Title: The burden of near-road traffic-related pollution: the example of asthma in children

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Background

Two important aspects have emerged in recent air pollution epidemiological research. First, numerous studies indicate that air pollution can contribute to the development of chronic pathologies, thus, impacting the incidence and prevalence of chronic disease. Then the evidence of health effects due to near-road concentrations of traffic-related pollution – in particular the ultrafine fraction - is growing fast.

These findings have important implications when estimating the burden of air pollution that include near-road traffic pollution and background air pollution generated from other sources. First, if one assumes that near road traffic-related pollution cause chronic disease, this burden should now be accounted for. Then, if one assumes that air pollution affects both the development of chronic pathologies and its exacerbation, the entire 'chronic disease career' that includes all its acute manifestations, ought to be attributed to air pollution no matter what caused the exacerbations.

The evidence of a role of near roadway traffic-related pollution is particularly strong for childhood asthma - the most prevalent chronic disease in children. Children living close to busy roads are more likely to develop asthma whereas urban background pollution is not associated with childhood asthma incidence. Traditional air pollution impact assessments quantified only the burden of acute exacerbations directly associated with acute air pollution exposure.

Objective

We derived the burden of acute exacerbations related to the chronic 'morbidity careers' attributed to near-road traffic-related pollution as well as the acute exacerbations attributable to urban background levels of air pollution in 10 European cities, all partners in the Aphekom project (Improving Knowledge and Communication for Decision Making on Air Pollution and Health in Europe). While our main assessment focused on childhood asthma, we expanded the evaluation for another important chronic condition in adults, namely CHD because similar patterns are expected.

Methods

Following an approach recently published [1, 2], we used an expansion of the Population-attributable fractions (PAF) for evaluating the burden of both chronic and acute effects of air pollution. Figure 1 illustrates the calculation approach. We first estimated among the healthy target population the number of chronic diseases due to near-road traffic pollution (figure 1, [2]) and due to other causes (figure 1, box [3]). Then, episodes of exacerbation of the diseases due to air pollution were further estimated among those for which near road traffic pollution was the cause of chronic disease onset (figure 1, [5]) and among those for which other causes than traffic pollution was the cause of chronic disease onset (figure 1, [6]). The sum of box [5] and [6] is in fact equal to the standard approach to evaluate the acute burden of air pollution but partitioned to distinguish the contribution due to local traffic pollution. We then calculated episodes of exacerbation among those for whom near-road traffic pollution was the cause of chronic disease onset but exacerbations were due to other causes than air pollution (figure 1, [8])—this represents the burden still ignored in other burden evaluations.

Results

Combining traffic density information and population data, we estimated that within the 10 cities included in our analysis, between 14% and 56% of the population lives within 75m of busy roads, represented by all streets and roads carrying more than 10,000 vehicles per day (Table 1). Exposure to busy roads was used as a proxy for near road traffic-related pollution. For comparison, the study in Southern California using direct information of residence distance to busy roads, measured that 15% of children in the study, representative of children in Southern California, were living within 75m of busy roads. This represented 6% and 9% of prevalent childhood asthma for two communities in Southern California[2]. This recent revised estimations showed thus that the asthma burden from traffic-related pollution is substantial and that this has resulted in a considerable under-appreciation of the total burden and costs of air pollution for this disease [2, 3]. The large exposure to near-road traffic related pollution that we estimated for European populations suggests that a large prevalence of asthma and asthma-related diseases may be attributable to near-road traffic population in Europe.

Conclusions

There is now sufficient biological evidence to support mechanistic pathways linking near road traffic-related pollution exposure to chronic diseases, especially for the onset of asthma in children. The findings on the potential morbidity impacts of near road traffic-related pollution may be specifically relevant for Europe where there is a high population density cohabiting with high traffic loads. Policies addressing specifically the concentrations of those near-road pollutants, such as ultrafine particles, could have very substantial benefits for public health.

References

1. Kunzli N, Perez L, Lurmann F, Hricko A, Penfold B, McConnell R. An attributable risk model for exposures assumed to cause both chronic disease and its exacerbations. *Epidemiology*. 2008;19:179-185

2. Perez L, Künzli N, Avol E, Hricko A, Lurmann F, Nicholas E, Gilliland F, Peters J, McConnell R. Global goods movement and the local burden of childhood asthma in southern california. . *Am J Public Health In press*. 2009
3. Brandt SJ, Perez L, Kunzli N, Lurmann F, McConnell R. Costs of childhood asthma due to traffic-related pollution in two california communities. *Eur Respir J*. 2012

Figure 1. Conceptual approach to derive the attributable impact of air pollution into account traffic exposure as cause for onset of chronic disease as reported in[1].

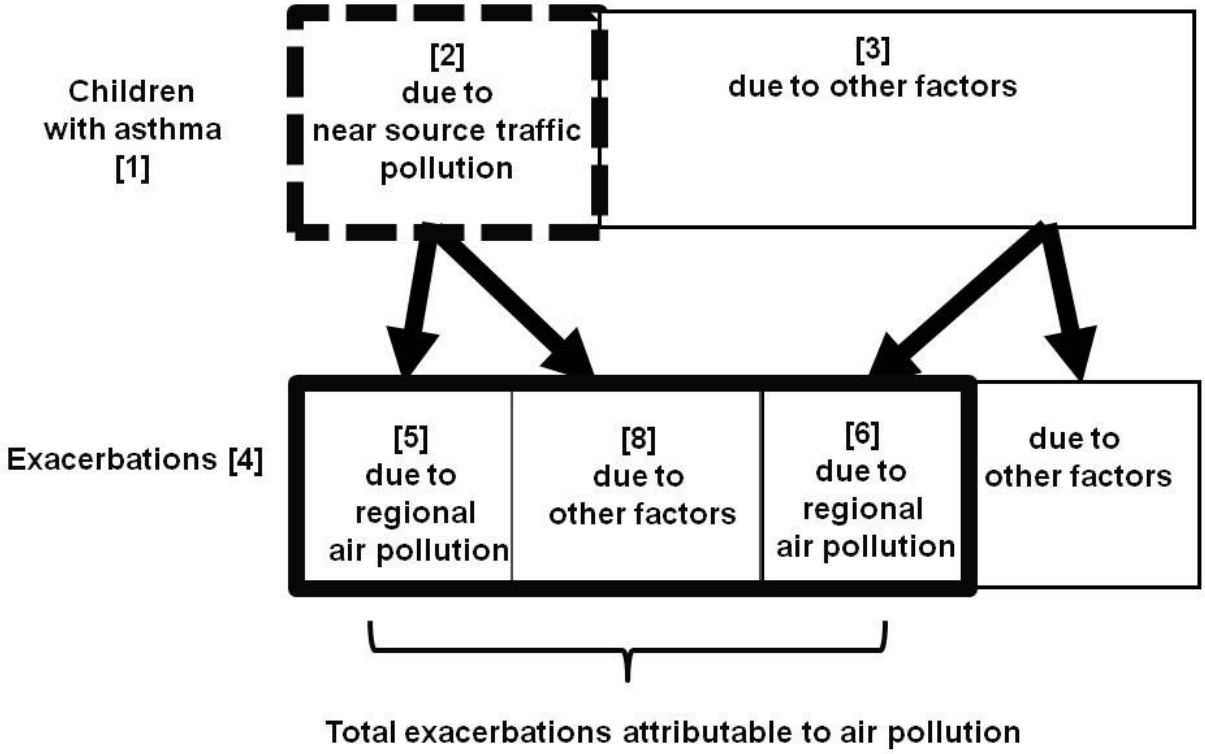

Table 1. Summary of exposure data for the evaluation of near road traffic related pollution burden in 10 cities in Europe

City	Total population (Million Habitants)	PM_{10} annual average (ug/m^3)	NO_2 annual average (ug/m^3)	% population within 75m of busy roads
Barcelona	1.5	33	36	56%
Bilbao	0.35	27	29	29%
Brussels	1.0	29	38	37%
Granada	0.24	34	31	14%
Ljubljana	0.27	32	28	23%
Rome	2.8	37	61	22%
Sevilla	0.70	41	29	20%
Stockholm	1.3	17	13	14%
Vienna	1.7	25	32	36%
Valencia	0.74	46	51	44%
All*	**10.6 (sum)**	**32 (mean)**	**35 (mean)**	**29% (mean)**

*Mean is across cities

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The burden of near-road traffic related pollution

The example of asthma in children

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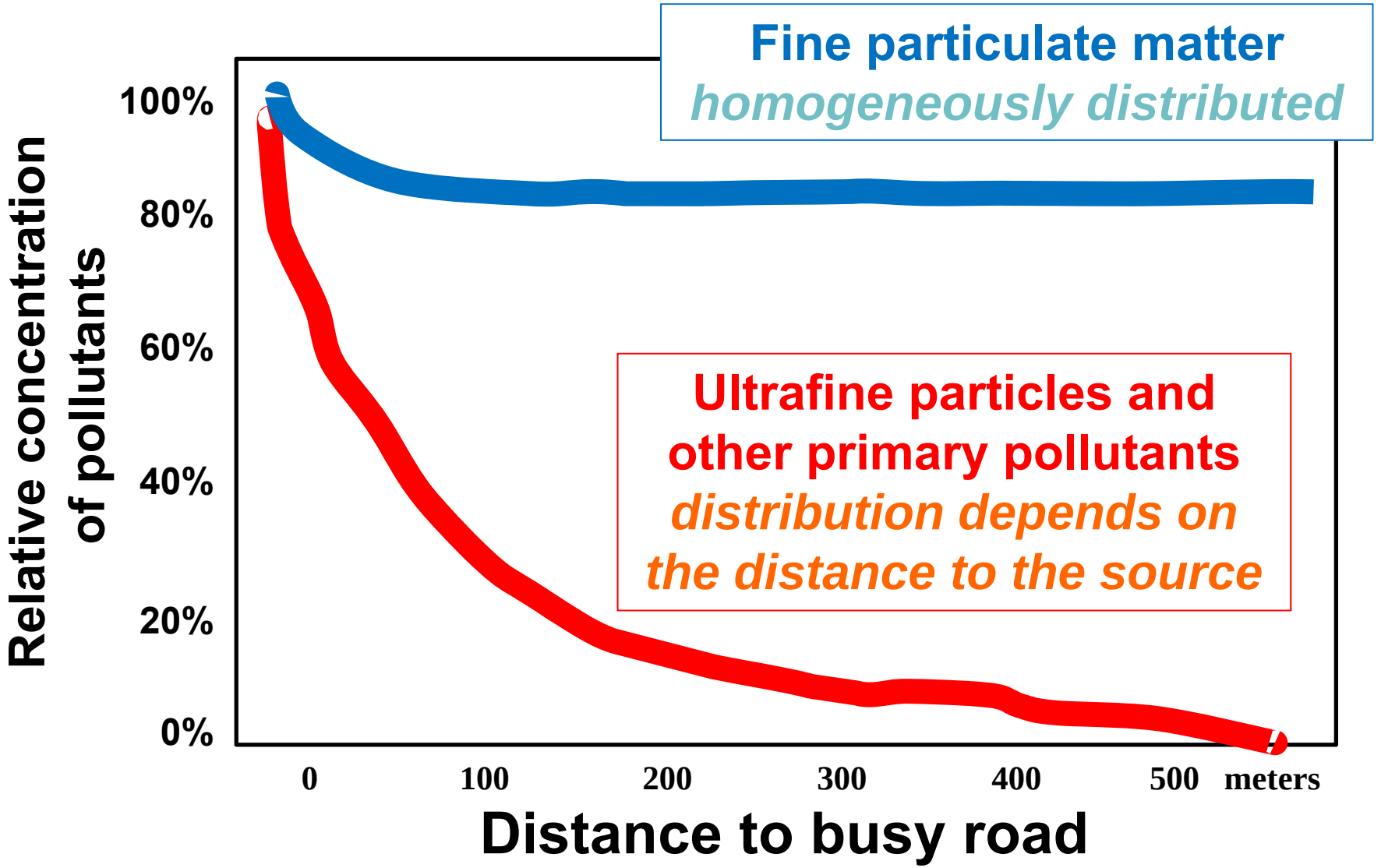
Overview

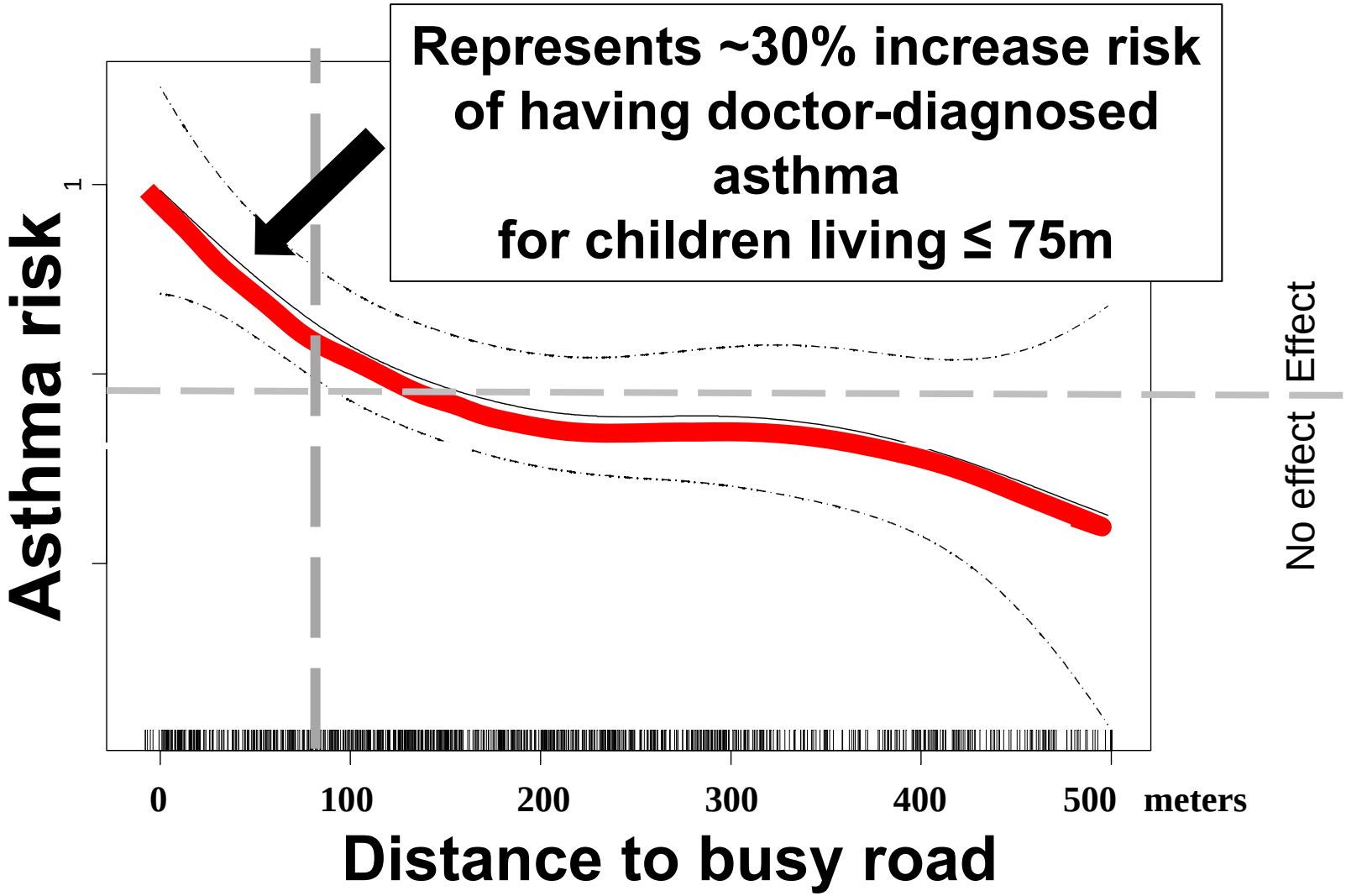
- Near road traffic-related pollution and asthma in children
- Methodological implications for estimating the morbidity burden due to air pollution
- Case study
- Implications of our findings for policy

Traffic proximity and exposure



Modified from Künzli, 2012

Residential distance to busy roads and childhood asthma



McConnell et al, EHP 2006

Evidence of air pollution effects in childhood asthma

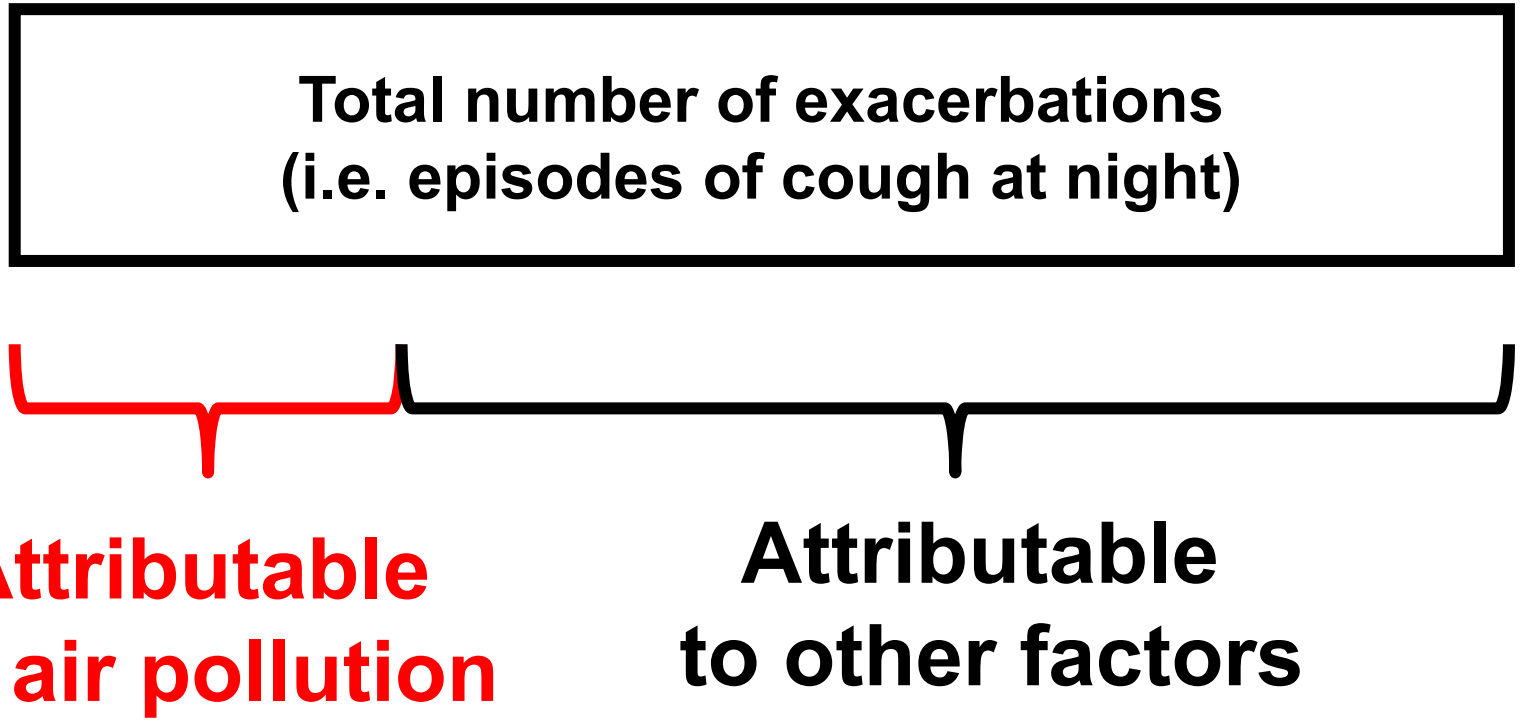
ESTABLISHED:
Background pollution triggers asthma symptoms (i.e. cough at night) among children that have asthma

NEW EVIDENCE:
Near-roadway traffic related pollution may cause the development of asthma

IMPLICATION:
The entire “asthma career“ (any disease linked to having asthma) of any children with asthma attributed to near-roadway traffic related pollution should also be attributed to this exposure

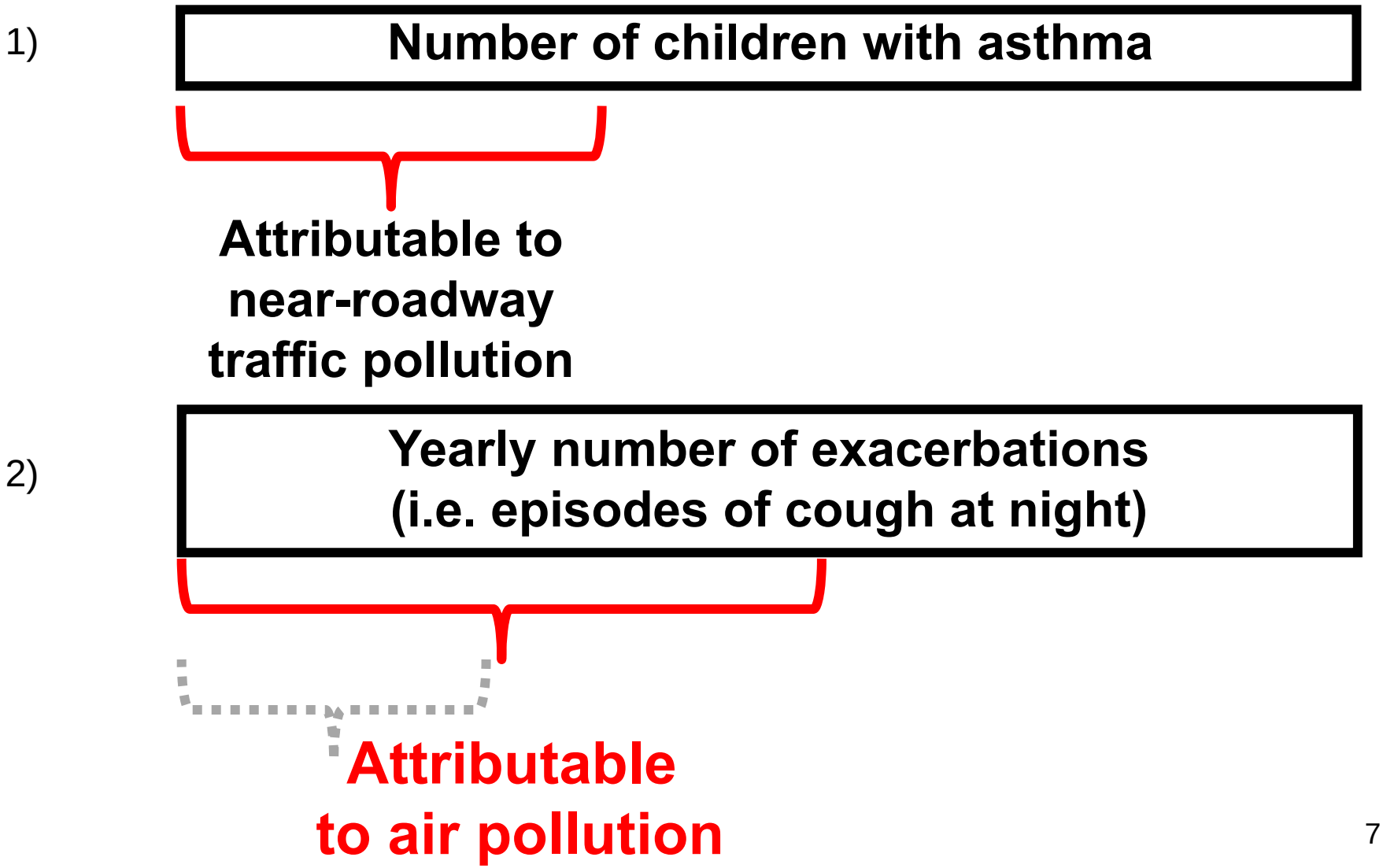
Traditional risk assessment approach

Assumption: air pollution only triggers asthma symptoms (among those that already have asthma)



Revised risk assessment approach

Assumption: there is causality between near-road traffic pollution and becoming and asthma patient



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Global Goods Movement and the Local Burden of Childhood Asthma in Southern California

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Burden scenario

1) Asthma due to long-term exposure to near road traffic-related pollution, represented by living at proximity of busy roads.

2) Asthma exacerbations (i.e. hospitalization and symptoms) due to exposure to regional air pollutants (NO_2 and O_3) above levels found in clean communities in Southern Los Angeles.

- *Exacerbations among the asthmatic children having asthma due to near-road traffic related pollution*
- *Exacerbations due to air pollution among all other children with asthma*

Children with asthma

attributable to near-roadway traffic-related pollution

Community	**% of children exposed to busy roads**	**Cases in % total asthmatic population**
Long Beach	12.8%	9.2%
Riverside	14.9%	6.1%

Exacerbations per year

(NO_2 reduction from current levels to background levels found in clean communities in Southern California)

Long Beach	**Standard approach**	**Revised approach**
Bronchitis episodes among asthmatics	3,400 (50%)	**3,700 (55%)**
Emergency Room visits for asthma	160 (2%)	**1,100 (11%)**
Clinic visits for asthma	500 (4%)	**1,600 (13%)**
Hospital admissions for asthma	30 (11%)	**51 (19%)**

Percentage of population living near busy roads

(>10,000 vehicles day)
in 10 European cities

City	Population (Mio. Hab)	PM_{10} annual average (ug/m^3)	% population within 75m
Granada	0.24	34	14%
Ljubljana	0.27	32	23%
Bilbao	0.31	27	29%
Sevilla	0.7	41	20%
Valencia	0.74	46	44%
Brussels	1.03	29	37%
Stockholm	1.3	17	14%
Barcelona	1.53	33	56%
Vienna	1.66	25	36%
Rome	2.81	37	22%

Implications for policy

- Underestimation of overall morbidity burden of air pollution

- Large public health benefits of reducing population exposure to near-road traffic-related pollution (beyond what is currently proposed)

- Need for establishing risk functions for “compound” of relevance for health to improve health impact evaluation (need to understand mixture of pollutants that cause effects)

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Aphekom

Improving Knowledge and Communication for Decision Making on Air Pollution and Health in Europe

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