

Air pollution and public health

A. Van Nieuwenhuysse

CORDEX meeting, September 25, 2017

Short-term (hours - days) and long-term exposure to air pollution (PM, NO₂, 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.

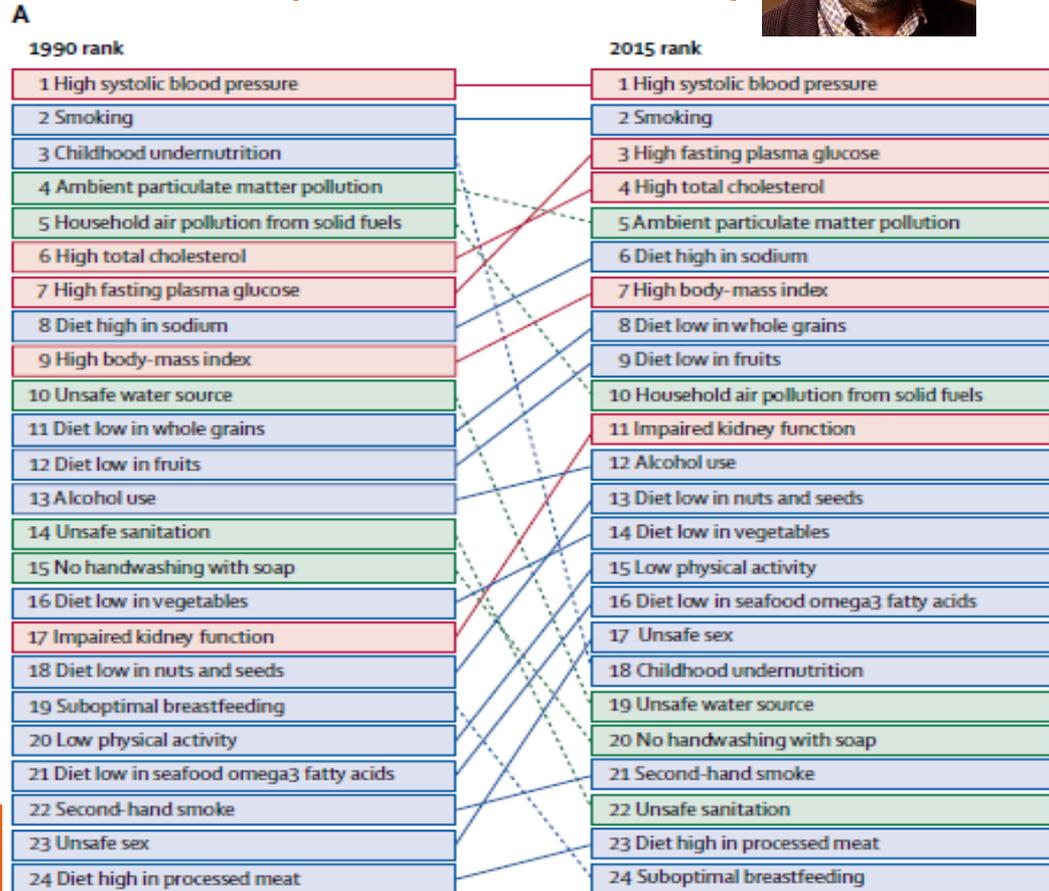
Neurological effects

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

Global Burden of Disease (GBD 2015)



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



Global Burden of Disease (GBD 2015)



In 2015, ambient PM_{2.5} was the sixth-ranked risk factor for DALYs (disability-adjusted life years) among the risk factors included in the GBD.



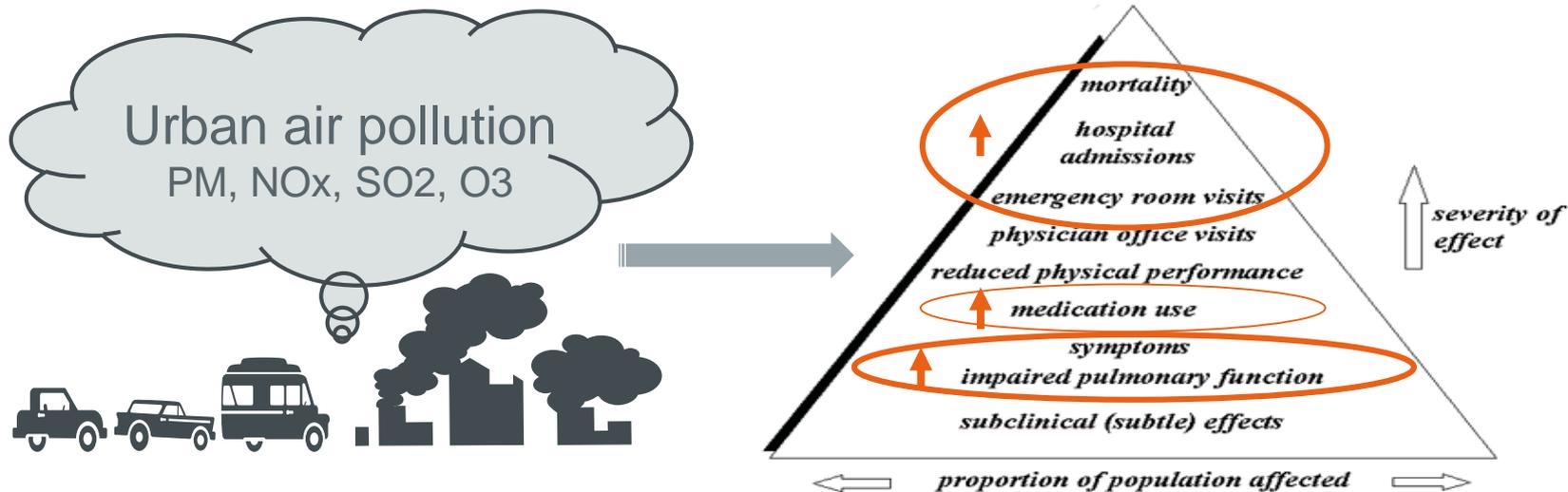
Respiratory medication sales and air pollution in Brussels (2005 to 2011)

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

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Background

Air pollution, asthma and COPD



Asthma and COPD

Objectives



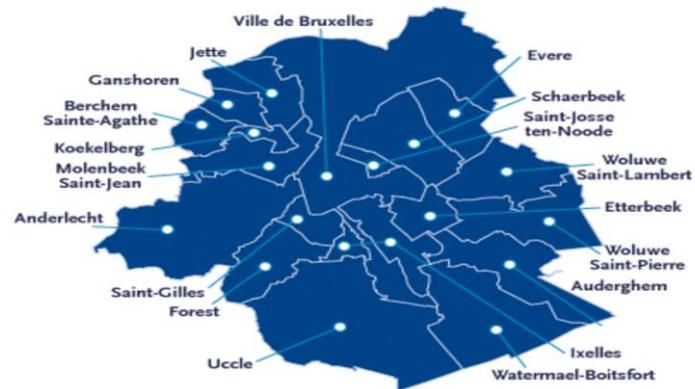
We investigated the association between air pollution (PM_{10} and NO_2) and reimbursement data of prescribed asthma and COPD medication in the Brussels-Capital Region (2005 to 2011).

Methods

Where? Brussels Capital region

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

Who? All registered inhabitants

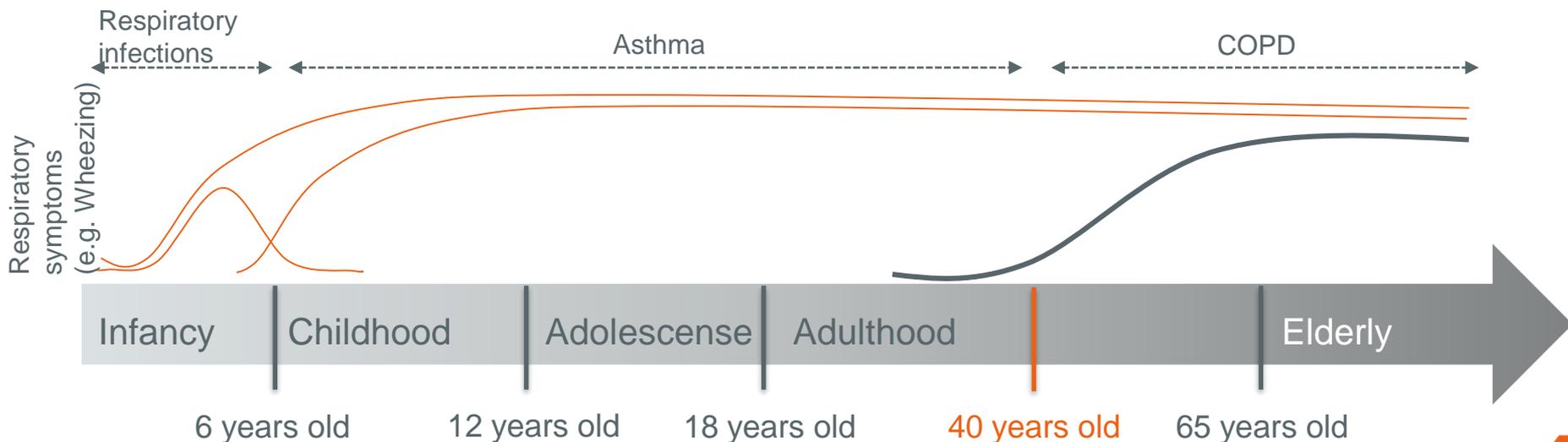


7 age groups





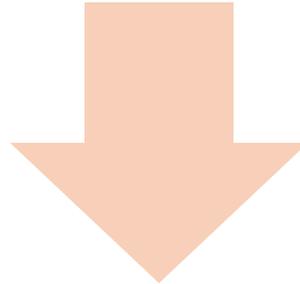
Evolution of chronic respiratory conditions: Asthma and COPD



Methods

Data

Asthma and COPD medication: reimbursement.



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

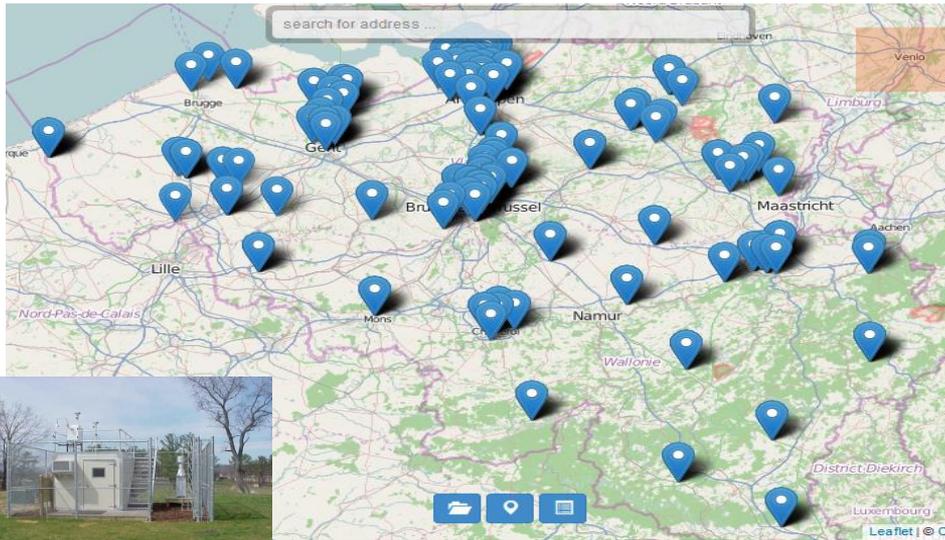
ATC code R03: Asthma and COPD medication.

- All medication.
- Short acting.

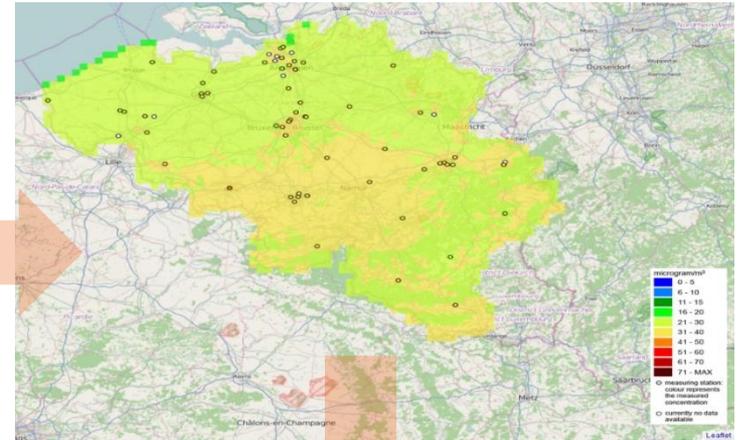
Methods

Data

Air pollution: PM_{10} and NO_2
Monitoring stations



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



Daily average concentrations
in the Brussels Capital Region

Methods

Data



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.

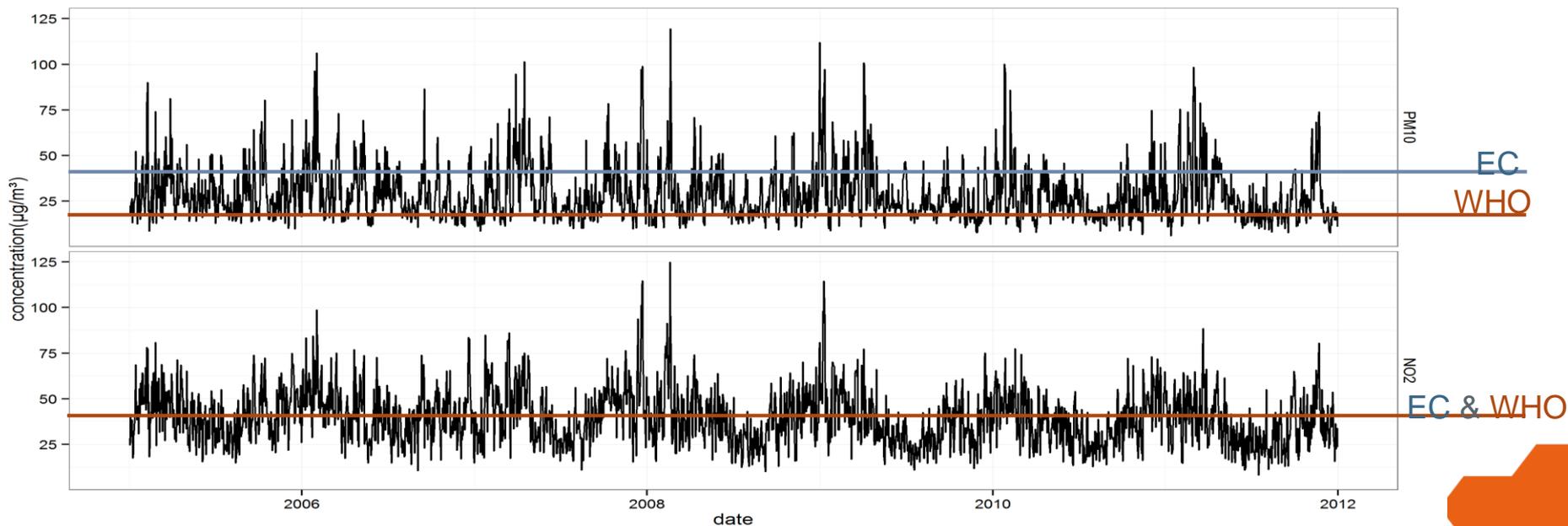
Results

Table 1: Description of the concentrations ($\mu\text{g}/\text{m}^3$) of PM_{10} and NO_2 , and the average relative humidity (RH, %), and minimum temperatures (t_{min} , $^{\circ}\text{C}$) in Brussels-Capital Region (Belgium).

	PM_{10}	NO_2	RH	t_{min}
Minimum	6.0	8.2	31.9	-8.1
P25	18.0	28.4	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 (annual means)	20	40	-	-
European Community recommendations (annual means)	40	40	-	-

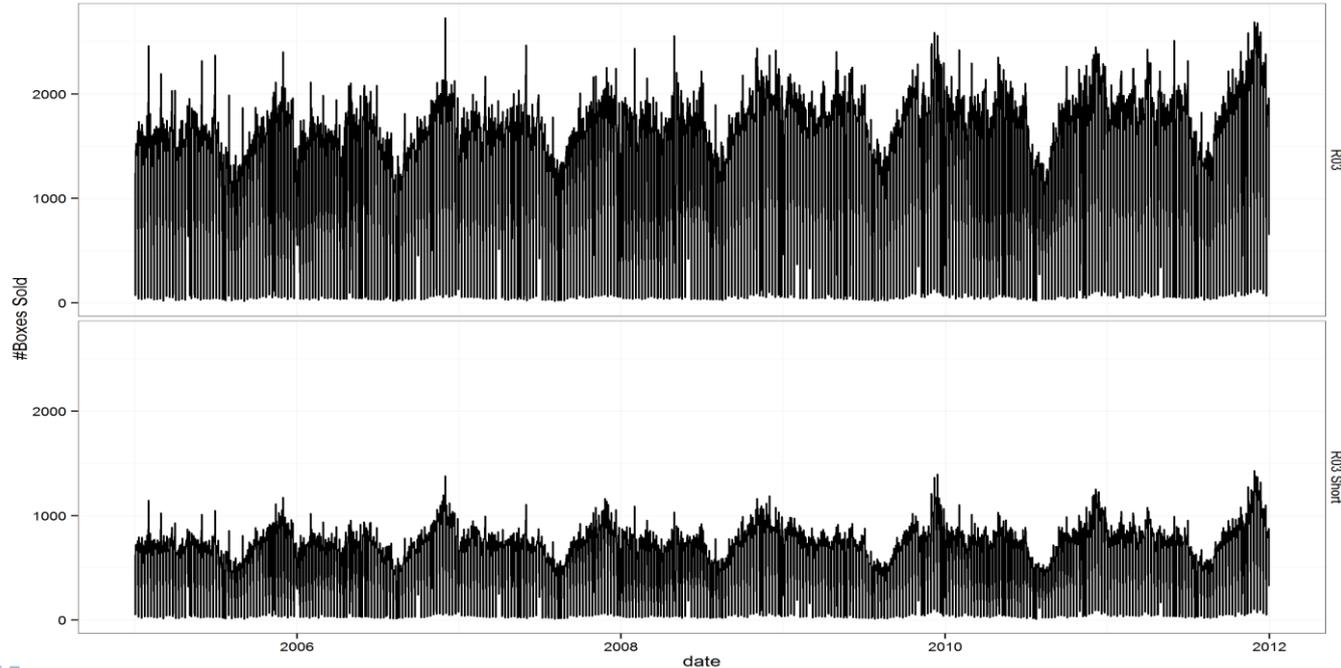
Results

Fig 1: Time-series plot of concentrations of **PM₁₀** and **NO₂** ($\mu\text{g}/\text{m}^3$), in Brussels-Capital Region (Belgium).



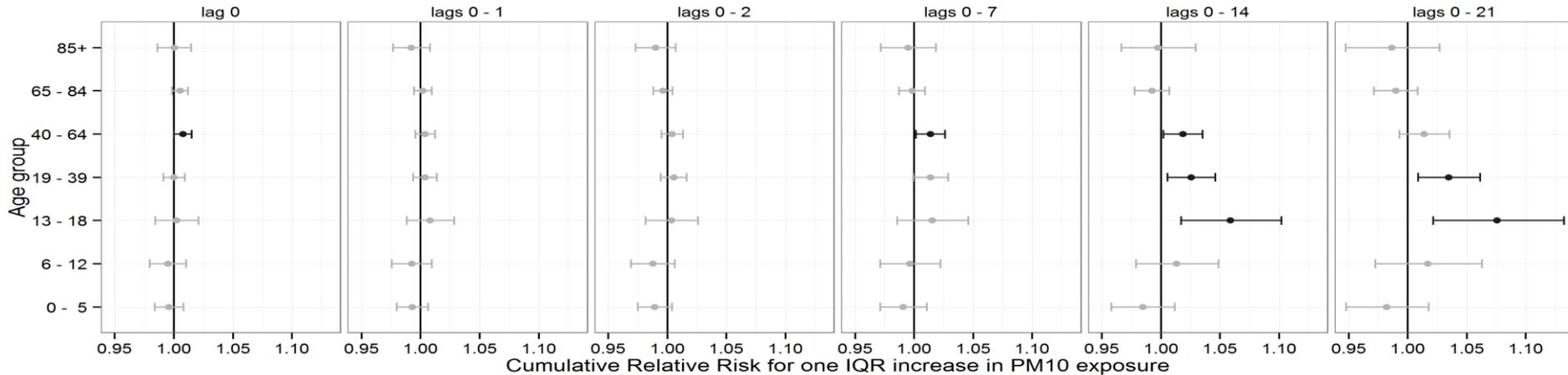
Results

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



Results

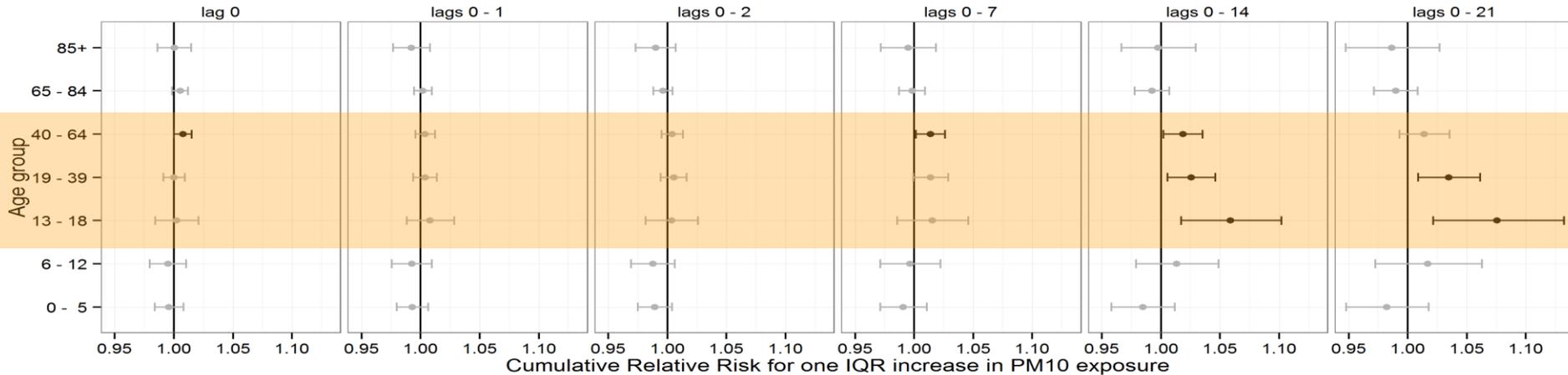
Fig 3: Estimated **cumulative relative risks (RR)*** and their 95% confidence intervals of sales of asthma and COPD medication per IQR ($17.1\mu\text{g}/\text{m}^3$) increase in the concentration of **PM10**, by age group.



*Adjusted for daily minimum temperature, average relative humidity, day of the week and influenza epidemics.

Results

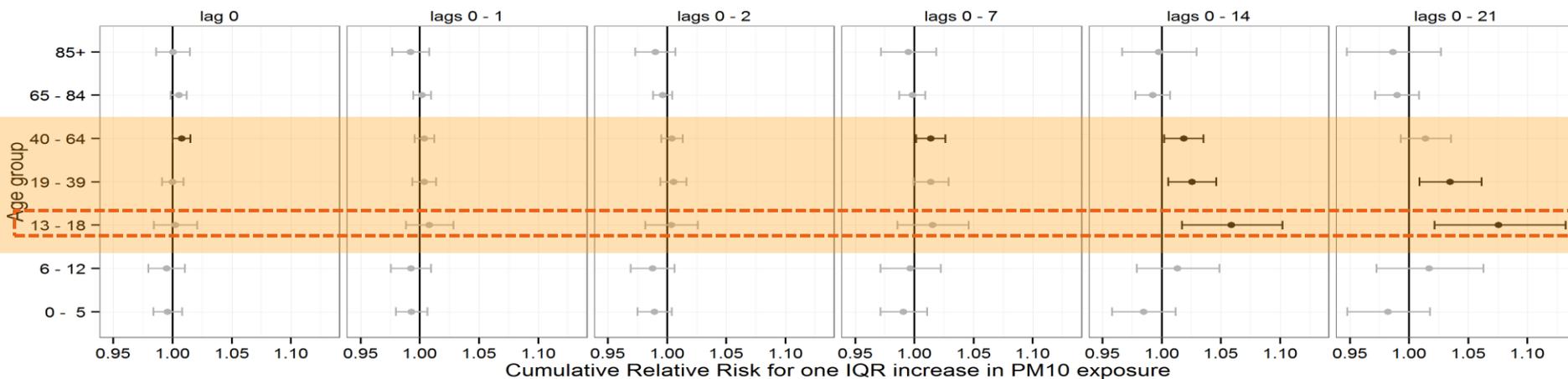
Fig 3 (ct'd): Estimated **cumulative relative risks (RR)*** and their 95% confidence intervals of sales of asthma and COPD medication per IQR ($17.1\mu\text{g}/\text{m}^3$) increase in the concentration of **PM10**, by age group.



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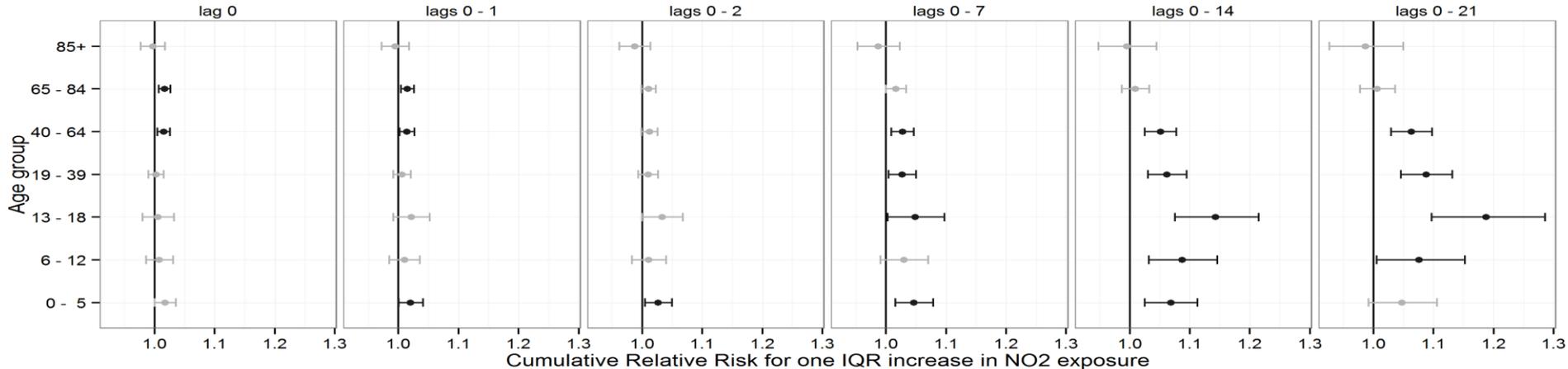
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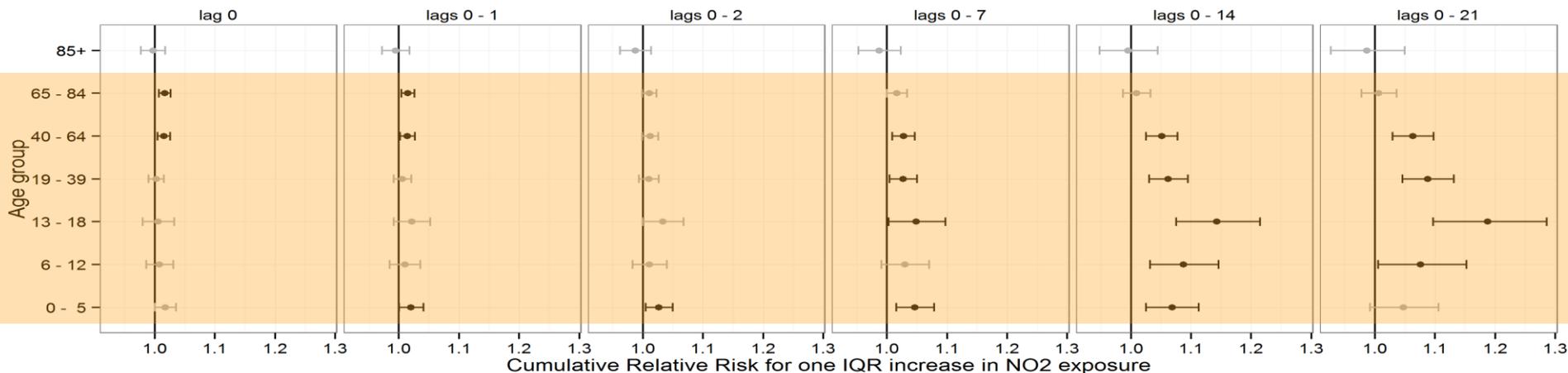
Fig 4: Estimated **cumulative relative risks (RR)*** and their 95% confidence intervals of sales of asthma and COPD medication per IQR (20-5 $\mu\text{g}/\text{m}^3$) increase in the concentration of **NO₂**, by age group.



*Adjusted for daily minimum temperature, average relative humidity, day of the week and influenza epidemics.

Results

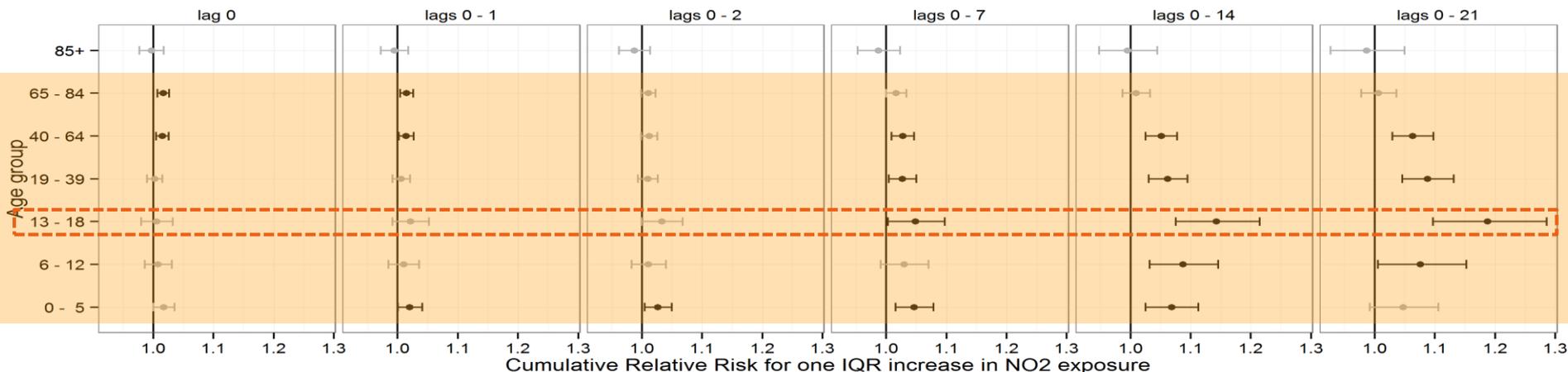
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Results

Fig 4 (ct'd): Estimated **cumulative relative risks (RR)*** and their 95% confidence intervals of sales of asthma and COPD medication per IQR (20.5 $\mu\text{g}/\text{m}^3$) increase in the concentration of **NO₂**, by age group.



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

Conclusion



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

Simons K, Devos S, Putman K, Coomans D, Van Nieuwenhuyse A, Buyl R.
Direct cost saving potential in medication costs due to a reduction in outdoor air pollution for the Brussels
CapitalRegion.
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.

Simons K, De Smedt T, Van Nieuwenhuyse A, Buyl R, Coomans D.
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.

Acknowledgements



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- The Interregional Communication Cell for the Environment (IRCEL-CELINE) and Brussels Environment (IBGE-BIM) for supplying data on air pollutants
- 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
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	Theophylline
R03DA08	Bamifylline
R03DC	Leukotriene receptor antagonists
R03DC01	Zafirlukast
R03DC03	Montelukast

*Short acting medication