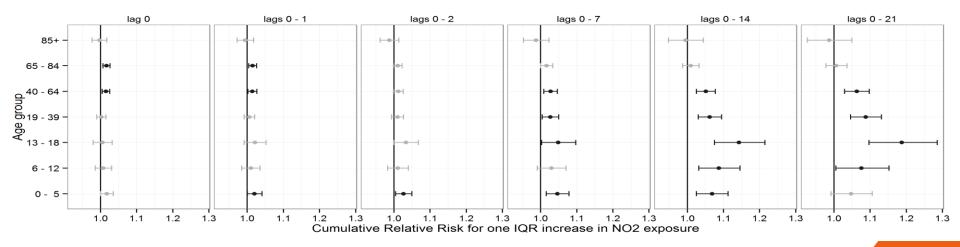


Fig 3 (ct'd): Estimated cumulative relative risks (RR)\* and their 95% confidence intervals of sales of asthma and COPD medication per IQR ( $17.1\mu g/m3$ ) increase in the concentration of PM10, by age group.



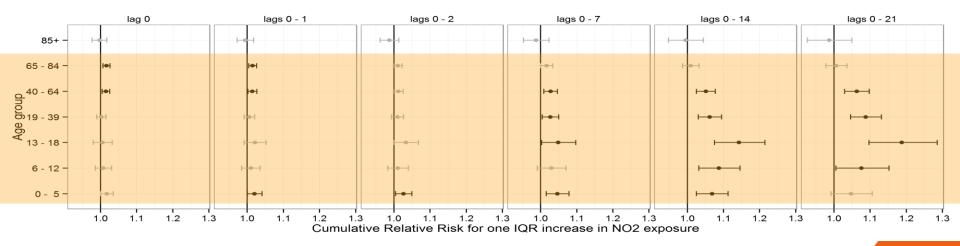


<u>Fig 4:</u> Estimated **cumulative relative risks (RR)**\* and their 95% confidence intervals of sales of asthma and COPD medication per IQR (20.5µg/m3) increase in the concentration of **NO2**, by age group.



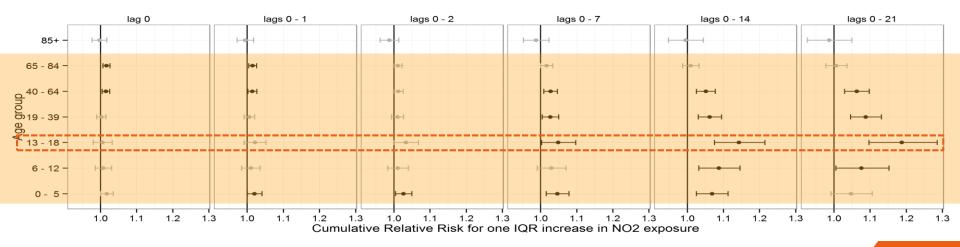


<u>Fig 4 (ct'd)</u>: Estimated **cumulative relative risks (RR)**\* and their 95% confidence intervals of sales of asthma and COPD medication per IQR ( $20.5\mu g/m3$ ) increase in the concentration of **NO2**, by age group.





<u>Fig 4 (ct'd)</u>: Estimated **cumulative relative risks (RR)**\* and their 95% confidence intervals of sales of asthma and COPD medication per IQR ( $20.5\mu g/m3$ ) increase in the concentration of **NO2**, by age group.



### **Results and discussion**



We demonstrate that concentrations of PM10 and NO2 are associated with daily sales of asthma and COPD medications in Brussels. These results are consistent with previous research.

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We demonstrate that concentrations of PM10 and NO2 are associated with daily sales of asthma and COPD medications in Brussels. These results are consistent with previous research.

Limitations	Strengths
Air pollution measurements: lack of precission	Largest study: 1 milion residents and 7years
Changes in exposure during commuting	Recent data (2005 – 2011)
Strong correlation between pollutants	7 age groups
Medication: Reinbursement instead of consumption or diagnosis	Long lags (up to 21 days)





High concentrations of urban air pollutants, in particular of NO2, are associated with increased sales of prescribed asthma and COPD medication, from birth to young elderly ages.

### **Publications**



Casas L, Simons K, Nawrot TS, Brasseur O, Declerck P, Buyl R, Coomans D, Nemery B, Van Nieuwenhuyse A. Respiratory medication sales and urban air pollution in Brussels (2005 to 2011). Environment International 2016, Jun 23. pii: S0160-4120(16)30237-9

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Science of the Total Environment 2016; 562: 760-5.

Guilbert A, Simons K, Hoebeke L, Packeu A, Hendrickx M, De Cremer K, Buyl R, Coomans D, Van Nieuwenhuyse A. Short-term effect of pollen and spore exposure on allergy morbidity in the Brussels-Capital Region. Ecohealth 2016, May 12. Epub ahead of print.

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Ensemble post-processing is a promising method to obtain flexible distributed lag models. A simulation study of time series of air pollution and daily mortality.

Air Quality, Atmosphere & Health. 2016; 1-12. First online Jan 9.

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- The Royal Meteorological Institute for supplying data on meteorological conditions

## Methods

ATC code	Definition	
R03	Asthma and COPD medication	
Inhaled		
R03AC	Selective beta-2-adrenoreceptor agonists	isp
R03AC02	Salbutamol*	
R03AC03	Terbutaline	
R03AC12	Salmeterol	
R03AC13	Formoterol	
R03AC18	Indacaterol	
R03AK	Adrenergics in combination with corticosteroids or other drugs	
R03AK03	Fenoterol and ipratropium bromide*	
R03AK04	Salbutamol and ipratropium bromide*	
R03AK06	Salmeterol and fluticasone	
R03AK07	Formoterol and budesonide	
R03BA	Glucocorticoids	
R03BA01	Beclometasone	
R03BA02	Budesonide	
R03BA05	Fluticasone	
R03BB	Anticholinergics	
R03BB01	Ipratropium bromide	
R03BB04	Tiotropium bromide	
R03BC	Antiallergic agents, excluding corticosteroids	
R03BC01	Cromoglicic acid	
Systemic		
R03CC	Selective beta-2-adrenoreceptor agonists	
R03CC02	Salbutamol	
R03CC03	Terbutaline	
R03CC04	Fenoterol	
R03CC11	Tulobuterol	
R03DA	Xanthines	
R03DA04 R03DA08	Theophylline	
R03DA08	Bamifylline	
R03DC01	Leukotriene receptor antagonists	
R03DC01	Montelukast	
RUSDCUS	IVIUITIEIUKASI	

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\*Short acting medication