



ARCHIMEDES
AIR Climate Health Impact in the
MEDITERRANEAN Eastern and Southern regions)



CASE STUDY 1 - The hidden economic burden of air pollution-related morbidity

Olivier Chanel

Aix-Marseille School of Economics - CNRS, France

Research director at French National Center for Scientific Research

Email: olivier.chanel@univ-amu.fr

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ORIGINAL PAPER

The hidden economic burden of air pollution-related morbidity: evidence from the Aphekom project

Olivier Chanel¹ · Laura Perez^{2,3} · Nino Künzli^{2,3} · Sylvia Medina⁴ ·
Aphekom group

(2) Swiss Tropical and Public Health Institute, Basel, and University of Basel, CH.

(3) The French Institute for Public Health / Santé publique France, Saint-Maurice, F.

Reference: Chanel O., Perez L., Künzli N., and Medina S. (2016) The hidden economic burden of air pollution-related morbidity: evidence from the Aphekom project, *European Journal of Health Economics*, 17(9), 1101–15,
Available at <http://link.springer.com/article/10.1007/s10198-015-0748-z>

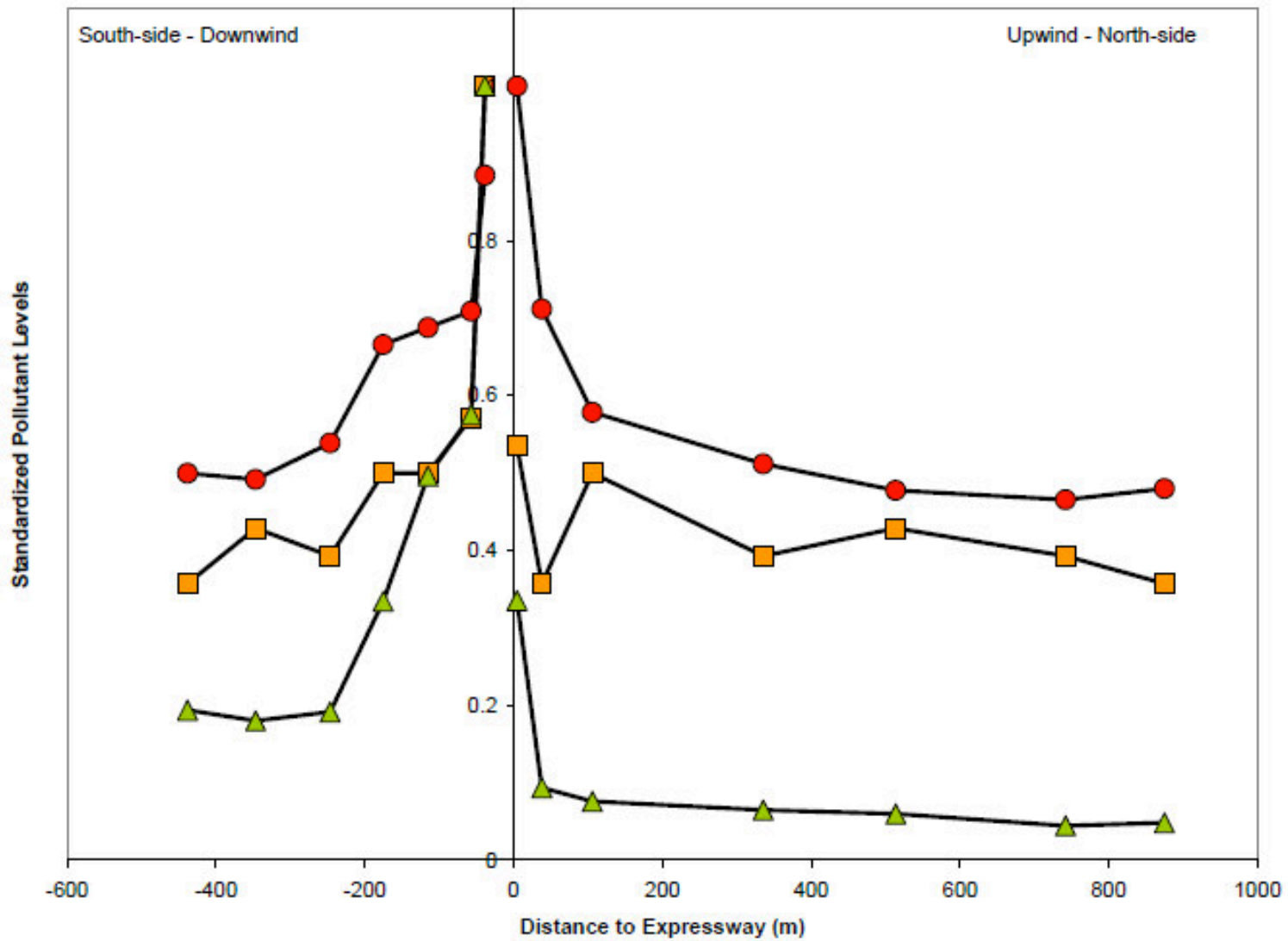
MOTIVATIONS

- Studies of health effects from exposure to AP have generally shown that LT health effects are much more severe than ST ones.

BUT

- Although chronic diseases (CD) are the likely contributors to the mortality impact, the burden of the chronic morbidity attributable to AP is not explicitly evaluated (except chronic bronchitis).
- Numerous studies indicate that AP can contribute to the development of chronic pathologies (the new onset of the disease).
- Evidence of health effects due to living in proximity to busy roads is growing fast => Near Road Traffic-related Pollution (NRTP) may capture something better than Background Pollution (BP).

Traffic proximity and exposure (Beckerman et al. 2008)





SPECIAL REPORT 17

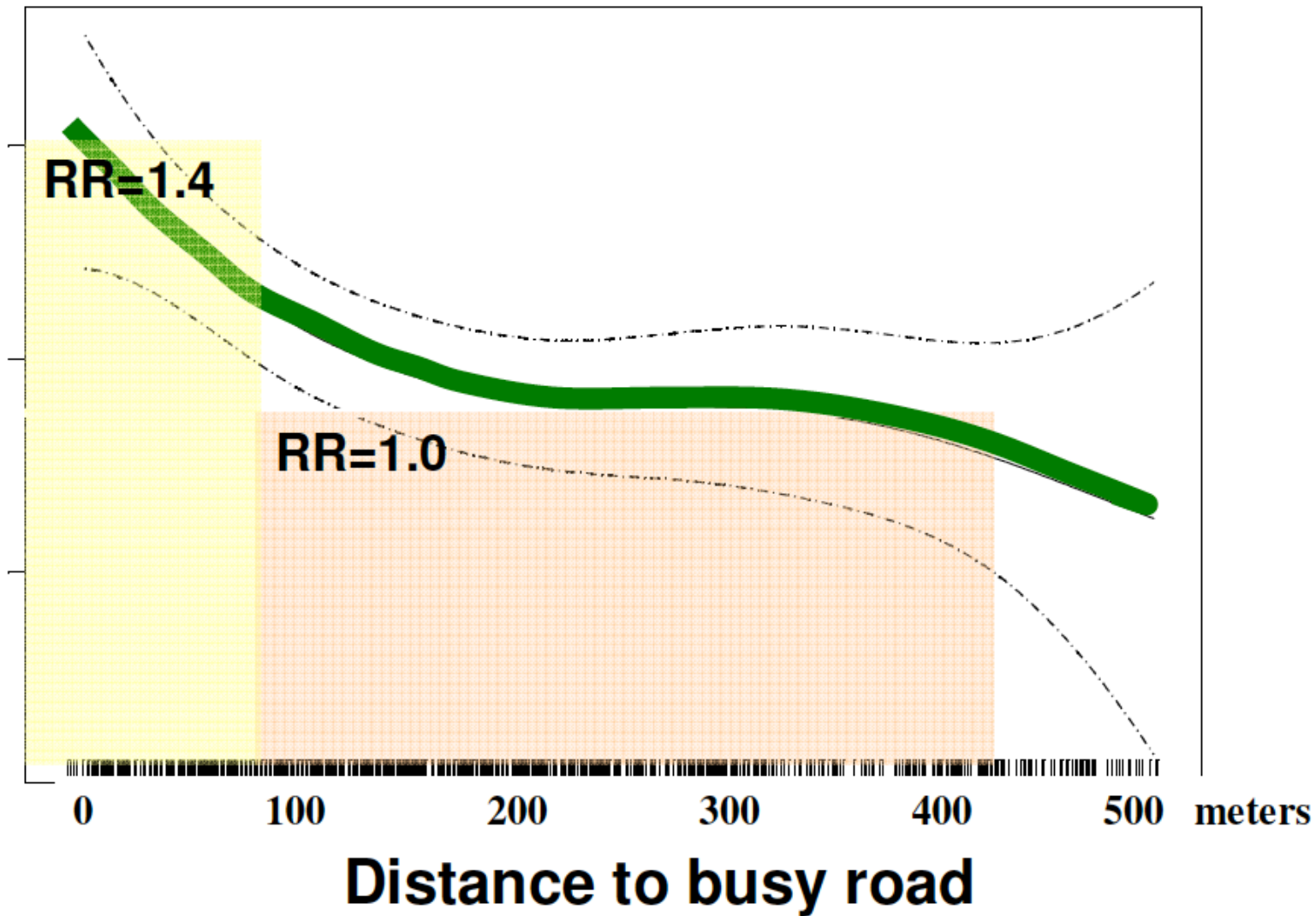
HEALTH
EFFECTS
INSTITUTE

January 2010

Traffic-Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects

HEI Panel on the Health Effects
of Traffic-Related Air Pollution

Asthma risk in children



McConnell et al, EHP2006

Objectives of this case study

Methodology

- Provide a step-by-step economic assessment of AP-related morbidity:
 - a “comprehensive air pollution HIA” that integrates effects of CD and acute diseases (exacerbation).
 - a monetary assessment of this comprehensive HIA.

Application

Estimate the health impacts and the economic impacts of air pollution with the standard HIA and with the comprehensive HIA for 10 European cities of the Aphekom project.

OUTLINE

1 Methodology

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12 How to develop a metric of traffic exposure

13 Methodological issues in economic assessment

2 Application

21 Collecting the relevant epidemiological data

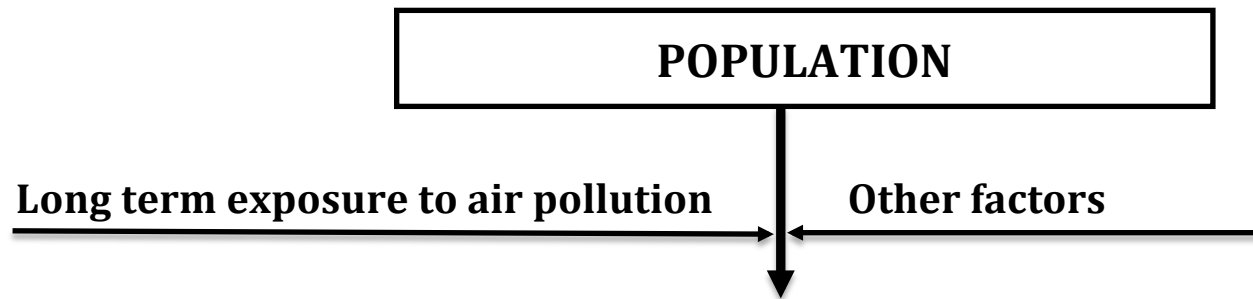
22 Collecting the relevant economic data

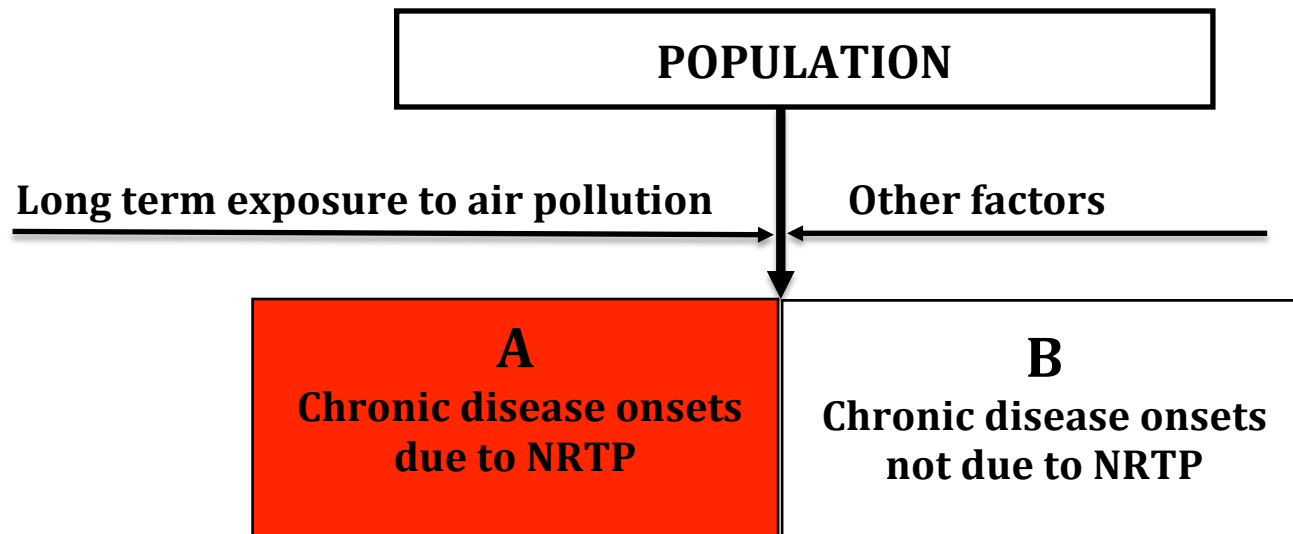
23 Annual health and economic assessments of the two HIA

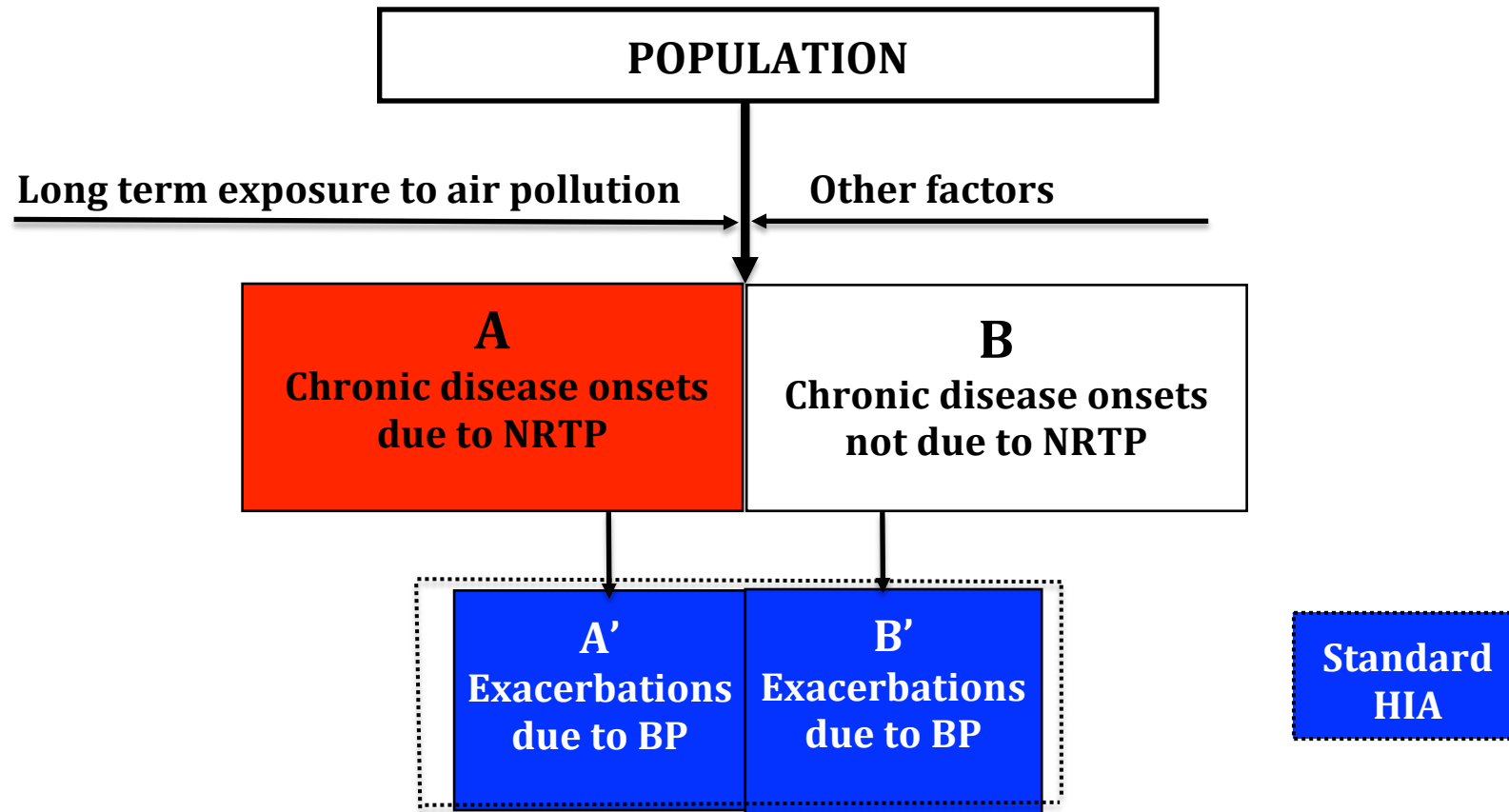
3 Concluding remarks

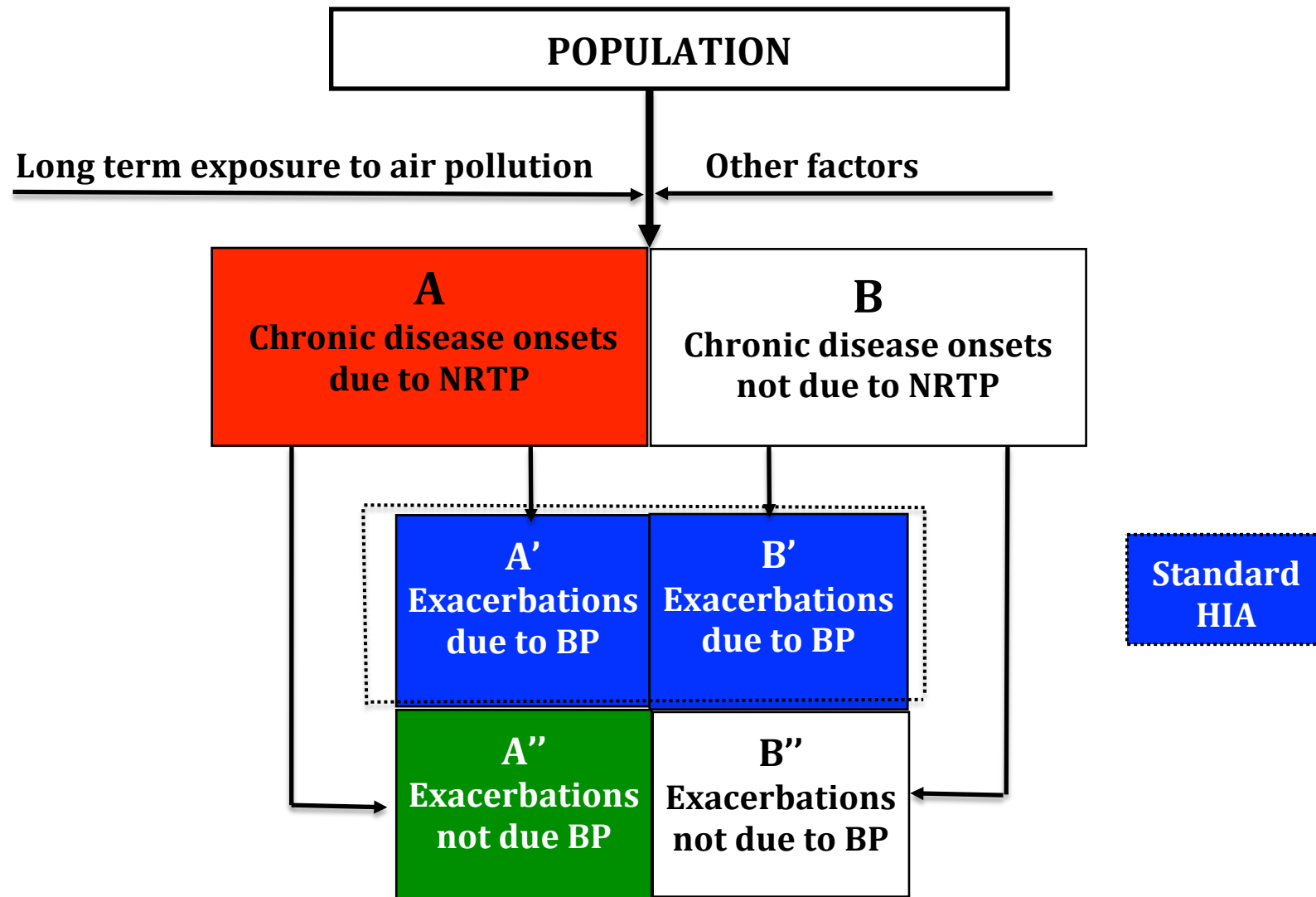
1 Methodology

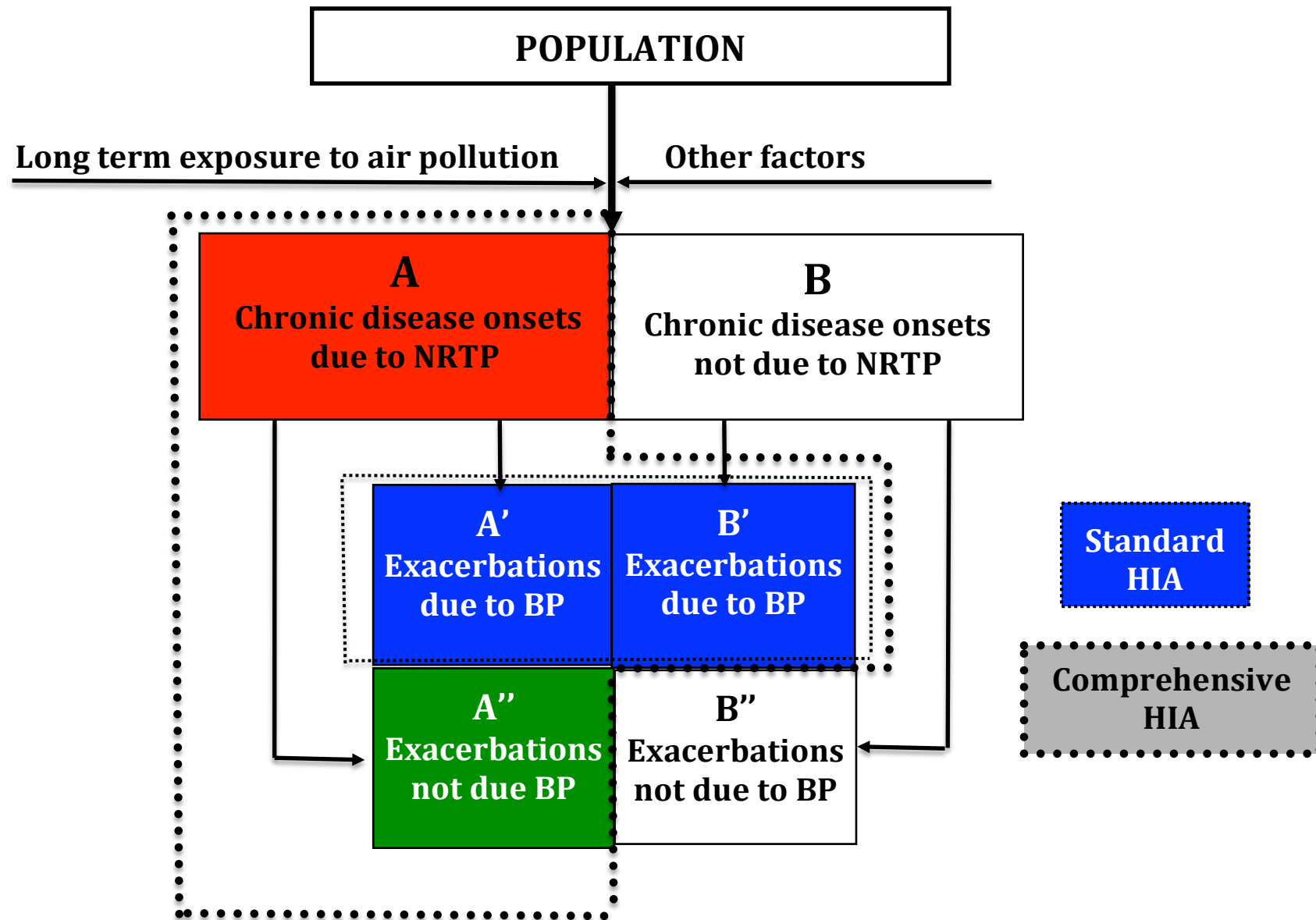
11 A comprehensive air pollution HIA











QUESTION: Which type of data do we need to develop a metric of traffic exposure?

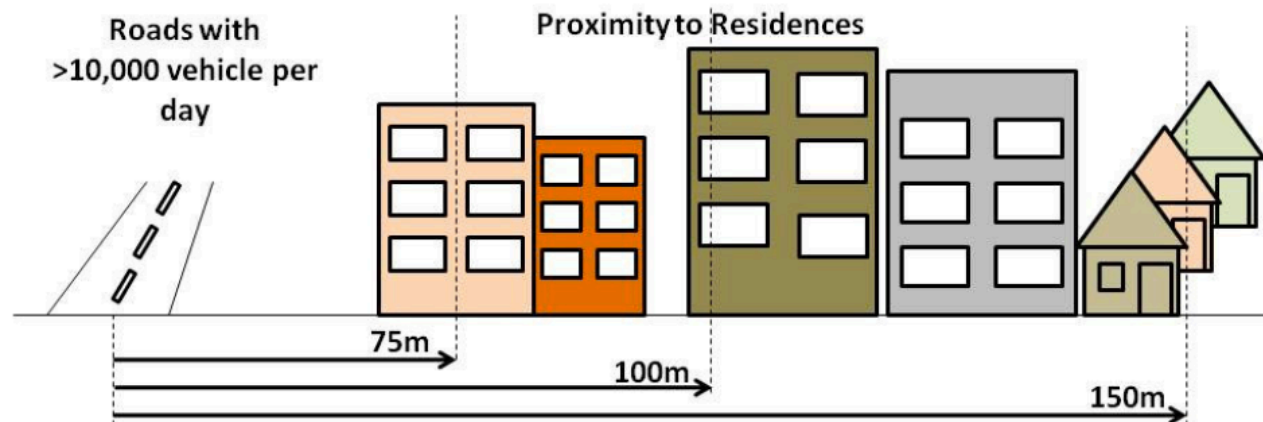
12 How to develop a metric of traffic exposure

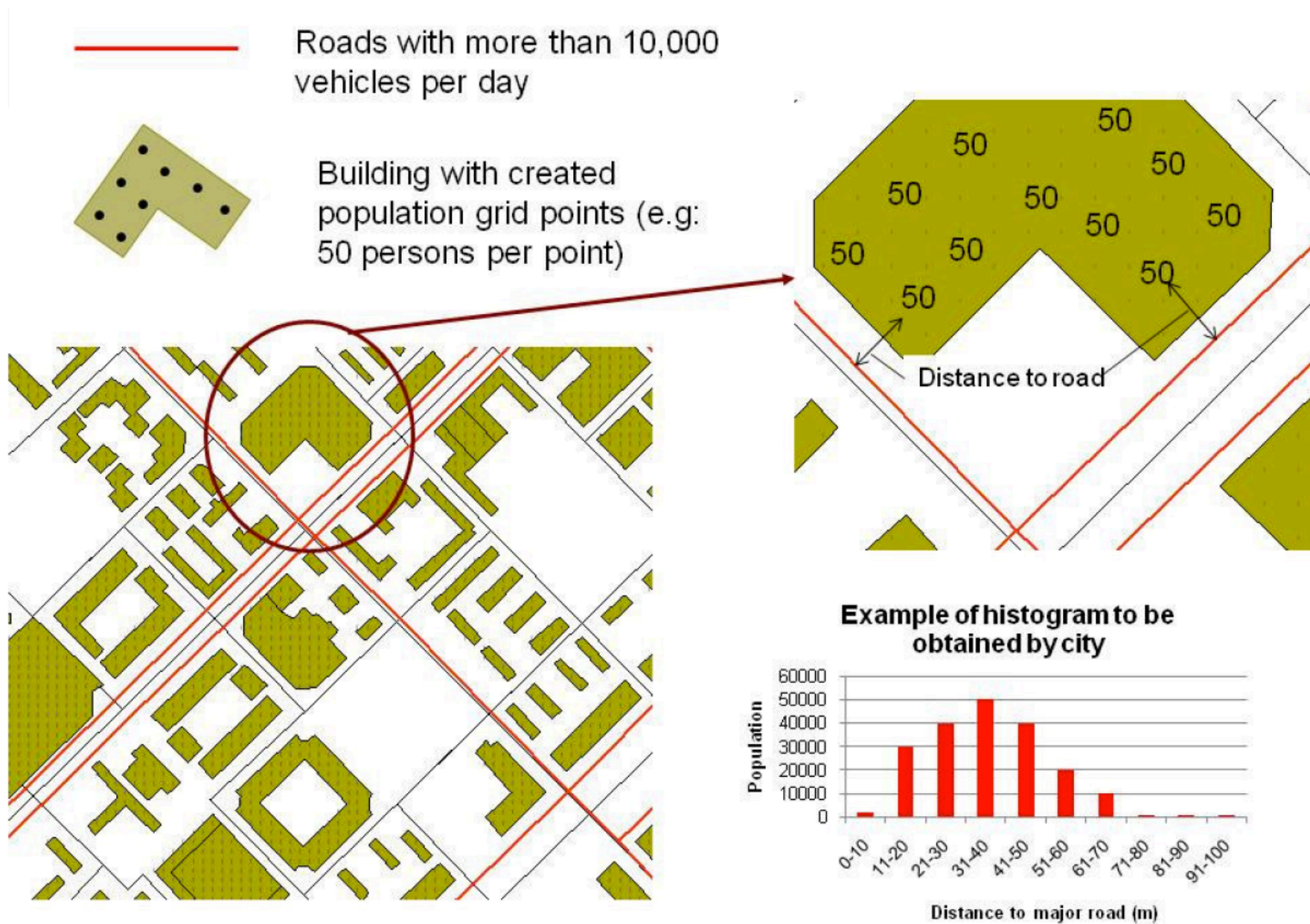
Data required:

- Population distribution by age and census or building,
- Land use maps,
- Traffic flow maps or road classification maps.

Method:

Use of Geographical Information System to compute the distance of each grid point (with associated population) with the nearest road classified as “major road” (>10,000 veh./day).





13 Methodological issues in economic assessment

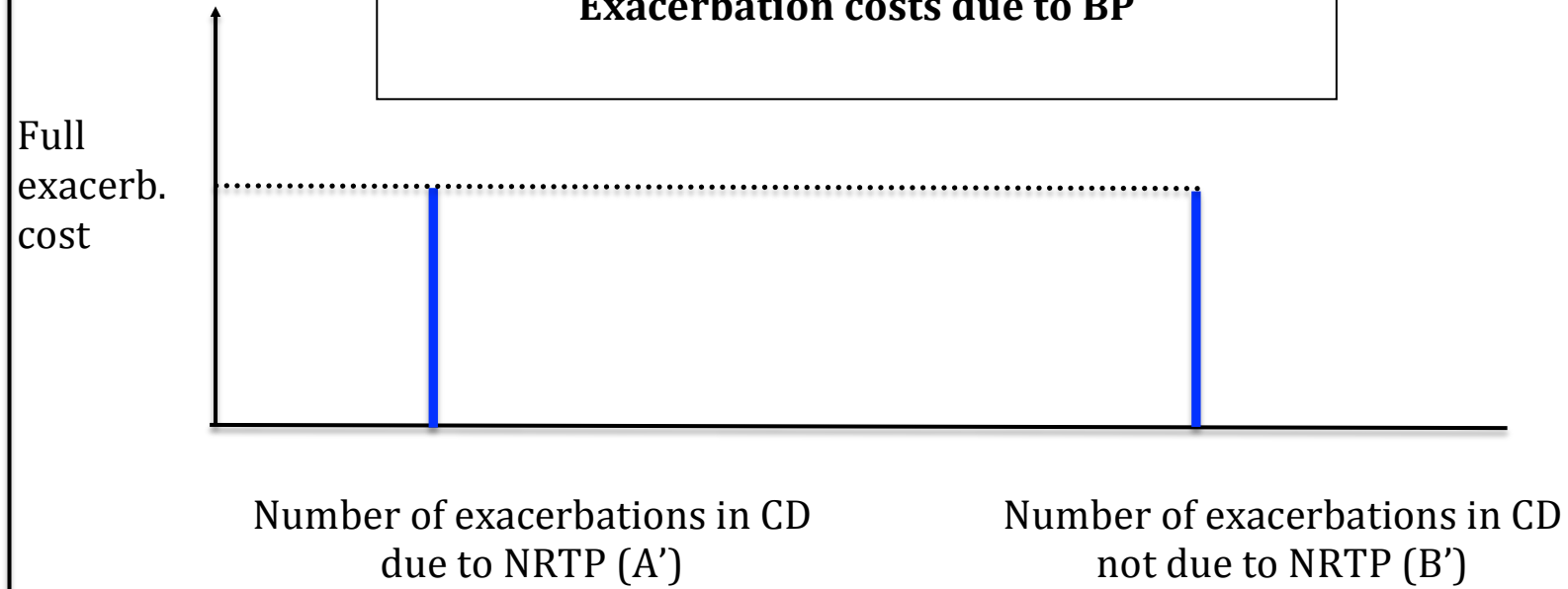
We need unit economic values for the relevant CD / exacerbations:

	Standard HIA	Comprehensive HIA
Outcomes	AP only causes exacerbation of existing CD	AP causes onset of CD AND exacerbations
Onset CD	-	Box A
Exacerbations	Boxes A' + B'	Boxes A' + B' + A''

The assumption that AP exposure affects the development of CD has two major consequences that require going beyond the standard economic approach:

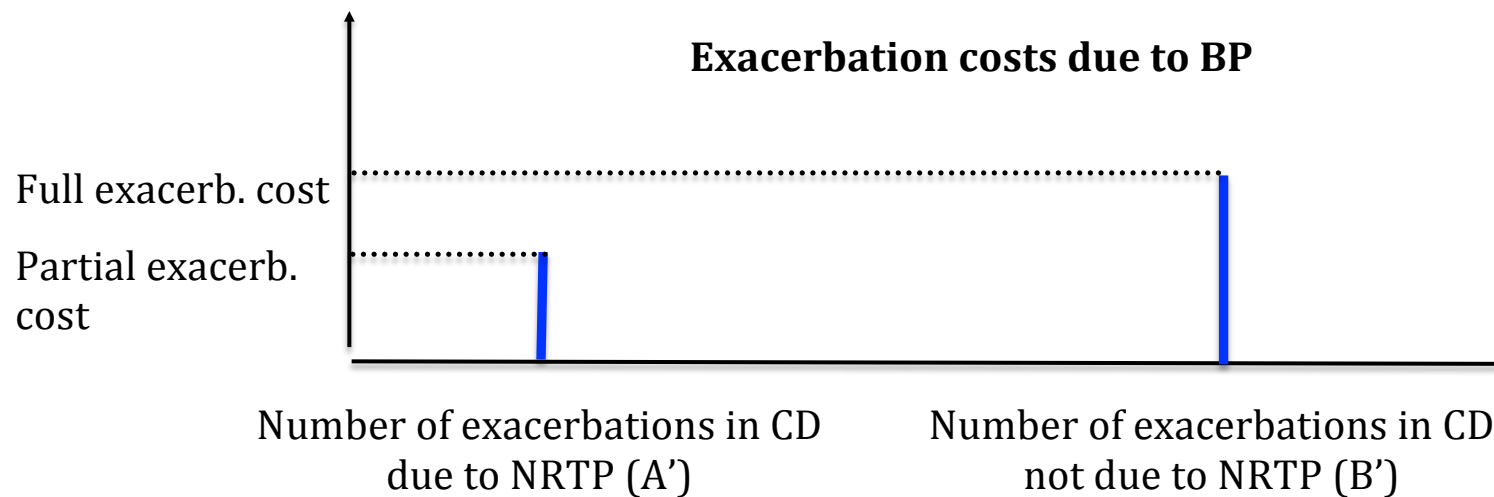
- the cost of a prevalent CD attributable to AP is required to assess chronic morbidity effects (box A)
- when valuing exacerbations among CD patients (boxes A' and A''), we should account for the fact that this prevalence cost already includes a fraction of the full exacerbation cost.

STANDARD HIA MONETARY ASSESSMENT
Exacerbation costs due to BP

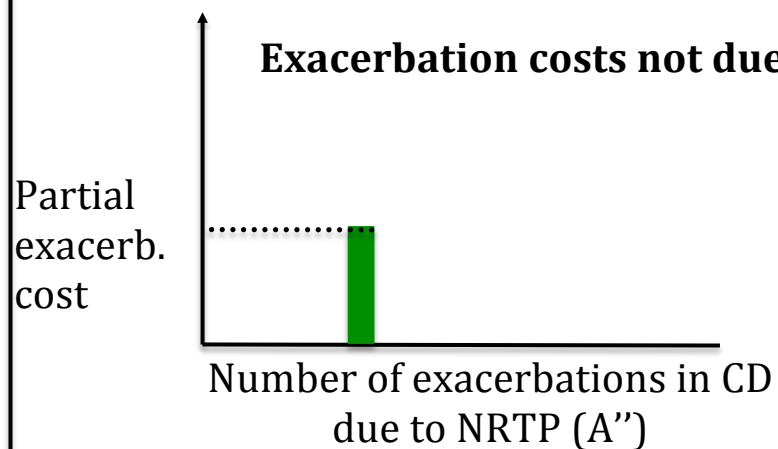


OVERALL COMPREHENSIVE HIA MONETARY ASSESSMENT

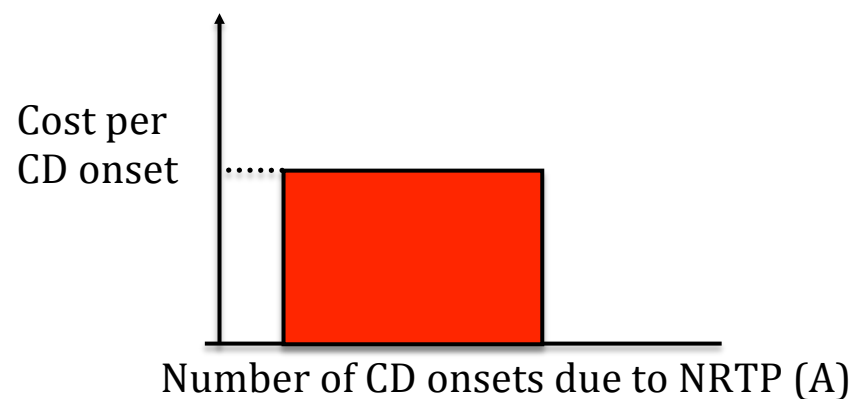
Exacerbation costs due to BP



Exacerbation costs not due to BP



Cost of CD onsets due to NRTP



2 Application

21 Collecting the relevant epidemiological data

211 The Aphekom project

The Aphekom project: “Improving Knowledge and Communication for Decision Making on Air Pollution and Health in Europe”, Cost: €1,470,900 (54% from European Commission), coordination S. Medina (SpF).

Over 3 years (2008-2011), the project has combined the efforts of 60 scientists working in 25 cities in 12 countries across Europe to provide new information and tools that enable decision makers to set more effective European, national and local policies.

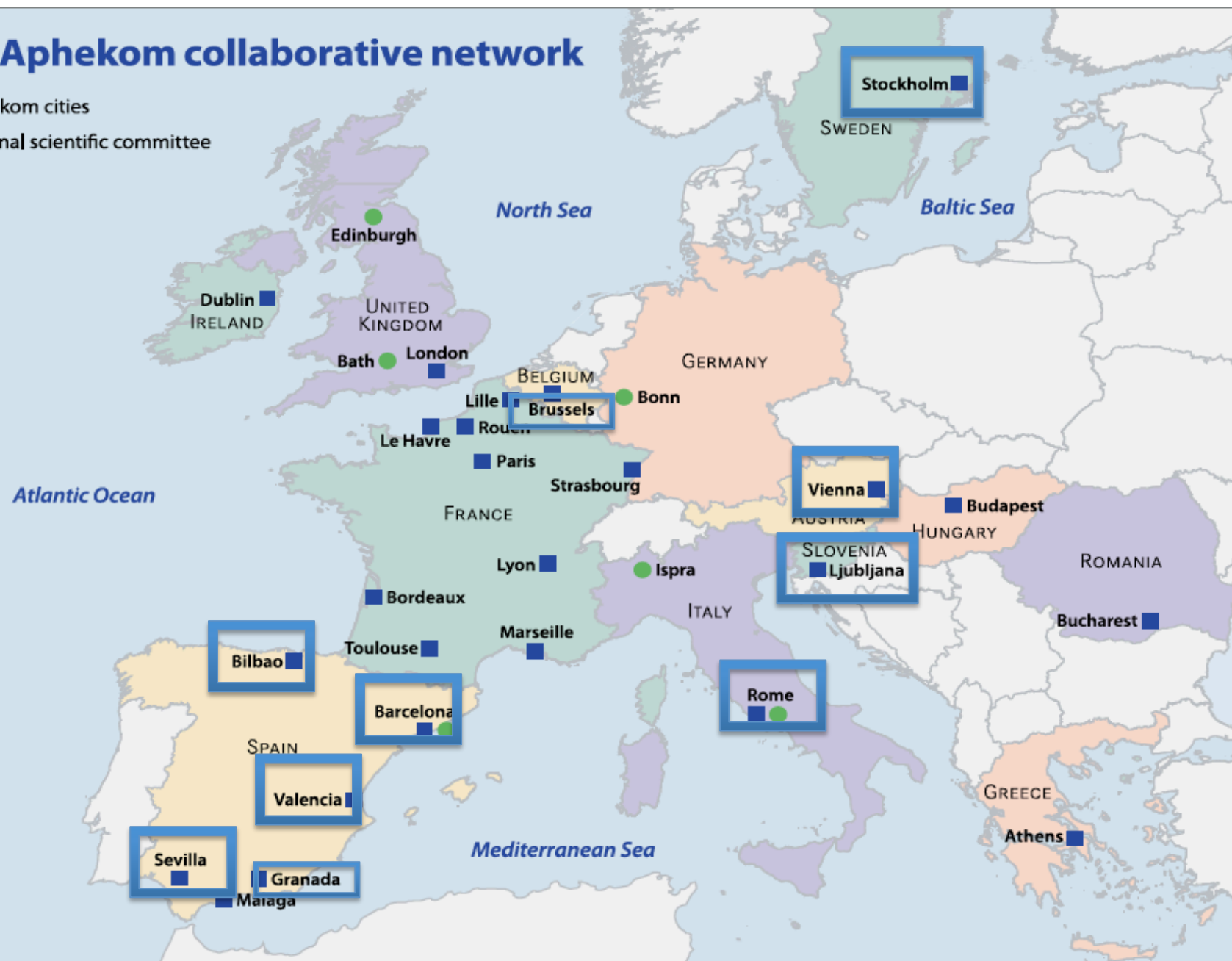
The Aphekom collaborative network

- Aphekom cities
- External scientific committee



The Aphekom collaborative network

- Aphekom cities
- External scientific committee



QUESTION: Which type
of data do we need for
the application to the 10
cities?

212 Computation of the air pollution exposure

Two superimposed scenarios (global burden)

- no one lives near major roads,
- BP is decreased to WHO AQG for PM₁₀/NO₂ (annual mean: 20 µg/m³).

	Population (Million hab.)	Background pollution		Exposure to traffic pollution		
		PM ₁₀ annual average (µg/m ³)	NO ₂ annual average (µg/m ³)	Fraction of population within 75m	Fraction of population within 100m	Fraction of population within 150m
Barcelona	1.53	33	36	56%	65%	77%
Bilbao	0.31	27	29	29%	40%	59%
Brussels	1.03	29	38	37%	47%	64%
Granada	0.24	34	31	14%	18%	28%
Ljubljana	0.27	32	28	23%	32%	47%
Rome	2.81	37	61	22%	29%	43%
Sevilla	0.70	41	29	20%	26%	38%
Stockholm	1.30	17	13	14%	20%	30%
Valencia	0.74	46	32	44%	55%	71%
Vienna	1.66	25	51	36%	44%	62%

213 Epidemiologic data

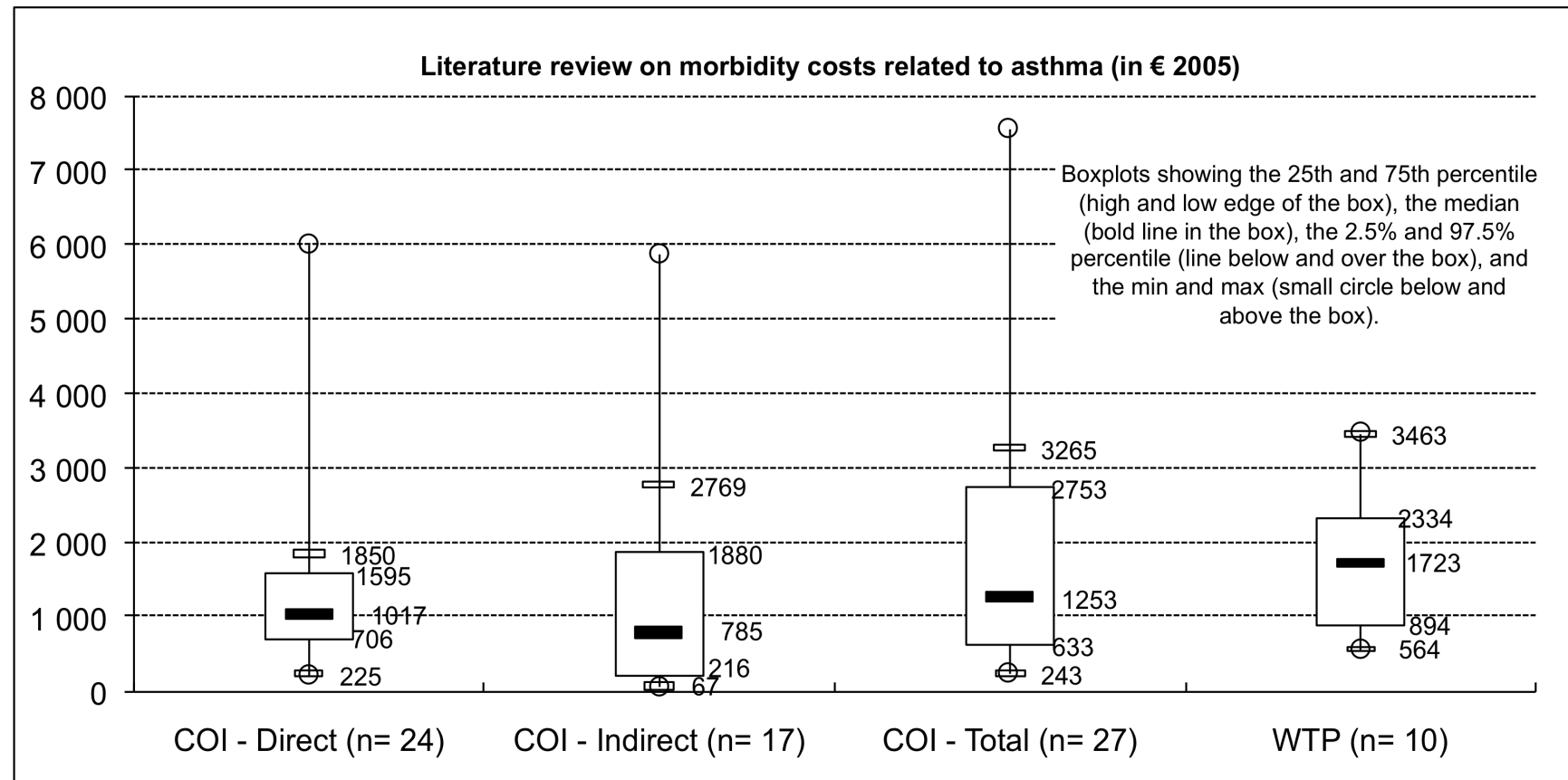
- **Two chronic outcomes (new CD onset):** Asthma prevalence (0-17) and Coronary Heart Disease (CHD) prevalence (+65).
- **Two acute outcomes (exacerbation):** Hospitalizations for asthma (0-17) and for Acute Myocardial Infarction (AMI) (+65).

Summary of the concentration–response functions used in computations

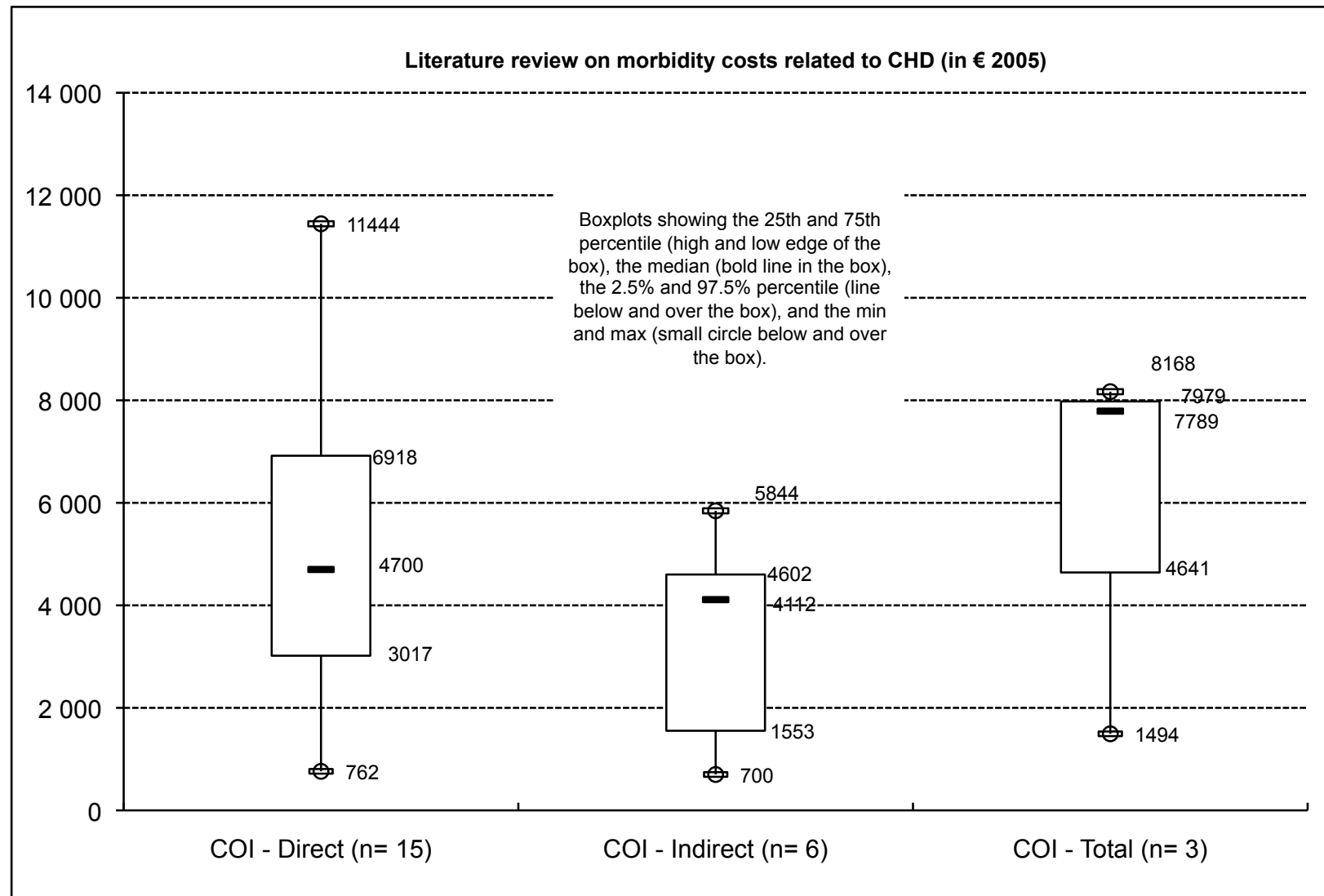
Health outcomes	CRF (95 % CI)	Unit of CRF
Asthma prevalence	1.64 (1.1–2.44)	Residence ≤ 75 m of busy roads defined as motorways, other highways, and arterial roads
Hospitalizations for asthma	1.012 (1.001–1.023)	PM ₁₀ per 10 $\mu\text{g}/\text{m}^3$
	1.07 (1.00–1.15)	PM ₁₀ per 5 $\mu\text{g}/\text{m}^3$
	1.0013 (1.0002–1.0024)	Meta-analytic estimate, PM ₁₀ per 1 $\mu\text{g}/\text{m}^3$
CHD prevalence	1.85 (1.21–2.84)	Busy road ≤ 150 m from home (defined as motorways and federal highways: $10\text{--}110 \times 10^3$ vehicles per day)
Hospitalizations for MI	1.026 (1.002–1.052)	NO ₂ per 10 $\mu\text{g}/\text{m}^3$
	1.005 (1.00–1.01)	NO ₂ per 8 $\mu\text{g}/\text{m}^3$
	1.0274 (1.0084–1.0479)	NO ₂ per 57.3 $\mu\text{g}/\text{m}^3$
	1.0005 (1.0002–1.0008)	Meta-analytic estimate, NO ₂ per 1 $\mu\text{g}/\text{m}^3$

22 Collecting the relevant economic data

221 Annual average prevalence cost of a CD patient



Boxplots on the literature review on annual morbidity costs related to asthma (€ 2005)



Boxplots on the literature review on annual morbidity costs related to CHD (€ 2005)

222 Average cost per exacerbation (COI method)

Average lengths of stay, hospitalization costs, work loss, direct and total hospitalization cost per exacerbation (€ 2005)

Country	Average length of stay in days		Average cost per day		Direct average hospital. cost		Average cost of work loss		Total average hospital. cost	
	Asthm.	AMI	Hosp. all causes	Work loss	Asthm.	AMI	Asthm.	AMI	Asthm.	AMI
Austria	5.1	8.4	319	83	1,627	2,680	847	114	2,474	2,794
Belgium	6.5	8.7	351	98	2,282	3,054	1,274	140	3,556	3,194
Italy	4.8	8.2	379	62	1,819	3,108	595	83	2,414	3,191
Slovenia	4	9.9	240	34	960	2,376	272	55	1,232	2,431
Spain	6.5	9	321	55	2,087	2,889	715	81	2,802	2,970
Sweden	6.1	7.8	427	92	2,605	3,331	1,122	118	3,727	3,449

Summary of the unit economic values (€2005)

Chronic diseases	Health outcomes	Direct costs	Indirect costs	Intangible costs	Total costs
Asthma	Annual average prevalence cost of asthma onset	1,332	90	1,630	3,052
	Average full asthma exacerbation cost	Depends on country (see previous table)			
	Average partial asthma exacerbation cost	Full exacerbation cost - 0.5 x annual prevalence cost			
CHD	Annual average prevalence cost of CHD	5,153	277	1,557	6,987
	Average full AMI exacerbation cost	Depends on country (see previous table)			
	Average partial AMI exacerbation cost	Full exacerbation cost - 0.215 x annual prevalence cost			

23 Annual health and economic assessments of the two HIA

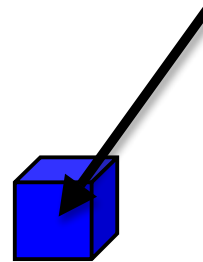
Health outcomes	Standard HIA		Comprehensive HIA	
	Cases ^a (95 % CI)	Burden ^b (95 % CI)	Cases ^a (95 % CI)	Burden ^b (95 % CI)
Asthma onsets due to NRTP (A)	NA	NA	33,200 (6200 to 59,600)	101.33 (18.92 to 181.90)
Asthma exacerbations (A' + A'' + B')...	21 (0 to 40)	0.054 (0 to 0.109)	251 (40 to 480)	0.488 (0.058 to 0.944)
... due to BP (A' + B')	21 (0 to 40)	0.054 (0 to 0.109)	21 (0 to 40)	0.052 (0 to 0.104)
... not due to BP in asthma onsets due to NRTP (A'')	NA	NA	230 (20 to 460)	0.435 (0.053 to 0.840)
Asthma total (A + A' + A'' + B')		0.054 (0 to 0.109)		101.81 (18.98 to 182.84)
CHD onsets due to NRTP (A)	NA	NA	37,200 (12,100 to 56,600)	259.92 (84.54 to 395.46)
CHD exacerbations (A' + A'' + B')...	140 (0 to 265)	0.496 (0 to 0.843)	4575 (1640 to 7575)	8.32 (2.94 to 13.47)
... due to BP (A' + B')	140 (0 to 265)	0.496 (0 to 0.843)	140 (0 to 265)	0.44 (0 to 0.74)
... not due to BP in CHD onsets due to NRTP (A'')	NA	NA	4430 (1510 to 7425)	7.87 (2.76 to 12.73)
CHD total (A + A' + A'' + B')		0.496 (0 to 0.843)		268.23 (87.49 to 408.93)
Total		0.550 (0 to 0.952)		370.05 (106.47 to 591.77)

BP background pollution, NRTP near road traffic-related pollution, CHD coronary heart disease, HIA health impact assessment, NA not applicable

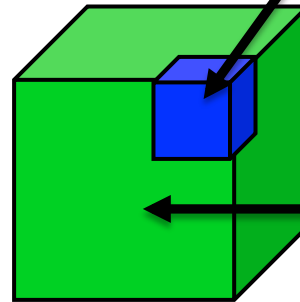
^a Annual numbers of health outcomes are estimates and are rounded to the nearest unit

^b Estimates of the monetary burden are in million euros

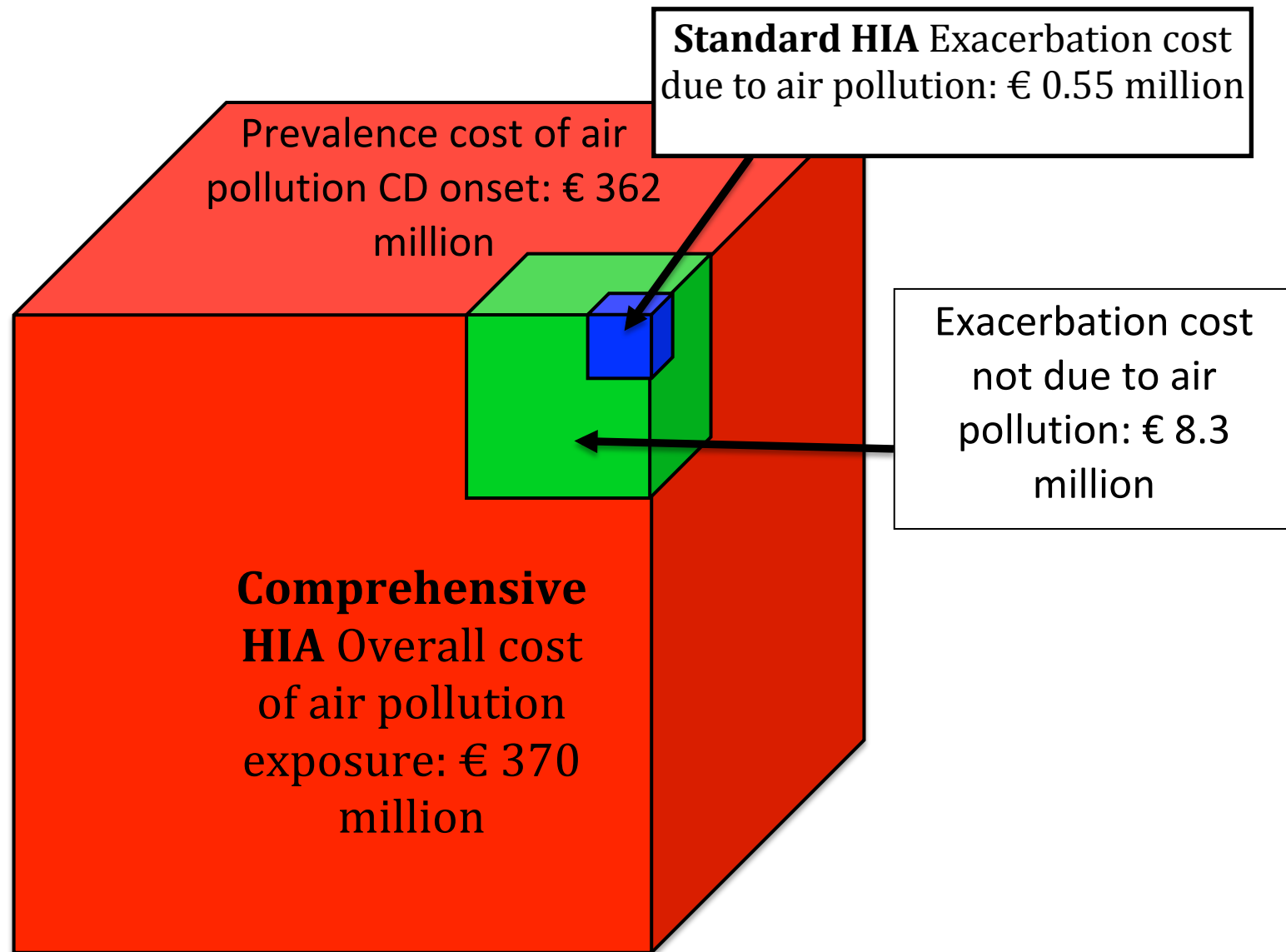
Standard HIA Exacerbation cost
due to air pollution: € 0.55 million



Standard HIA Exacerbation cost
due to air pollution: € 0.55 million



Exacerbation cost not
due to air pollution: €
8.3 million



3 Concluding remarks

Findings

- Pollutants along busy roads could be responsible for a large but preventable burden of CD and related acute morbidities in (European) urban areas.
- We found considerable larger burden of AP than with the standard HIA.
- Best preventive action is to avoid the exacerbation by avoiding the disease altogether => focus on the risk factors for onset of CD.

Perspectives

- Approach applicable to other diseases associated to air pollution exposure (like chronic obstructive pulmonary disease, lung cancer).
- May help decision-makers to properly take into consideration the full benefits of projects concerning agriculture, energy, health, transport, waste, water, etc., where CDs caused and exacerbated by a common factor are involved: environmental (heavy metals, hazardous chemicals) or not (smoking, alcohol consumption, nutrition).