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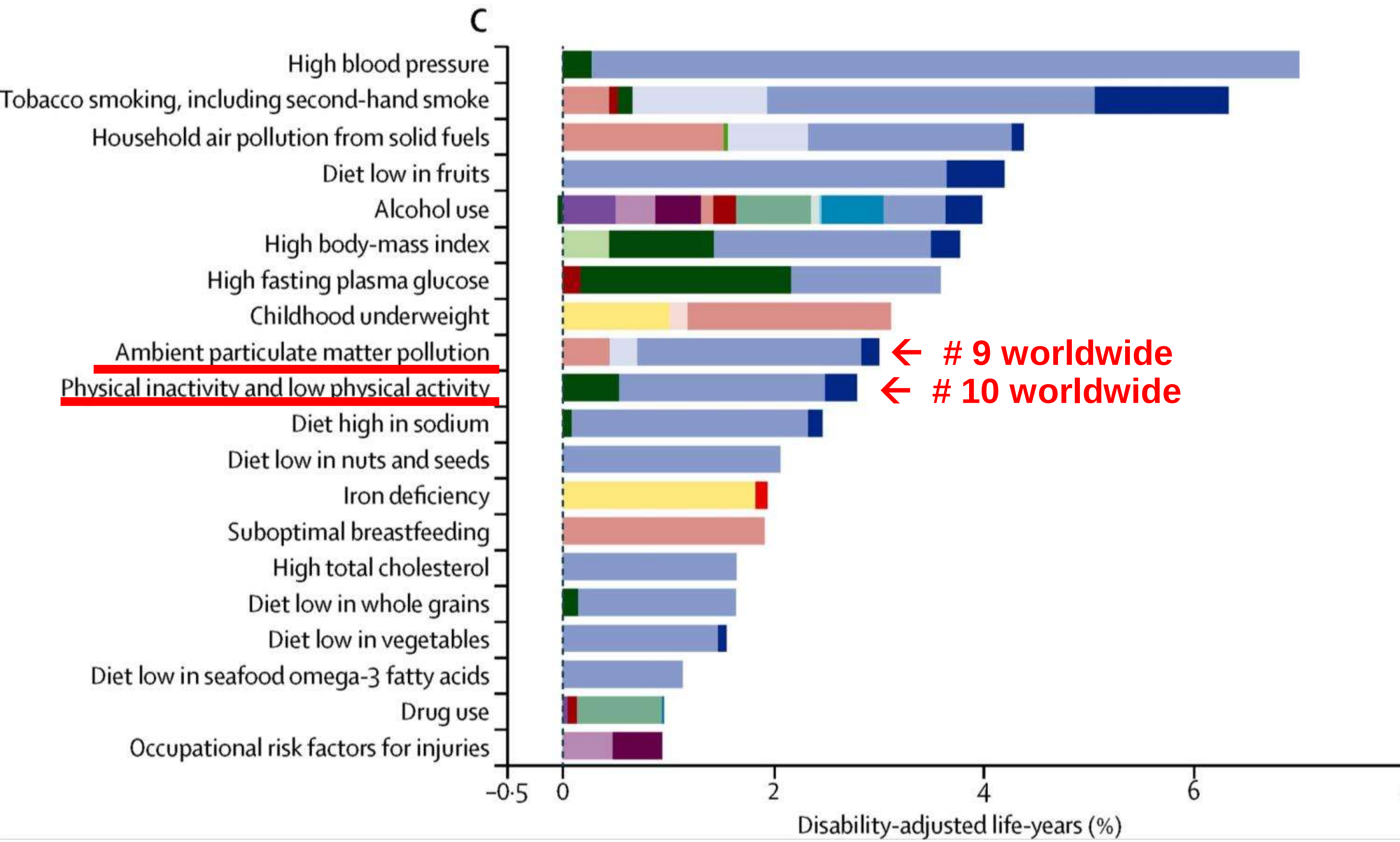
Air pollution and cycling

Audrey de Nazelle

Cycling towards a better Enfield: Health, Business and Travel
8th April 2016
Enfield, UK

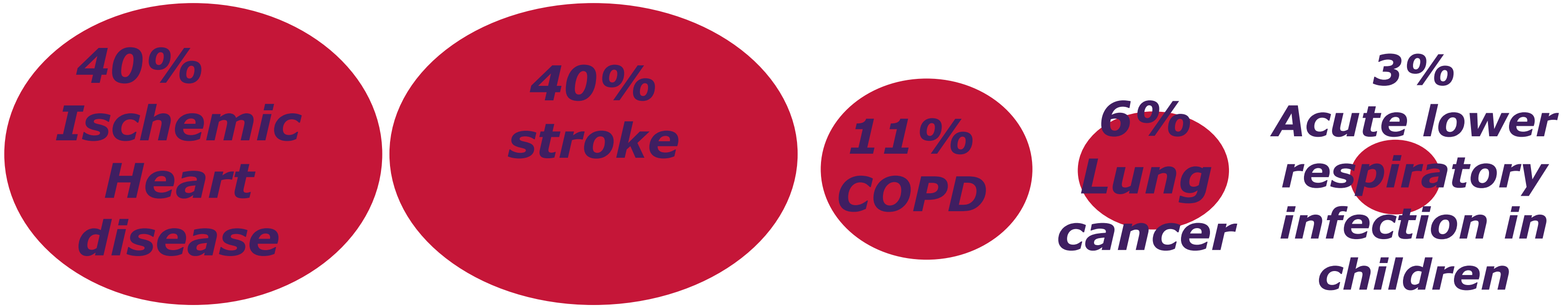
Global Burden of Disease 2010: top risk factors



Lim et al. The Lancet 2012

Ambient air pollution health effects

- More than 3 million deaths/year (particulate matter and ozone)



- But also:
  - low birth weight and preterm birth
  - cognitive development
  - autism
  - diabetes
  - obesity

UK

UK (PM2.5):

- 29 000 premature deaths,
- average loss in life expectancy 6 months.

London:

- Around 9500 deaths per year from both PM2.5 and NO2 (assuming 30% overlap, 3500 deaths from PM2.5, 5900 from NO2)

Enfield:

- 138 deaths (1944 years of life lost) from PM2.5
- 212 deaths (2999 years of life lost) from NO2 (assuming 30% overlap)

(Walton et al. 2015)

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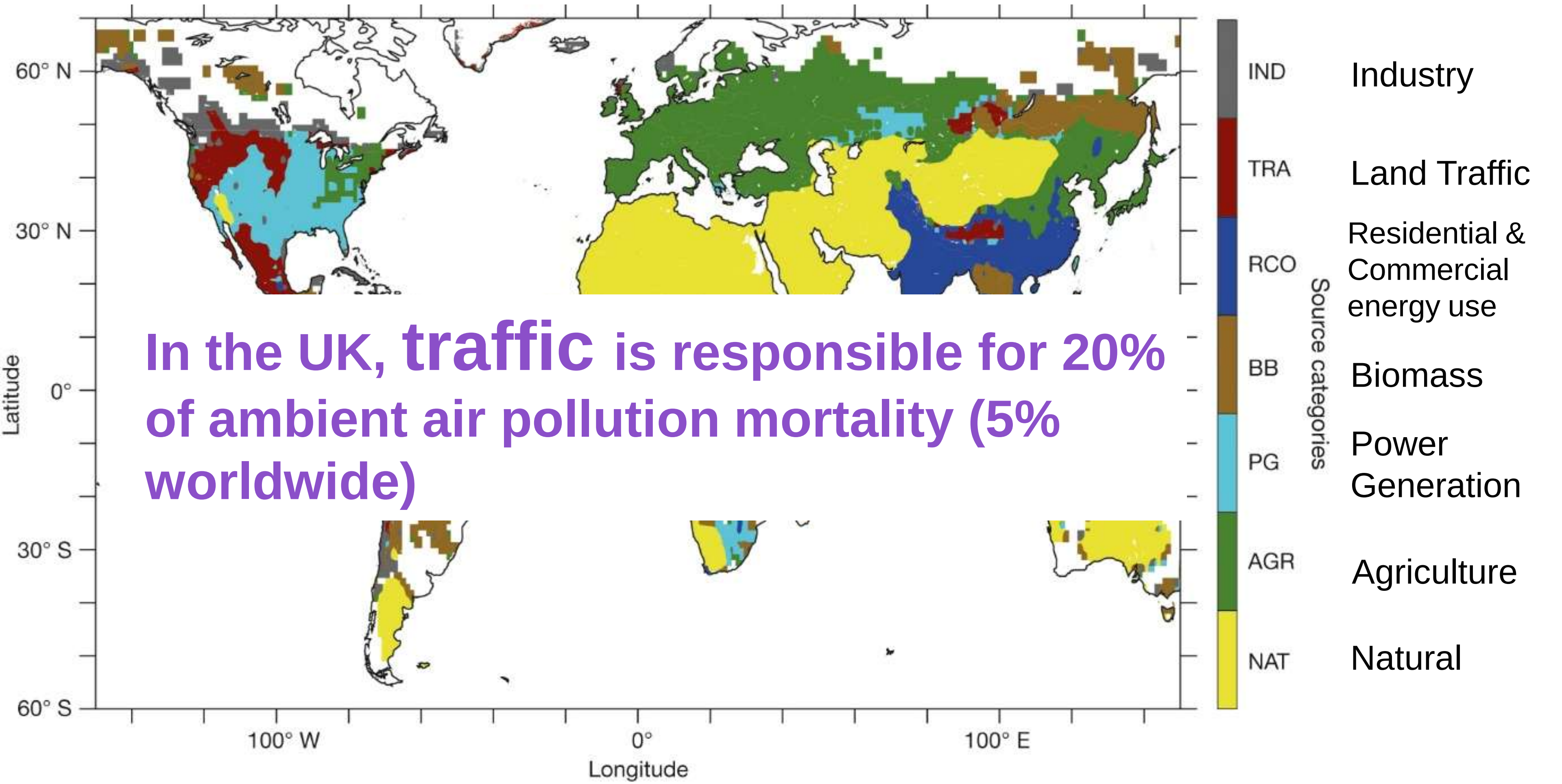
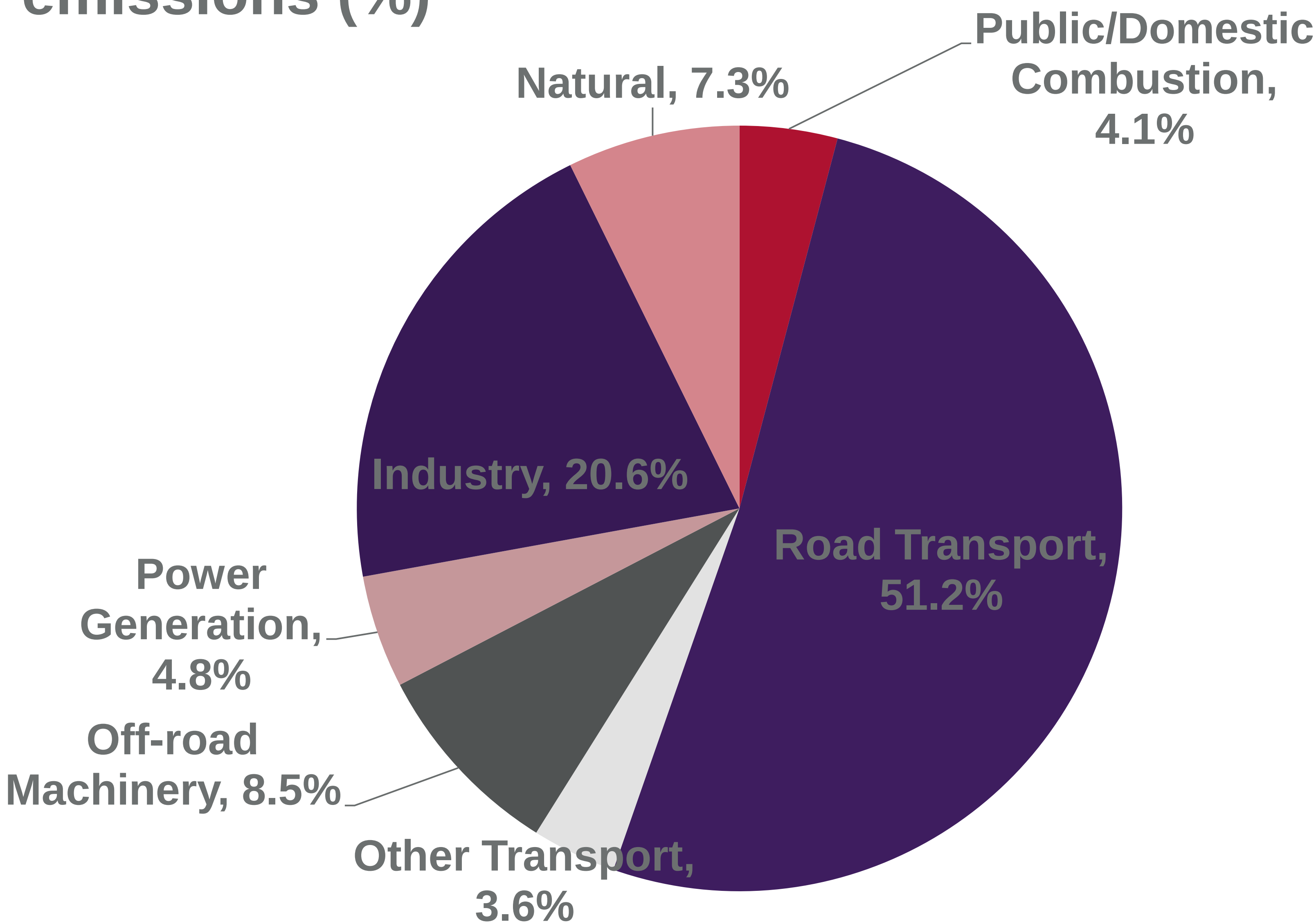
Source categories responsible for the largest impact on mortality linked to outdoor air pollution in 2010



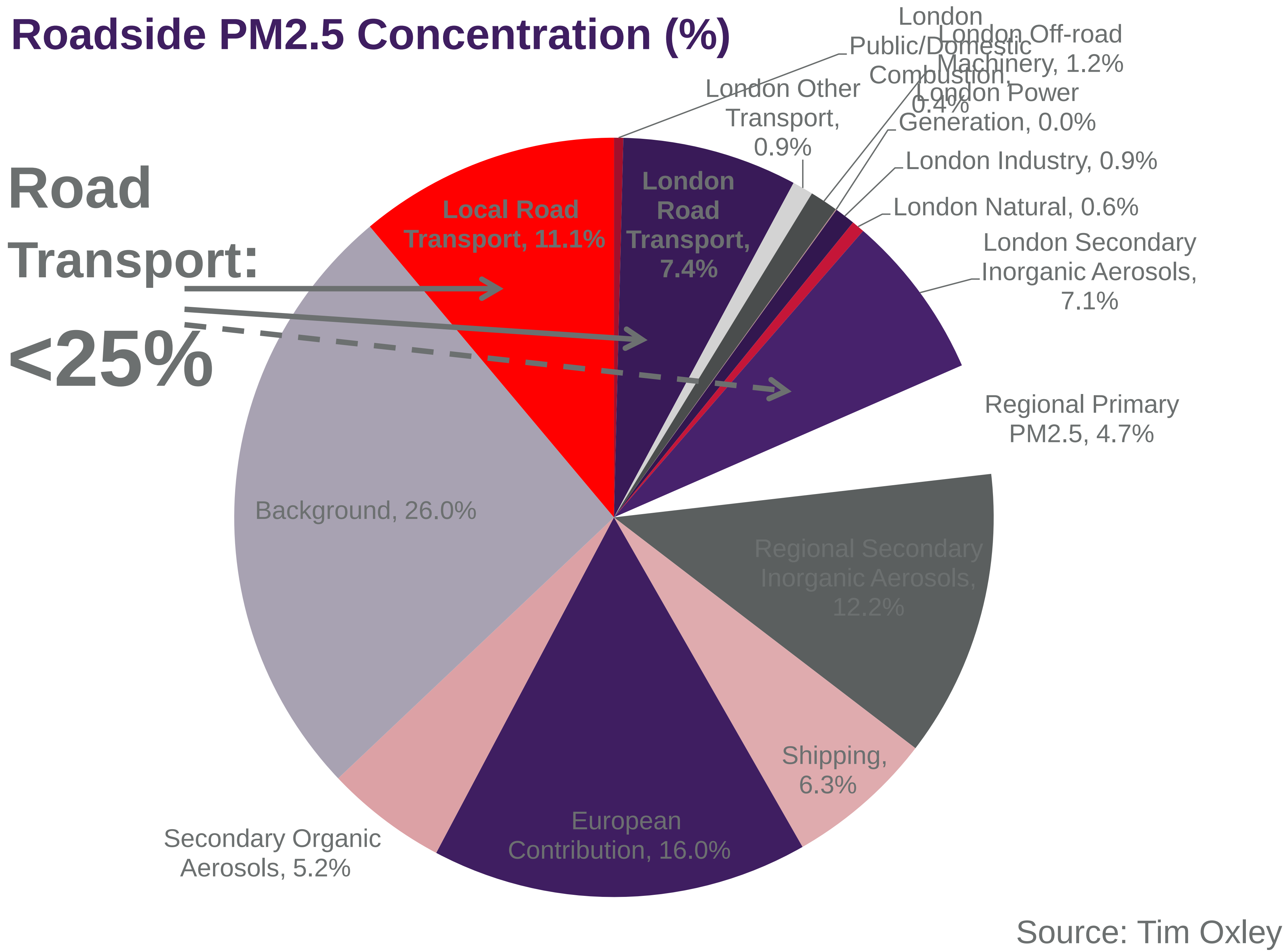
In the UK, traffic is responsible for 20% of ambient air pollution mortality (5% worldwide)

J Lelieveld *et al. Nature* **525**, 367-371 (2015) doi:10.1038/nature15371

Greater London PM2.5 emissions (%)



Source: Tim Oxley


Roadside PM2.5 Concentration (%)
Road Transport: <25%
Local Road Transport, 11.1%
London Road Transport, 7.4%
London Other Transport, 0.9%
London Public/Domestic Combustion, 0.4%
London Off-road Machinery, 1.2%
London Power Generation, 0.0%
London Industry, 0.9%
London Natural, 0.6%
London Secondary Inorganic Aerosols, 7.1%
Regional Primary PM2.5, 4.7%
Regional Secondary Inorganic Aerosols, 12.2%
Shipping, 6.3%
European Contribution, 16.0%
Secondary Organic Aerosols, 5.2%
Background, 26.0%
Source: Tim Oxley

What could be the effect of cycling schemes on air pollution?

- Could lead to an overall reductions in air pollution, but this is difficult to prove
- Examples of rigorously evaluated impacts of interventions on air pollution are scarce
- Even ambitious large-scale policies are difficult to evaluate

→ examples…

- Car free sundays in Mestre (Italy): no effect on air quality (Masiol et al. 2014)
- Car free day in Paris: 40% reduction in areas where cars were banned (Airparif)

London Congestion Charging Scheme

- Introduced in February 2003 ($22km^2$)
- Study measured air pollution 2001-2004 in affected and control sites, at background sites:
  - 12% decrease in PM10
  - 10 to 25 % decrease in NO,
  - 2 to 20% increase in NO2

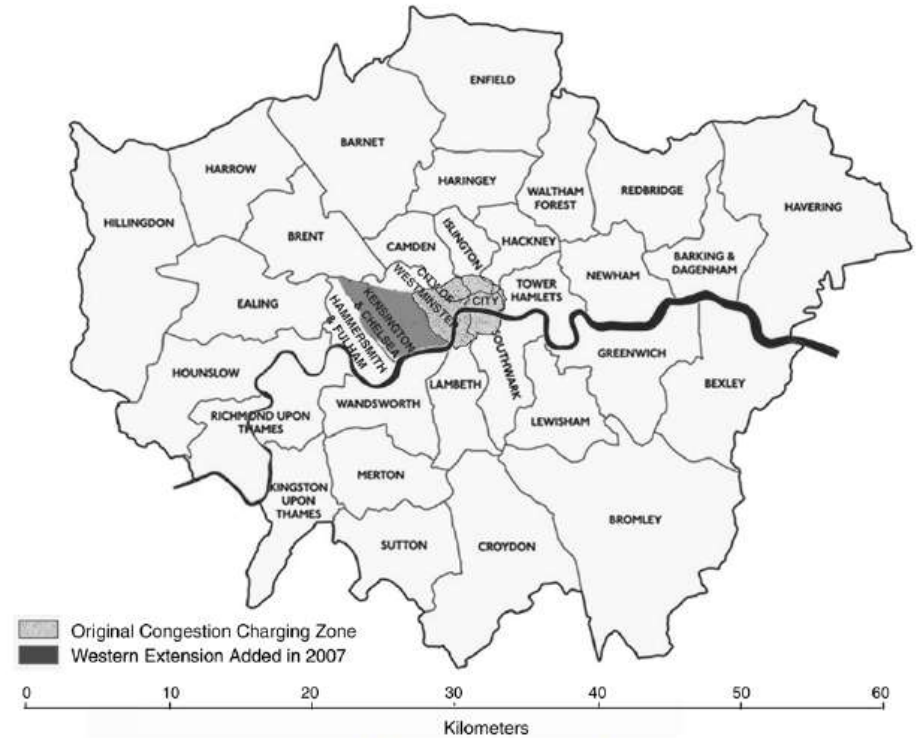


Figure 2. Relationship of the CCZ to Greater London. (Map includes the Western Extension, which was introduced in 2007.) Adapted with perm from Transport for London 2006.

Difficulties in attributing changes in air pollution:

Weather
Construction
Increase in diesel-powered buses and taxis
Other trends and changes
Number and location of air quality monitors

Expected reductions from local level schemes necessarily relatively small.

Changes in air pollution and deaths/year for transport scenarios in Barcelona

scenario	PM2.5 concentration % reduction
20% in-city car trip reduction, all replaced by biking	0.32
20% in-out city car trip reduction, 20% replaced by biking	0.58

Rojas-Rueda et al. Environment International 49 (2012) 100-109

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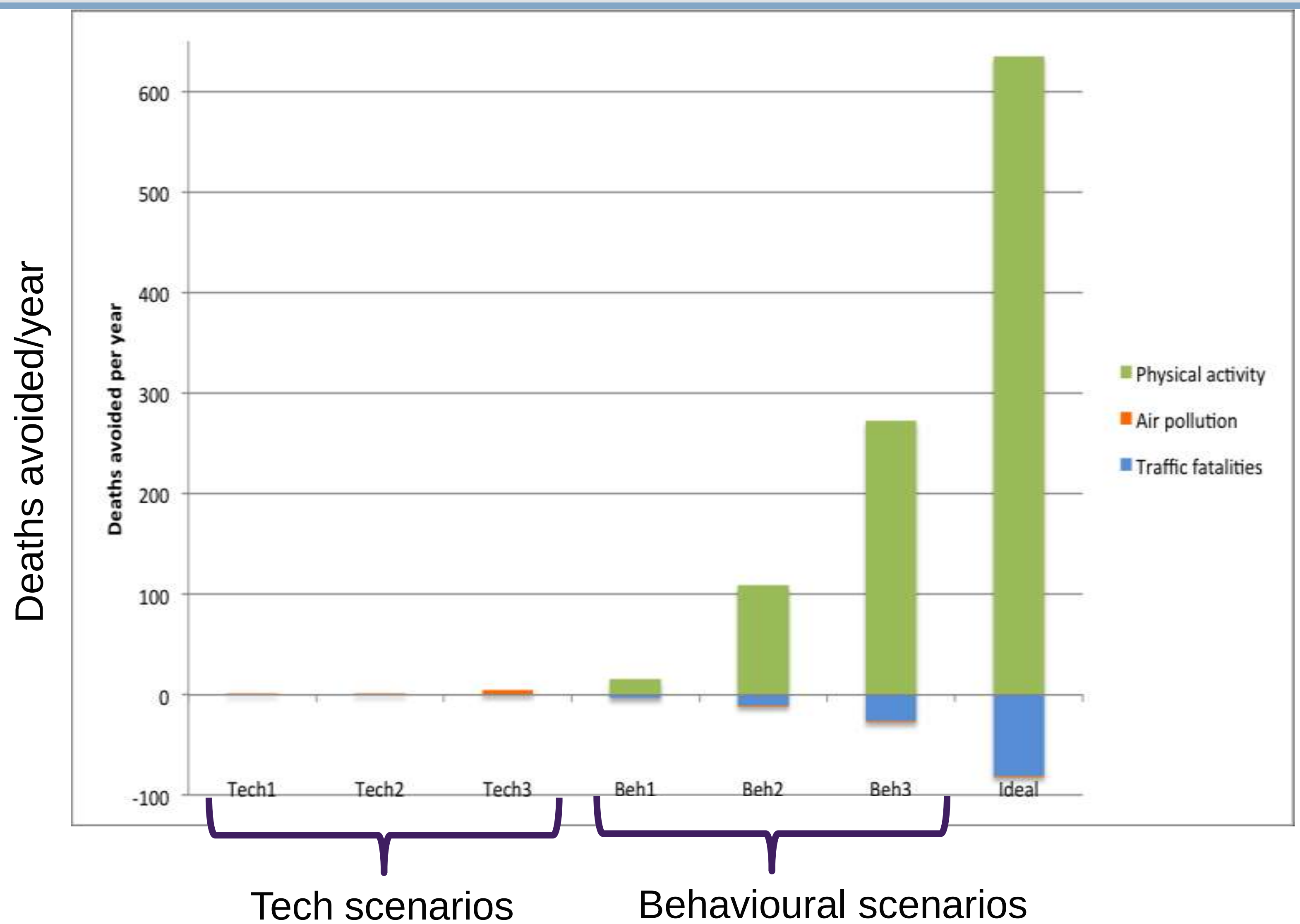
Tech vs behaviour

Scenario	Technological and behavioural changes
Tech 1	All double-deck buses to hybrid; all single deck buses to zero emission; all taxis to Euro 6 (diesel black cabs)
Tech 2	Tech 1 + Ultra Low Emission Zone (ULEZ) implemented
Tech 3	Tech 2 + ban diesel cars completely from London
Behaviour 1	Cycle superhighway (all reduced car traffic to bicycles) – reduce traffic flow 10%
Behaviour 2	Increased active travel (5% car trips to cycling; 5% car trips to walking) and public transport (10% car trips to bus) = 20% of car trips replaced
Behaviour 3	Most increased active travel (25% car trips to cycling; 15% car trips to walking) and public transport (10% car trips to bus) = 50% of car trips replaced
Combined ideal	No private cars in London (30% car trips to bus, all of which are zero emission; 50% car trips to cycle; 20% car trips to walking) and all black cabs zero emission, including London wide ULEZ standards for remaining vehicles

Tech vs behaviour



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Current major public health challenges

- Urban air pollution
- The gobal physical inactivity pandemic
- Traffic injuries (8th cause of death worldwide, 6 in Western Eu)
- Climate change

→ International calls for multilevel approaches: planning cities for health

→ Active travel policies

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Cities planning to go (partly) car-free

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Effectiveness and health impacts of transport policies: The PASTA project

PASTA

PHYSICAL ACTIVITY THROUGH SUSTAINABLE TRANSPORT APPROACHES

YOU CAN PARTICIPATE!

www.pastaproject.eu

Contact me: Audrey de Nazelle, anazelle@imperial.ac.uk

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Extra slides

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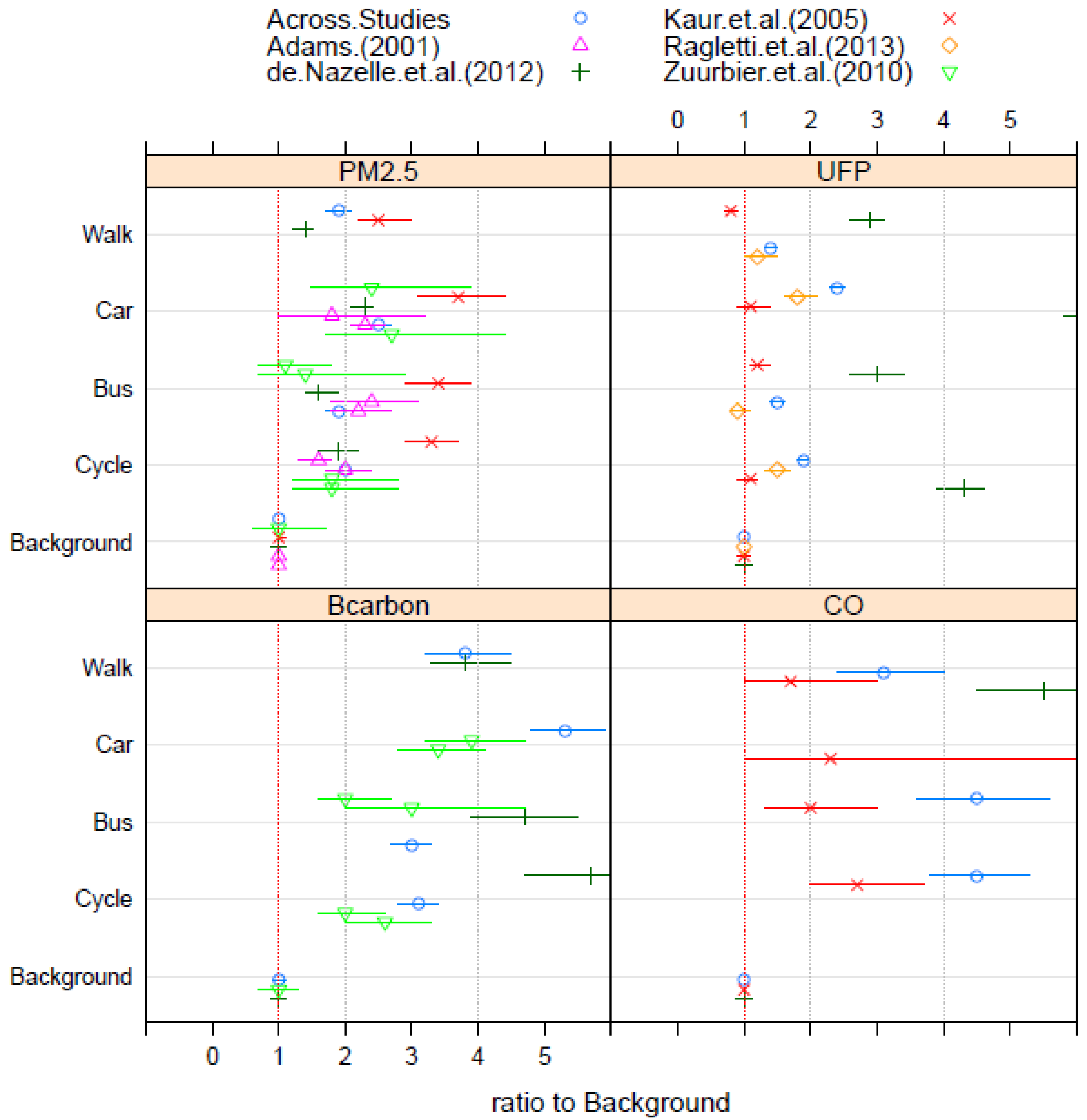
Literature review on exposure contrasts in different modes in Europe:

Modes vs background concentrations



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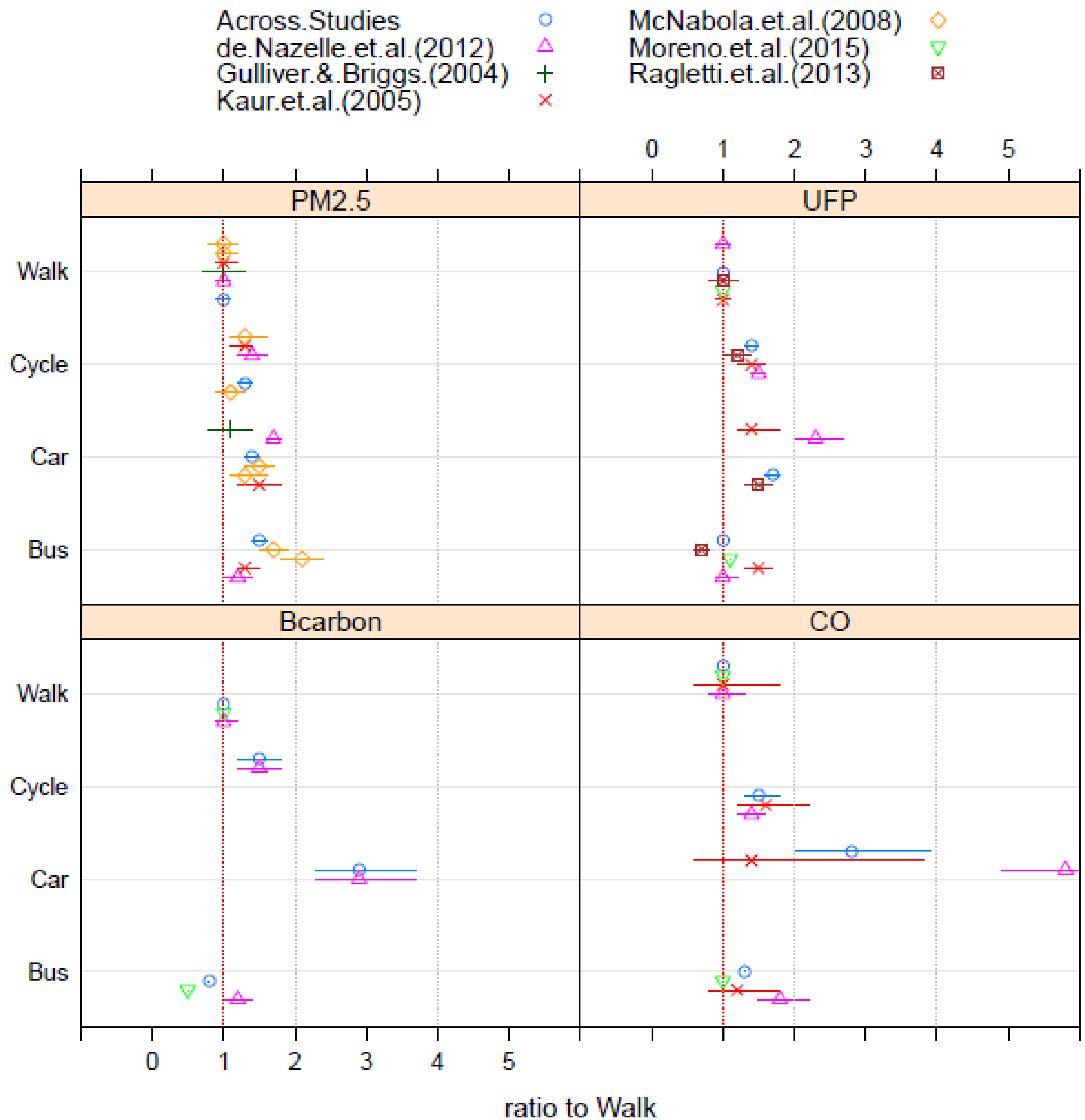
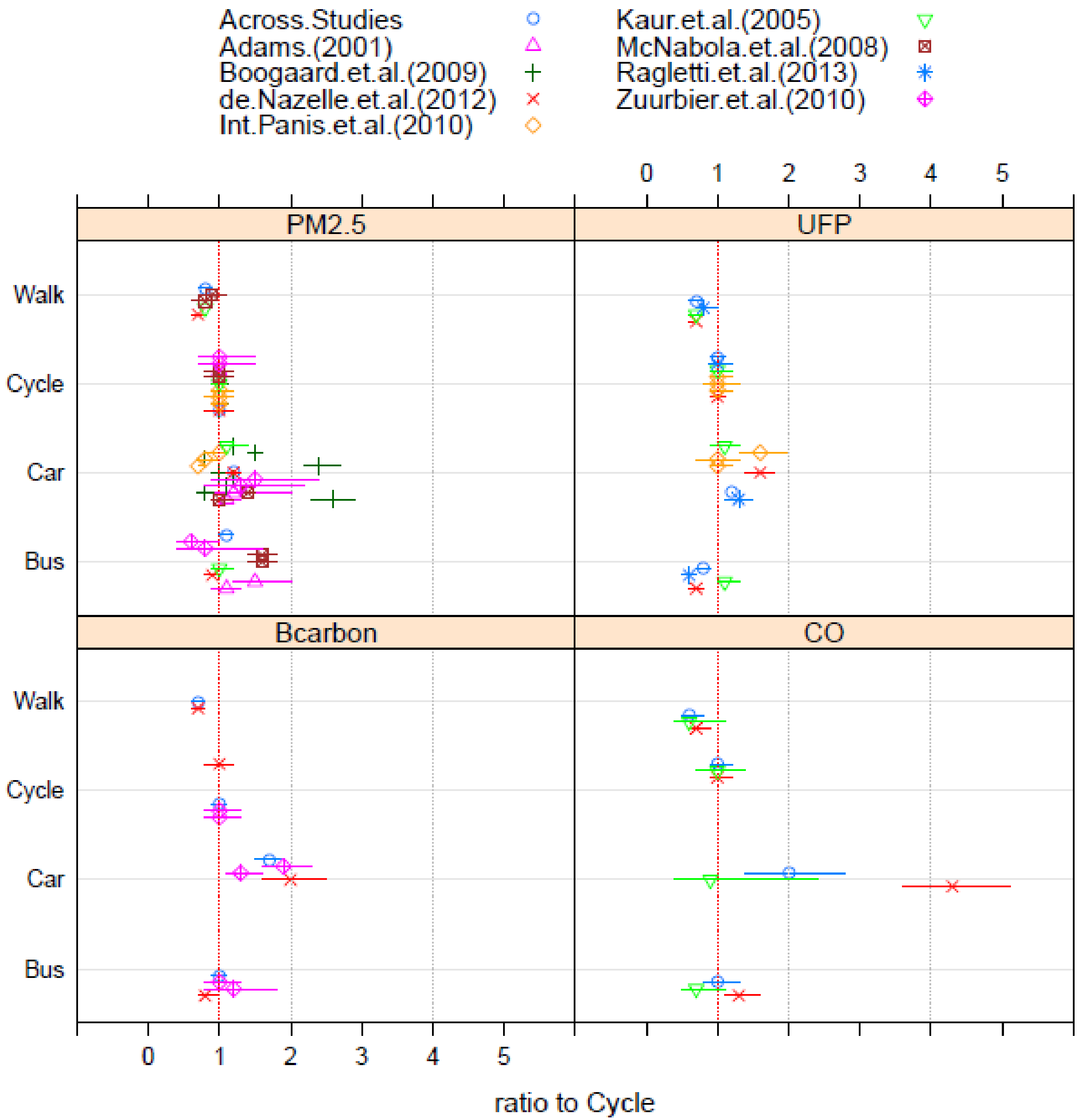
Literature review on exposure contrasts in different modes in Europe:

Modes vs walk



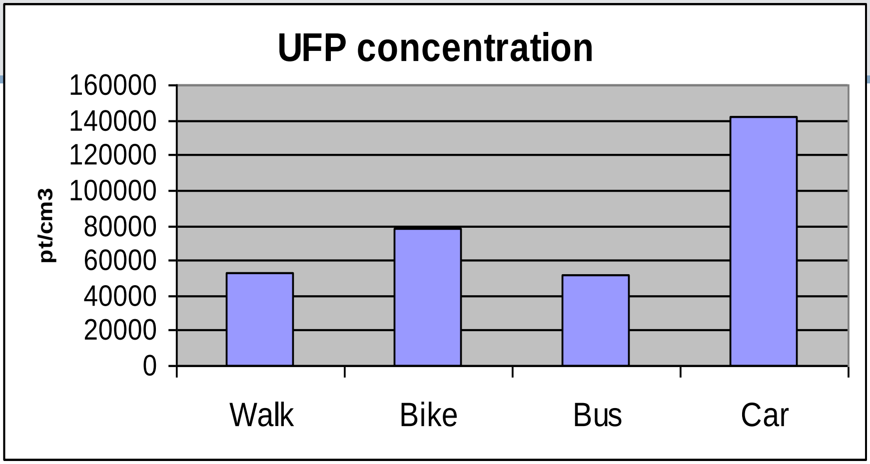
Literature review on exposure contrasts in different modes in Europe:

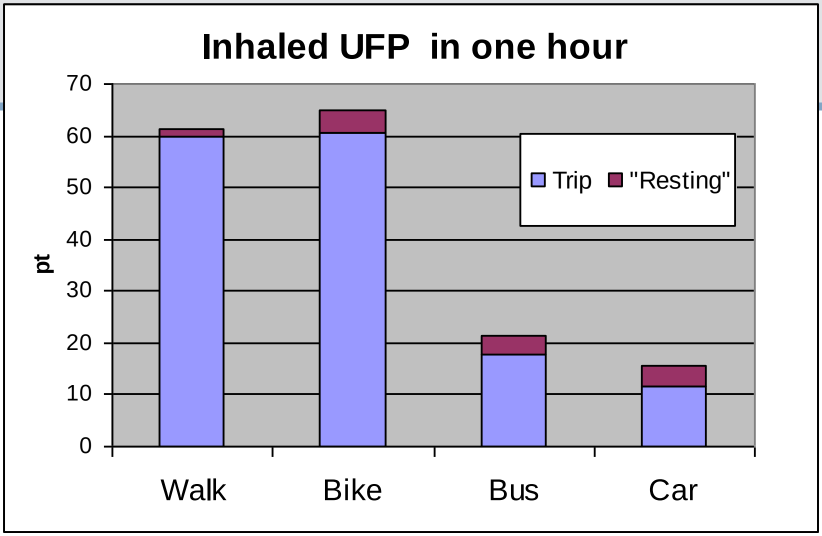
Modes vs Cycle



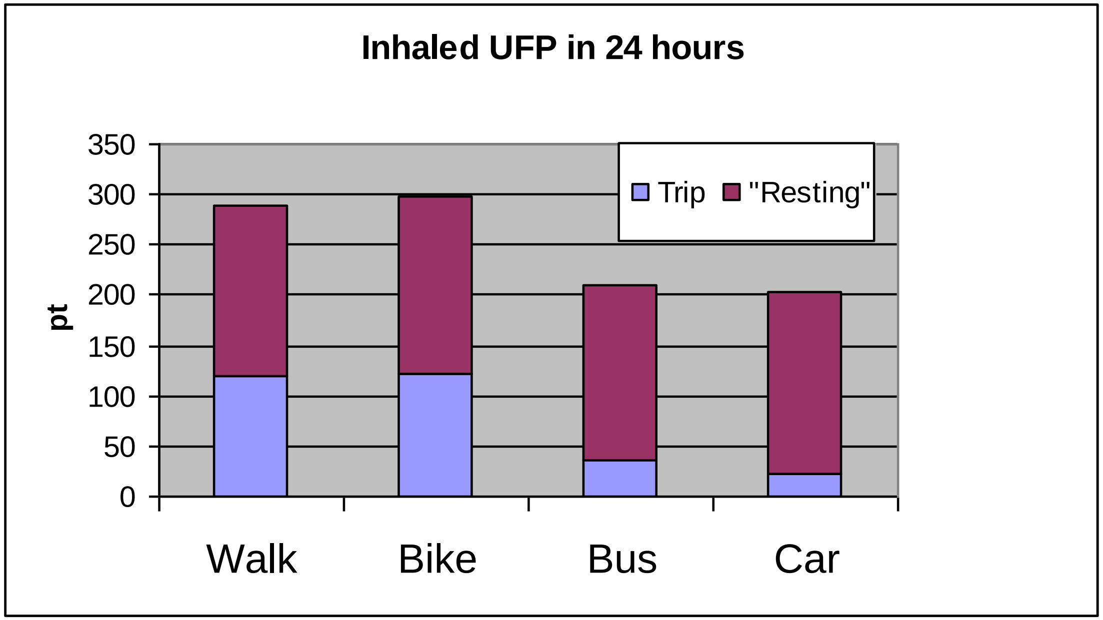
Average concentrations and inhaled doses

de Nazelle et al. 2012 Atmospheric Environment. 59:151-159; 2012

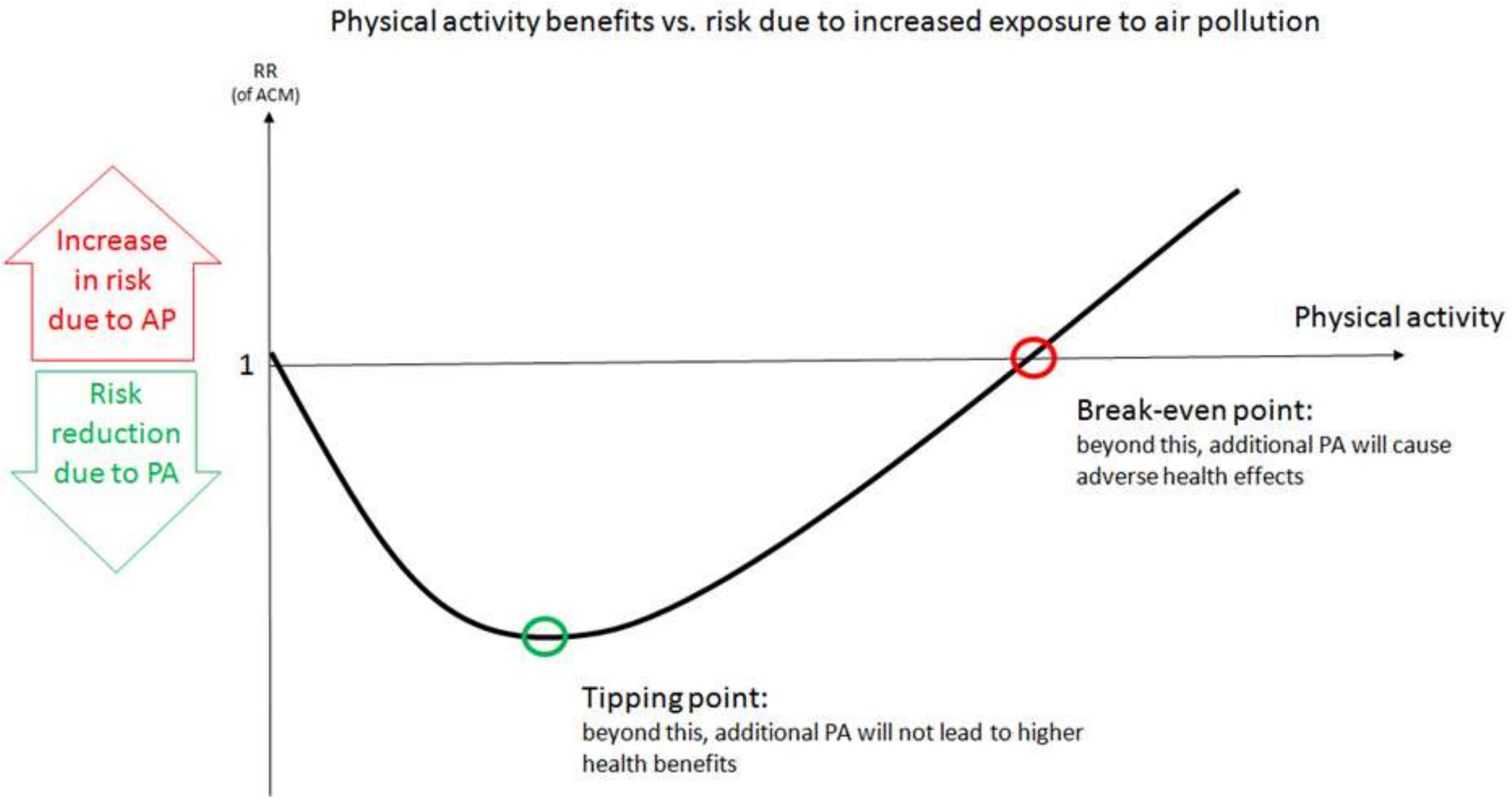




	IR (L/min)	Trip time (min)
Walk	23	49
Bike	37	24
Bus	10	34
Car	10	28



For a given level of air pollution, is there a tipping beyond which additional physical activity does not bring additional benefits, and a "break-even" point beyond which additional physical activity brings greater risks?



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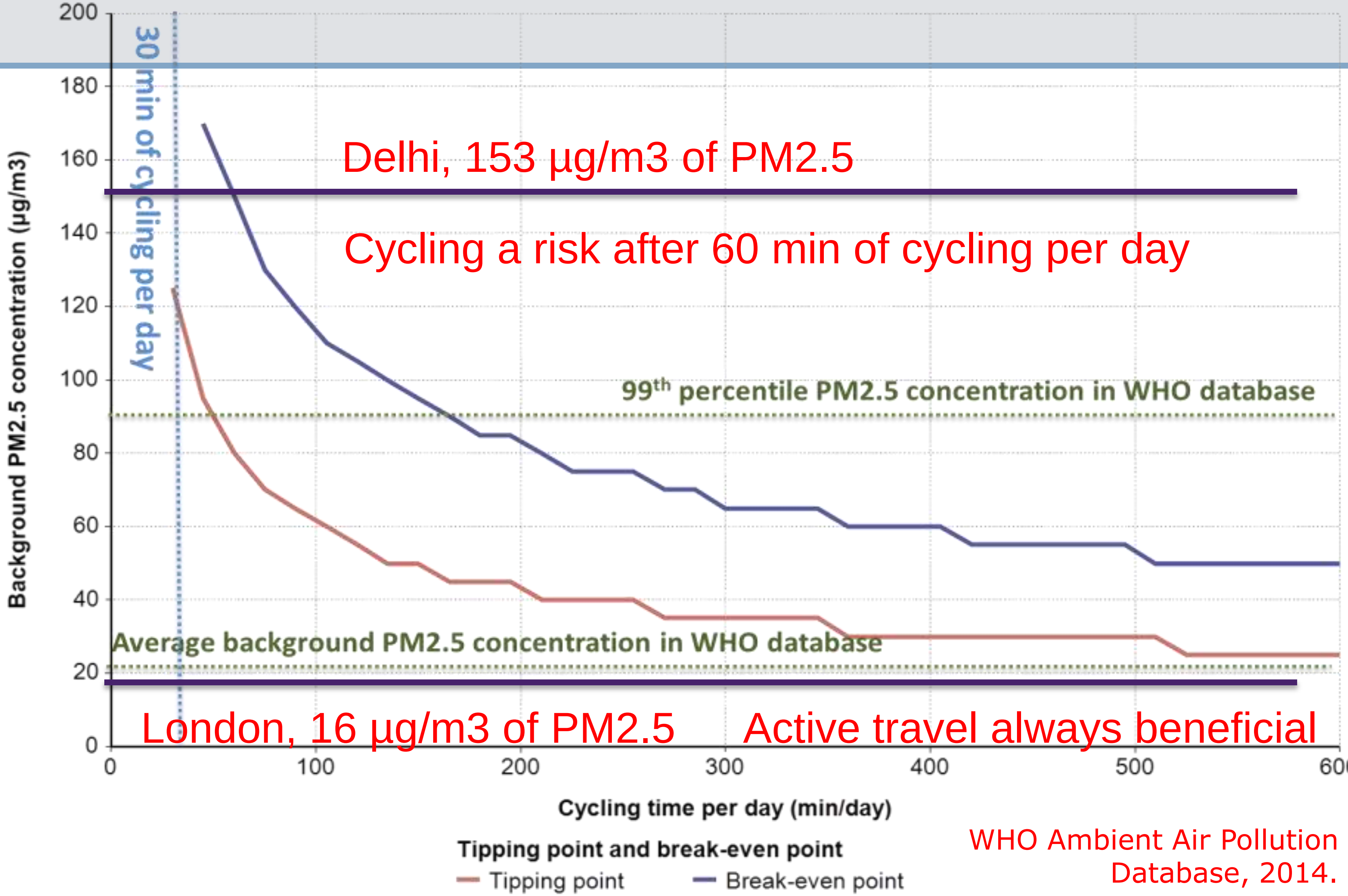
When risks become higher than benefits: Cycling



WHO Ambient Air Pollution Database, 2014.

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Purely technological solutions vs demand management? (e.g. active travel)

- Reduction in vehicle use leads to reductions in non-exhaust emissions and noise
- Woodcock et al. (2009) Comparison of GHG emission policy scenarios in London: **death per million people**

scenario	physical activity	Air pollution	Traffic mortality	TOTAL
increased active travel	**-528**	**-21**	**+11**	**-538**
lower carbon emission vehicles	**0**	**-17**	**0**	**-17**

Woodcock et al. 2009 The Lancet , v3674, 9705: 1930-1943