

Systematic review of selected health effects of long-term exposure to traffic-related air pollution

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UNECE Air Convention (LRTAP)

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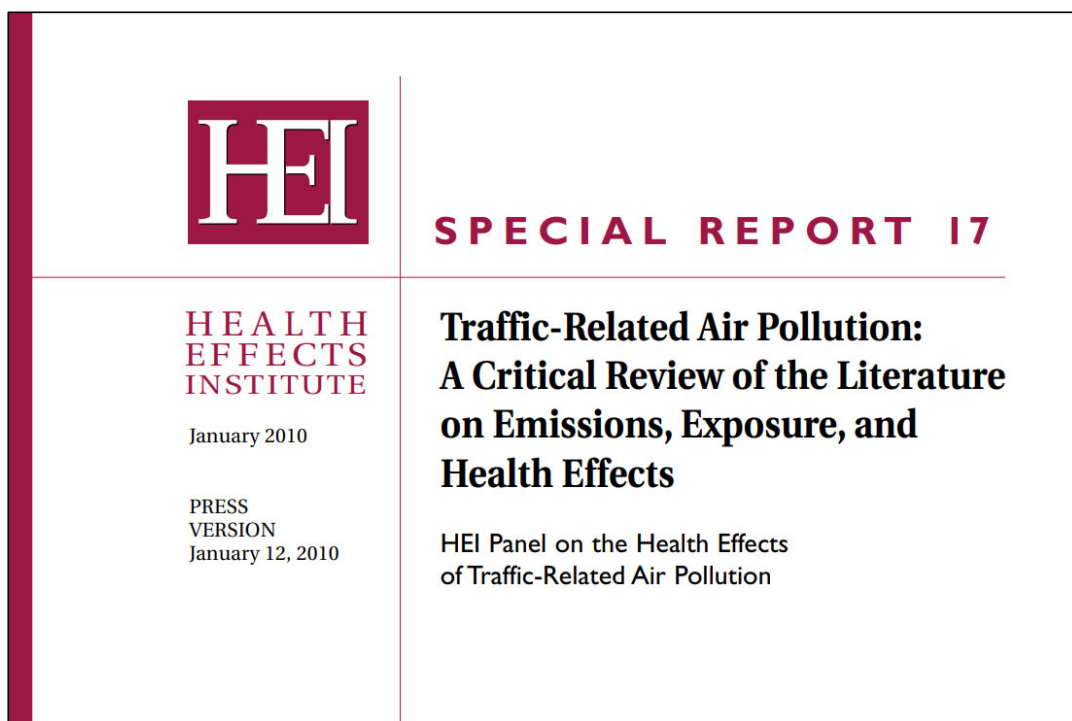
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	RESEARCH REPORT
HEALTH EFFECTS INSTITUTE Number 208 September 2021	Mortality and Morbidity Effects of Long-Term Exposure to Low-Level PM_{2.5}, BC, NO₂, and O₃: An Analysis of European Cohorts in the ELAPSE Project Bert Brunekreef, Maciej Strak, Jie Chen, Zorana J. Andersen, Richard Atkinson, Mariska Bauwelinck, Tom Bellander, Marie-Christine Boutron, Jorgen Brandt, Iain Carey, Giulia Cesana, Ole Hertel, Barbara Hoffmann, Nicole Jans, Jochem Klomparens, Amar Mehta, Gabriele M. O. Raaschou-Nielsen, Torben S. Schwarze, Kathrin Wolf
	RESEARCH REPORT
HEALTH EFFECTS INSTITUTE Number 211 January 2022	Assessing Adverse Health Effects of Long-Term Exposure to Low Levels of Ambient Air Pollution: Implementation of Causal Inference Methods Francesca Dominici, Antonella Zanobetti, Joel Schwartz, Danielle Braun, Ben Sabath, and Xiao Wu
	RESEARCH REPORT
HEALTH EFFECTS INSTITUTE Number 210 December 2021	Global Burden of Disease from Major Air Pollution Sources (GBD MAPS): A Global Approach Erin McDuffie, Randall Martin, Hao Yin, and Michael Brauer



HEI 2010 Traffic and Health Review



A Panel was convened to review the traffic and health literature **up to 2008**.

Detailed chapters on emissions, exposure, toxicology and epidemiology.

At that time, evidence was considered sufficient to support a causal relationship between traffic-related air pollution and exacerbation of **asthma** in children. Suggestive and/or limited evidence for other health outcomes.

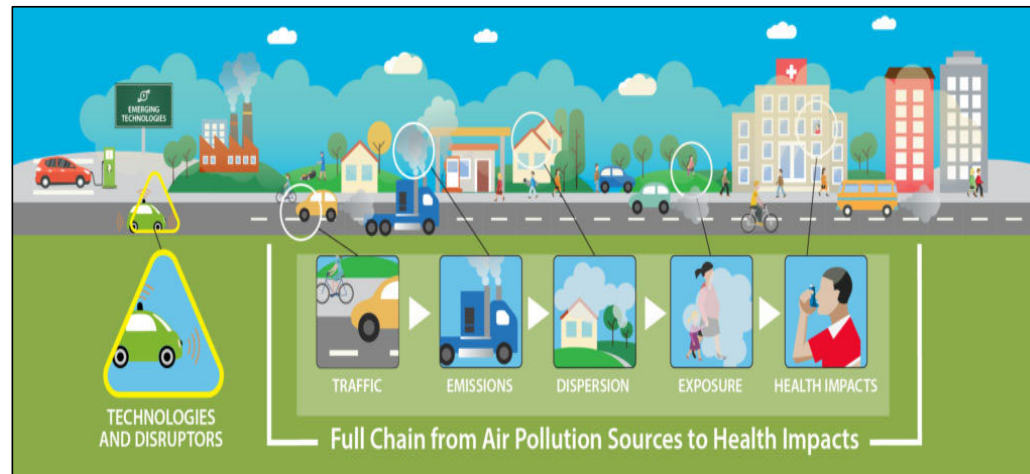
<https://www.healtheffects.org/>

New Review of the Traffic and Health Literature

Strong interest in an update of the review:


- ✓ Substantial new research published
- ✓ Regulations and vehicular technology have advanced
- ✓ Interest in non-tailpipe emissions and traffic noise is increasing

HEI appointed a new panel to systematically review epidemiologic studies in 2018.



The full chain of events linking TRAP to health effects. Source: Center for Advancing Research in Transportation Emissions, Energy and Health (CARTEEH), available from: <https://www.carteeh.org/>.

The New HEI Traffic Review has been recently published

	<h2>SPECIAL REPORT</h2>
<h3>HEALTH EFFECTS INSTITUTE</h3> <p>Number 23 June 2022</p>	<h3>Systematic Review and Meta-analysis of Selected Health Effects of Long-Term Exposure to Traffic-Related Air Pollution</h3> <p>HEI Panel on the Health Effects of Long-Term Exposure to Traffic-Related Air Pollution</p>

<https://www.healtheffects.org/publication/systematic-review-and-meta-analysis-selected-health-effects-long-term-exposure-traffic>

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Short communication

Long-term exposure to traffic-related air pollution and selected health outcomes: A systematic review and meta-analysis

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HEI Panel on the Health Effects of Long-term Exposure to Traffic-Related Air Pollution

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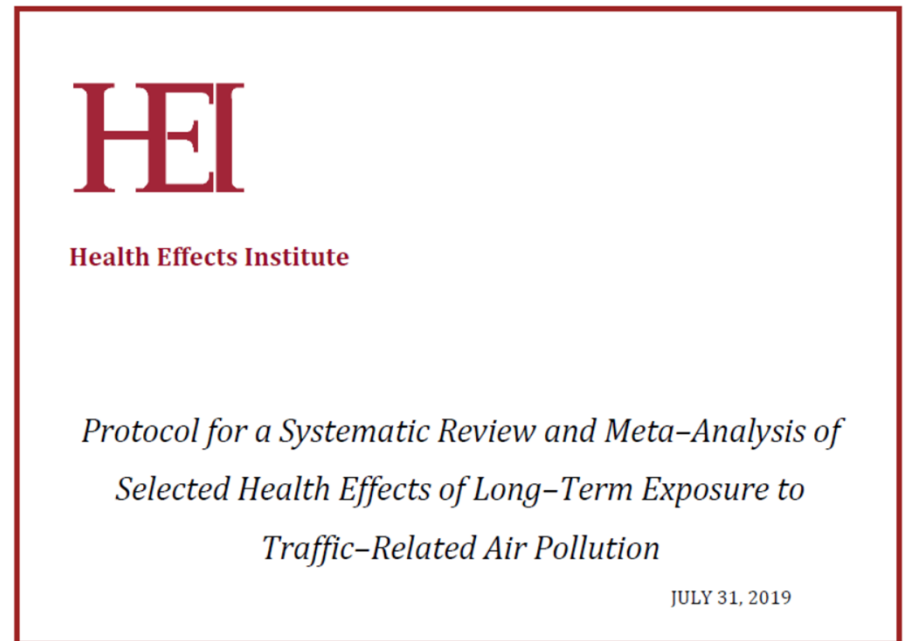
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Robert O'Keefe, Martha Ondras, Allison Patton, Ellen
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van Erp



A Systematic Review

- ✓ Use methods largely based on standards set by Cochrane Collaboration, World Health Organization, and the National Institute of Environmental Health Sciences
- ✓ Summarize epidemiological results quantitatively, where possible
- ✓ Include an evaluation of the risk of bias in individual studies
- ✓ Reach conclusions about the confidence in the quality of the body of evidence and with assessing the level of confidence in the presence of an association.



The review protocol was published in July 2019 on the HEI website* and registered with Prospero**

* <https://www.healtheffects.org/announcements/panel-publishes-protocol-review-traffic-related-air-pollution>

** https://www.crd.york.ac.uk/PROSPERO/display_record.php?RecordID=150642

Important Methodological Features of the Traffic Review

Conducted largest effort of this type to date.

- Evaluates the epidemiologic literature only.
- Focuses on a selected set of health outcomes chosen *a priori*, including mortality, cardiovascular and respiratory morbidity and birth outcomes.

Applies a new exposure framework.

- Considers only long-term exposure to traffic-related air pollution.
- Considers exposure contrasts in near-roadway and neighborhood environments.

Assesses confidence in the evidence for an association.

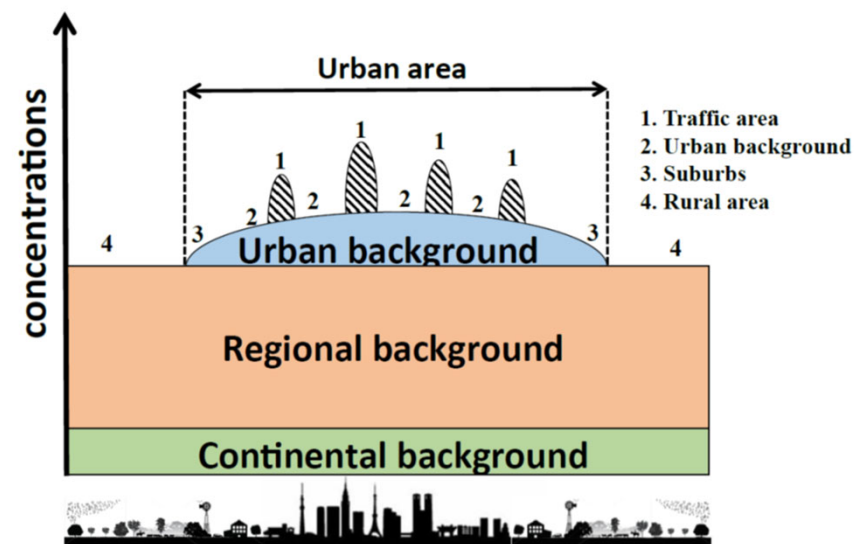
- 2 complementary methods with ratings of very low, low, moderate, or high for traffic-related air pollution mixture, not individual pollutants.

Exposure Framework

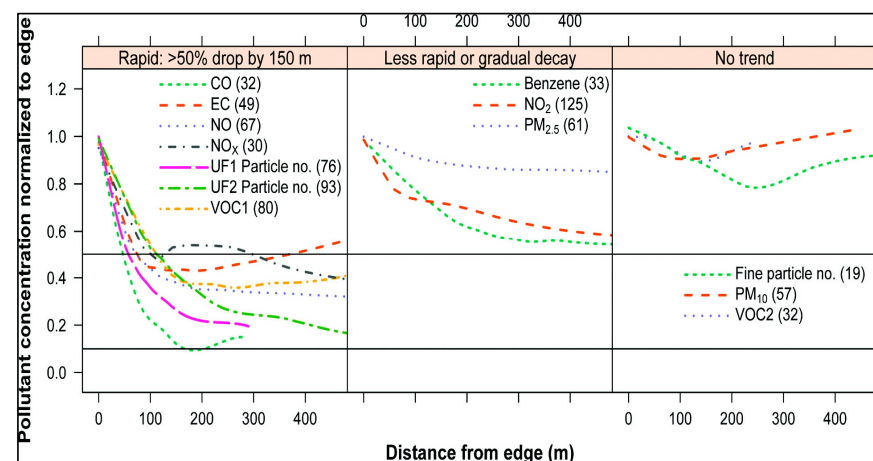
Exposure assessment of TRAP is challenging because it is a complex mixture and is characterized by high spatial and temporal variability.

- ✓ Still no pollutant specific for traffic sources
- ✓ TRAP impacts at different scales

Three strategies were developed to select 'traffic-related' studies, namely the selection of traffic-related pollutants, the exposure assessment method and its spatial resolution.



Source: Fuzzi et al. 2015.



Source: Karner et al. 2010.

Confidence Assessments

Separate assessments for confidence in the quality of the body of evidence (modified OHAT) and in the presence of an association (narrative) (high, moderate, low, and very low)

For each exposure-outcome pair by study design



For each exposure-outcome pair



For each health outcome



Overall confidence

Methods for Confidence in the Quality of the Body of Evidence (Modified OHAT* – or GRADE**-type approach)

Initial Confidence by Key Features of Study Design	Factors Decreasing Confidence	Factors Increasing Confidence	Confidence in the Body of Evidence
High (++++) 4 Features	<ul style="list-style-type: none"> • Risk of Bias • Unexplained Inconsistency • Indirectness • Imprecision • Publication Bias 	<ul style="list-style-type: none"> • Large Magnitude of Effect • Dose Response • Residual Confounding <ul style="list-style-type: none"> – Studies report an effect and residual confounding is toward null – Studies report no effect and residual confounding is away from null • Consistency <ul style="list-style-type: none"> – Across animal models or species – Across dissimilar populations – Across study design types • Other <ul style="list-style-type: none"> – e.g., particularly rare outcomes 	High (++++)
Moderate (+++) 3 Features			Moderate (+++)
Low (++) 2 Features			Low (++)
Very Low (+) ≤1 Features			Very Low (+)

- Features**
- Controlled exposure
 - Exposure prior to outcome
 - Individual outcome data
 - Comparison group used

- ✓ Initial rating based on study design features
- ✓ Upgrade or downgrade based on certain factors
- ✓ The Panel did not apply the methods in a “mechanistic” way

*Office of Health Assessment and Translation (OHAT), 2019. Handbook. National Toxicology Program, National Institute of Environmental Health Sciences, U.S. Dept of Health and Human Services.

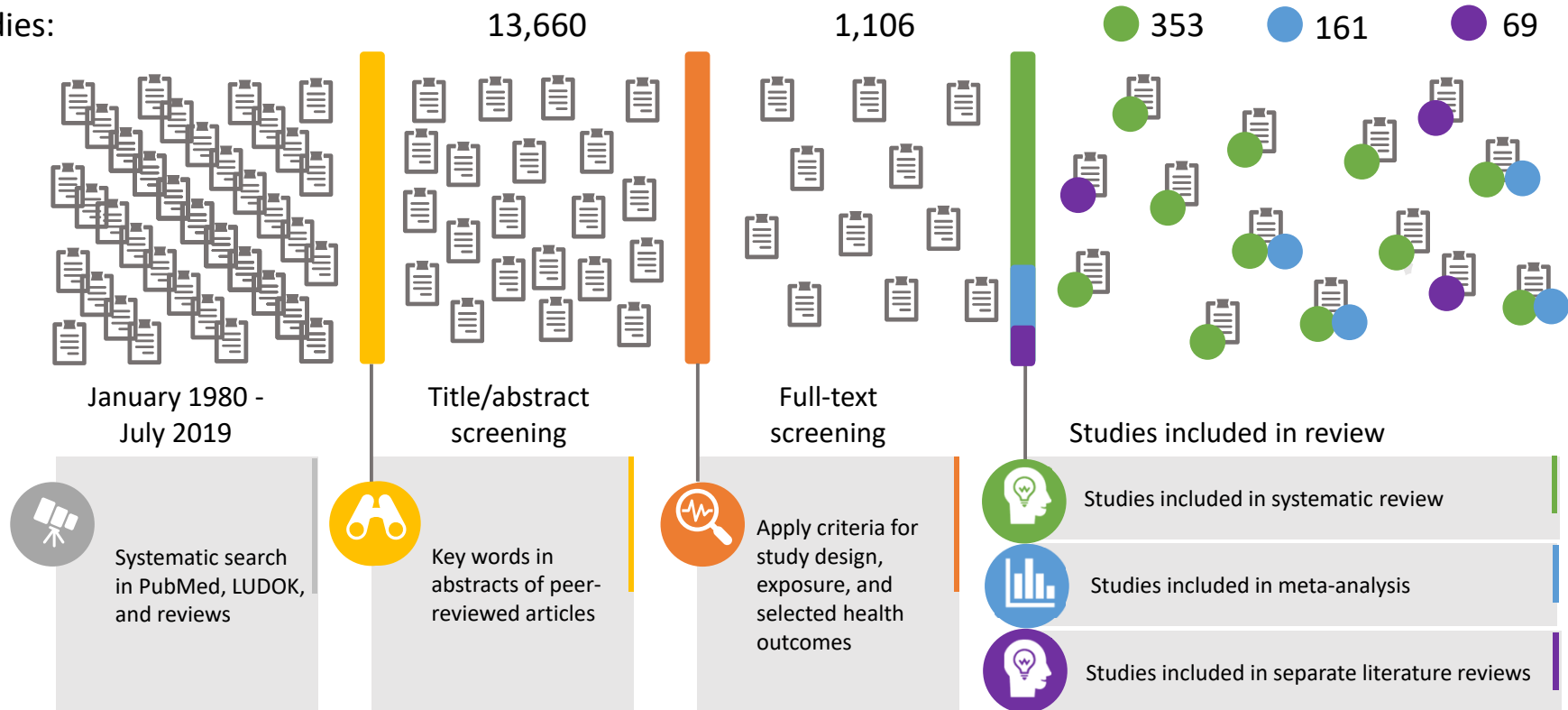
**Grading of Recommendations Assessment, Development and Evaluation (GRADE). 2013. Handbook.

Addition of a Broader “Narrative” Approach to Maximize What can be Learned from Observational Studies

- ✓ GRADE-type assessments focus on the quality of the body of evidence rather than the presence of an association.
- ✓ Those assessments are heavily geared towards studies entering a meta-analysis.
- ✓ Hence, the Panel deemed it necessary to accompany the GRADE-type assessment with a broader “narrative” assessment.

Number of studies identified

studies:

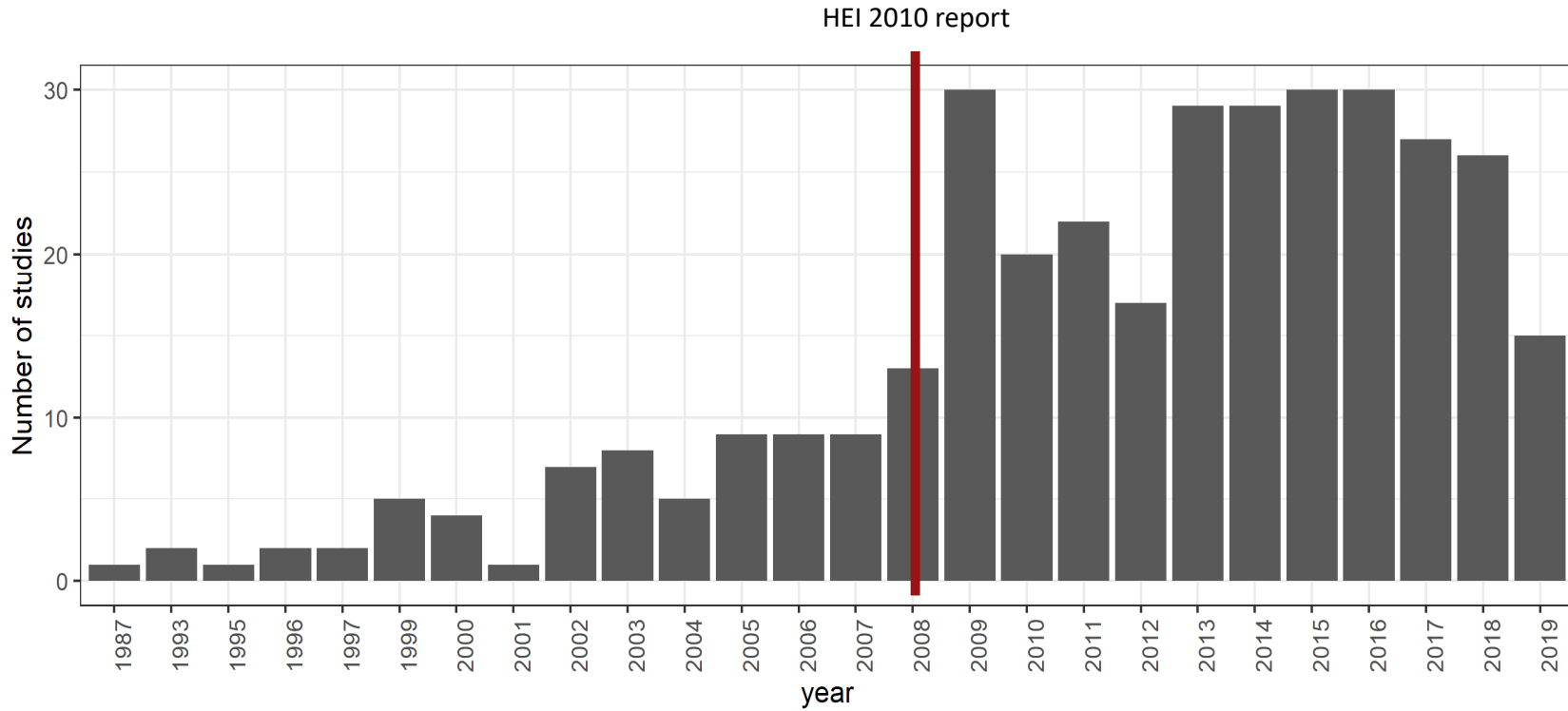


Systematic review on the health effects of long-term exposure to traffic-related air pollution

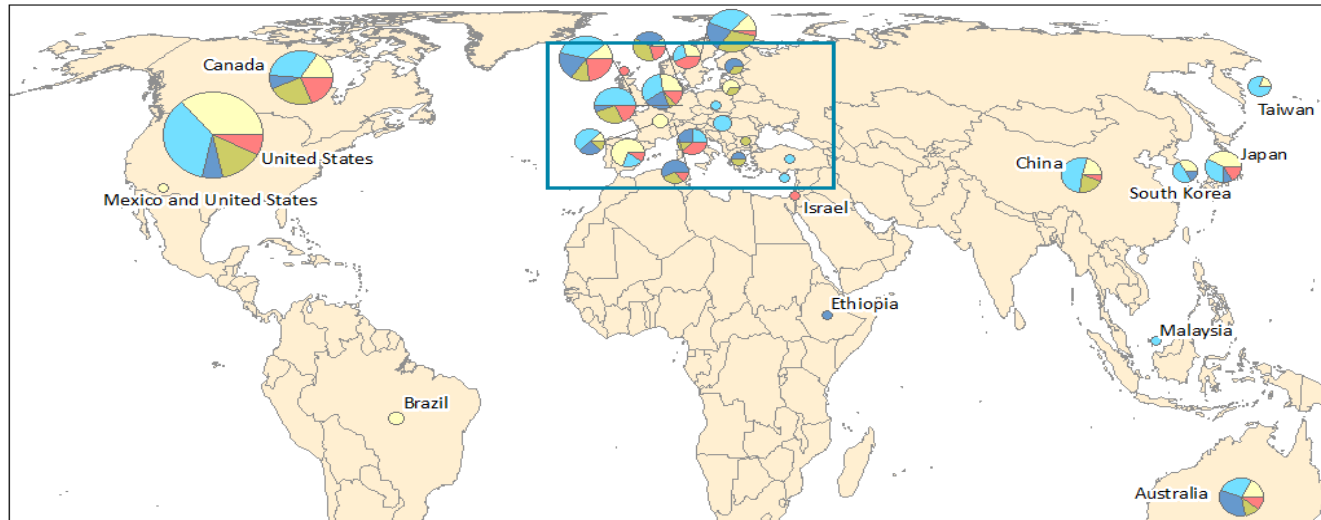
Literature Search Results

353 studies included

Health outcome Category	Total number of studies
Birth outcomes	86
Respiratory outcomes - children	118
Respiratory outcomes - adults	50
Cardiometabolic outcomes	57
Mortality	48



Geographical Location of the Studies



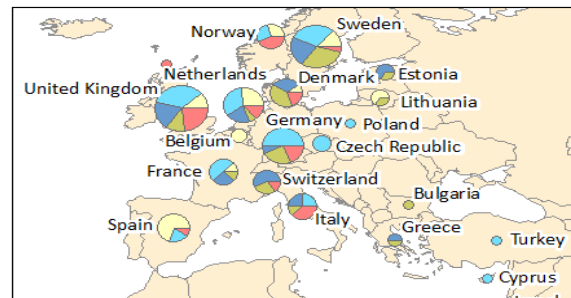
Studies in World Countries

Legend

28 Circle size indicates total studies for country
Range: 1 to 91

Health outcomes studied

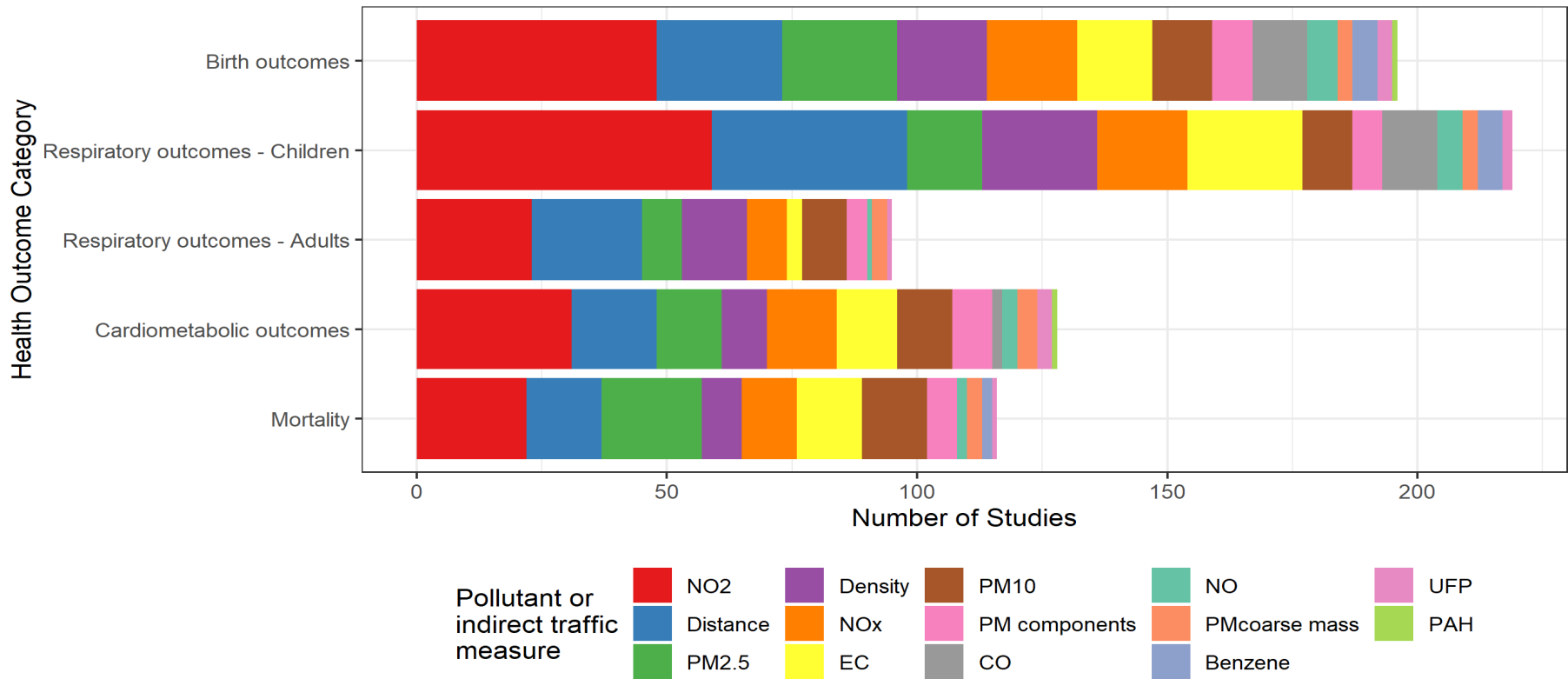
- Birth outcomes
- Respiratory outcomes - children
- Respiratory outcomes - adults
- Cardiometabolic outcomes
- Mortality



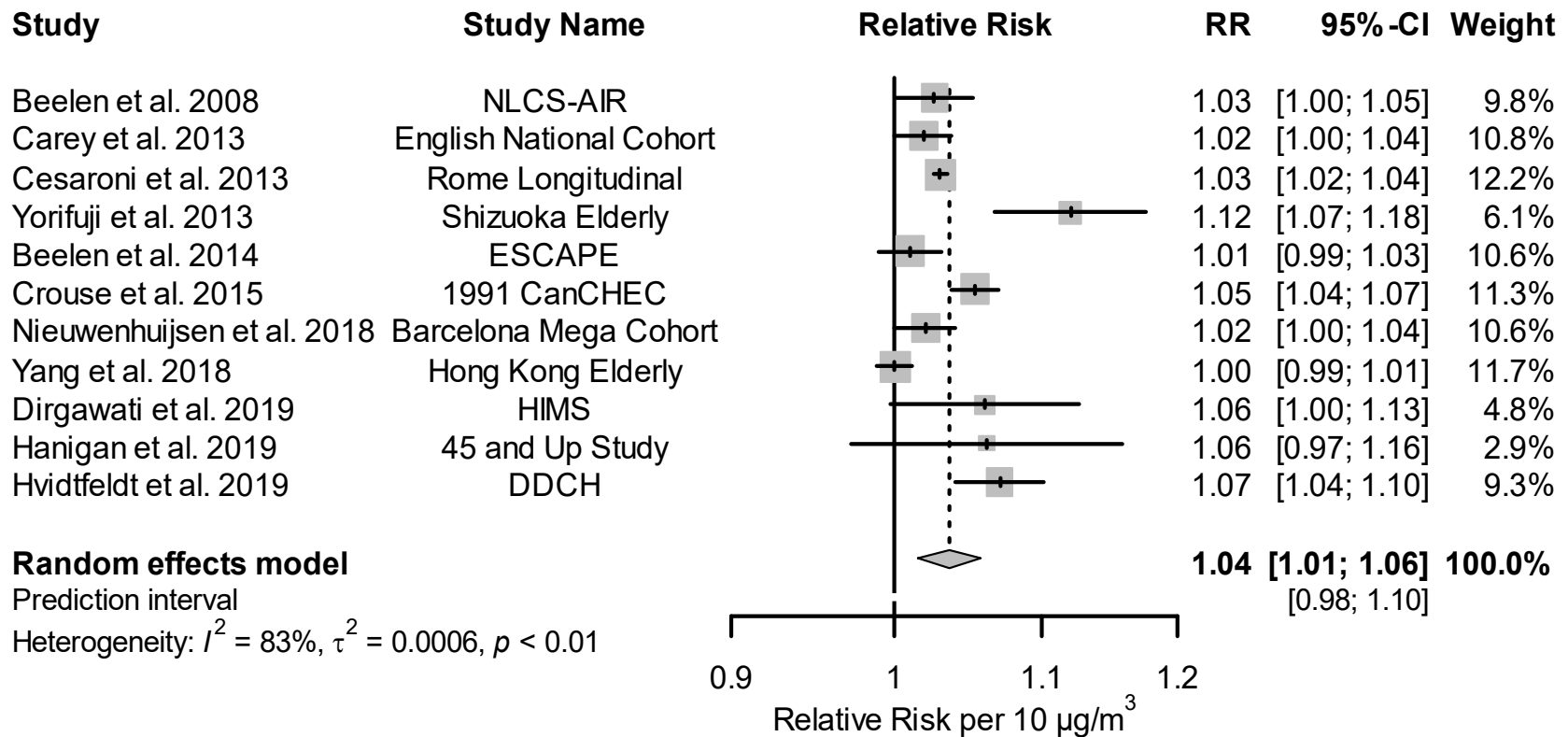
Studies in European countries

Region	Total number of studies
Europe	163
North America	130
Asia	41
Other regions	19

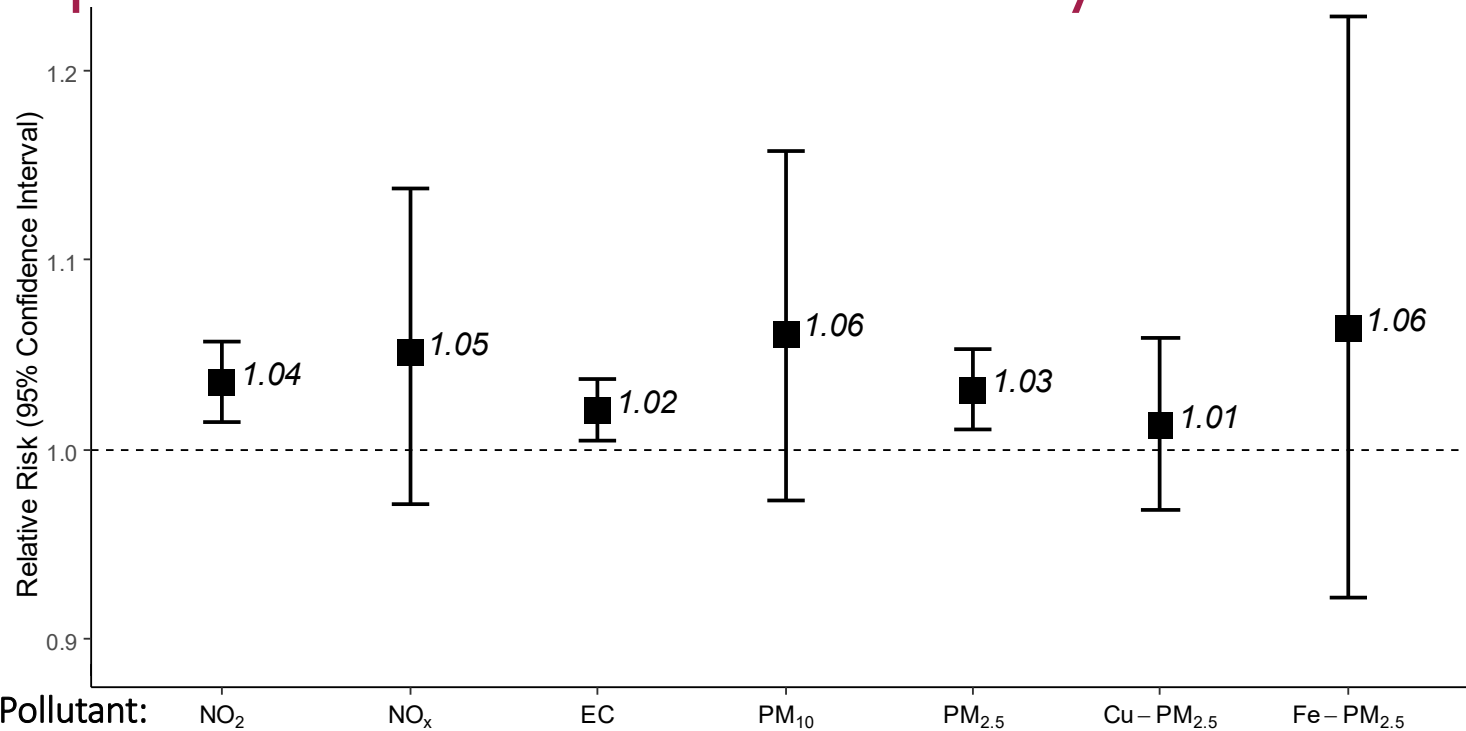
Number of Studies by Outcome and Pollutant



Meta-analysis NO₂ – All cause mortality



Meta-analysis of associations between traffic-related air pollutants and all-cause mortality



No. studies in meta-analysis:

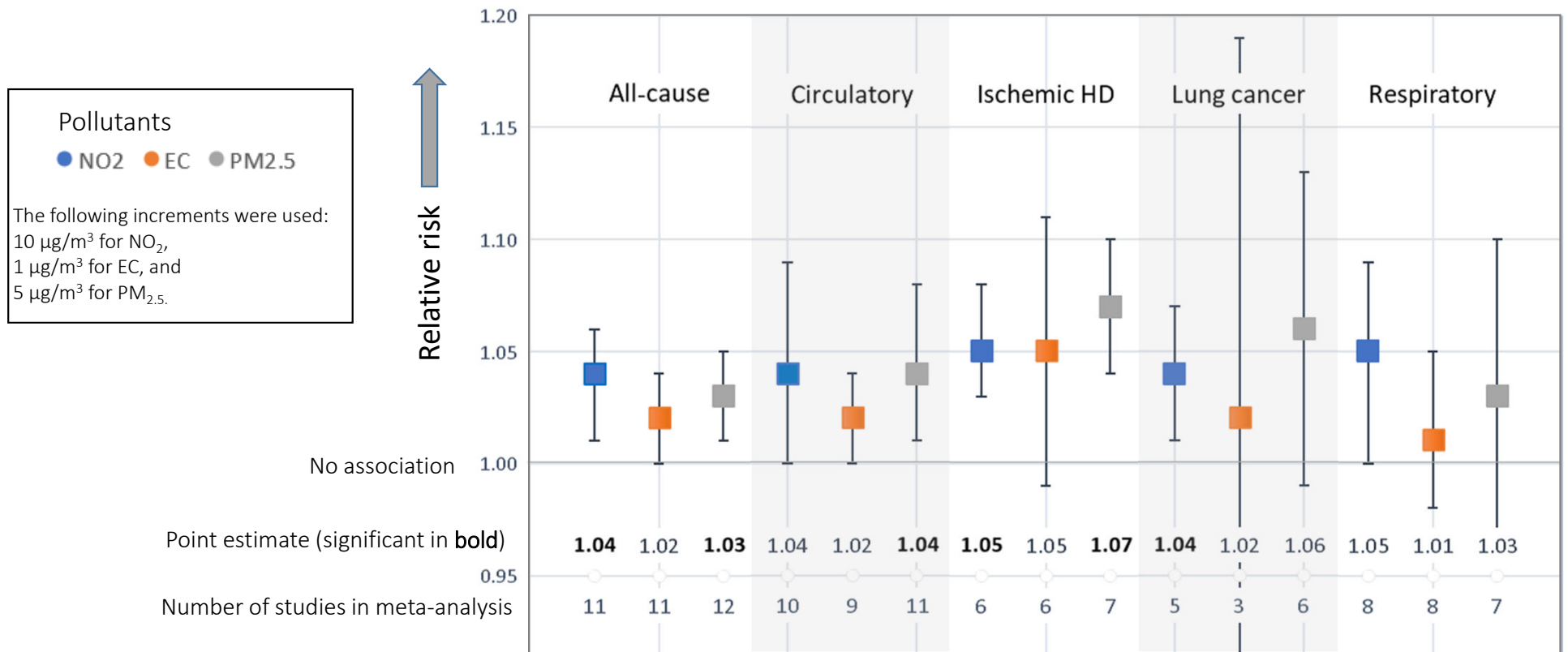
11 5 11 6 12 3 3

Increments:

10 µg/m³ 20 µg/m³ 1 µg/m³ 10 µg/m³ 5 µg/m³ 5 ng/m³ 500 ng/m³

Effect estimates cannot be directly compared across the different traffic-related pollutants because the selected increments do not necessarily represent the same contrast in exposure. The individual pollutants are considered as indicators of the TRAP mixture.

Meta-analysis of associations between traffic-related air pollutants and selected mortality outcomes*



*Outcomes selected where the confidence in the evidence for an association with TRAP was judged high (all-cause, circulatory and ischemic HD; moderate to high (lung cancer), or moderate (respiratory)).

Meta-analysis of associations between traffic-related air pollutants and selected morbidity outcomes

Pollutants

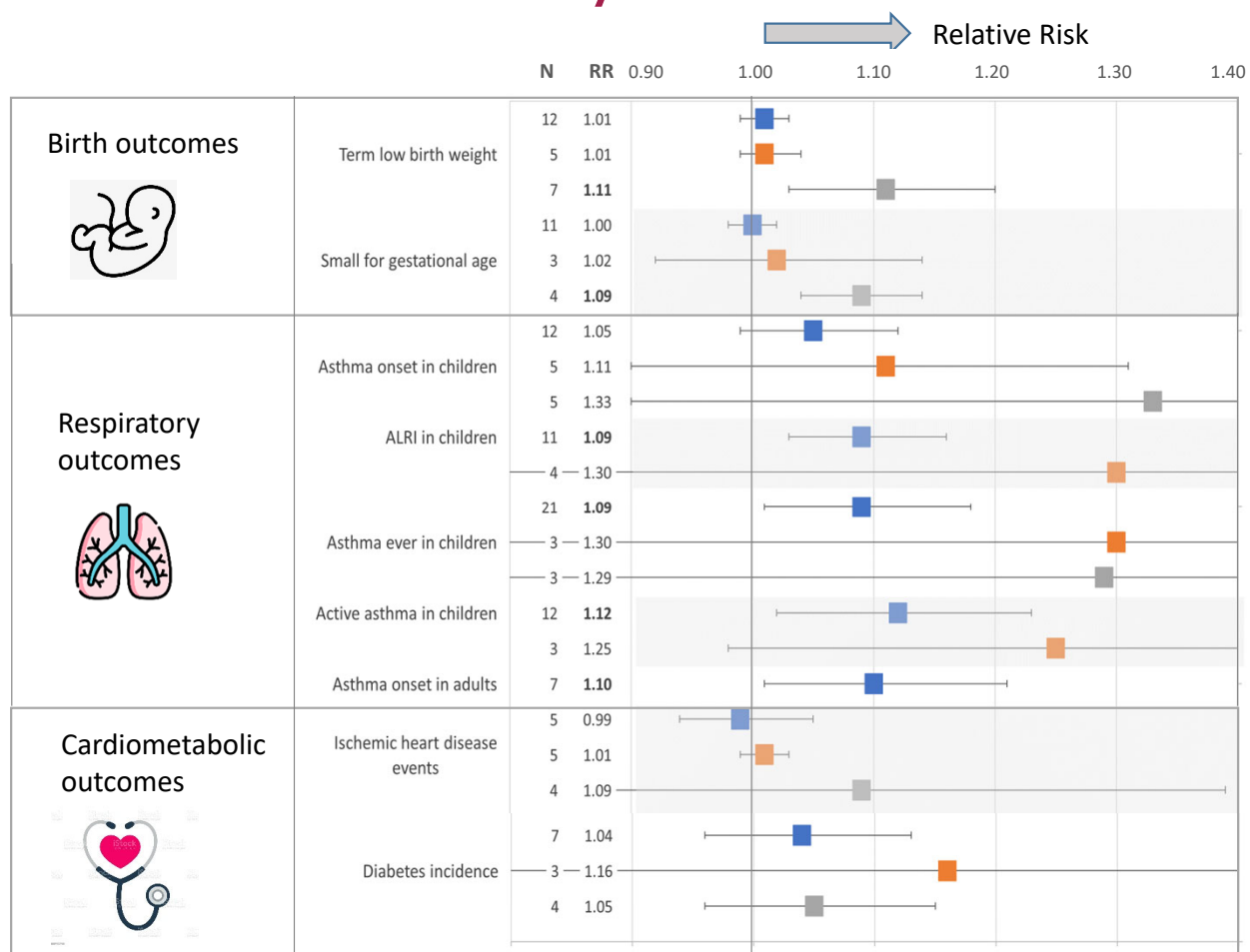
- NO₂ ● EC ● PM_{2.5}

The following increments were used:
 10 µg/m³ for NO₂
 1 µg/m³ for EC
 5 µg/m³ for PM_{2.5}

RR = point estimate (significant in **bold**)

N = number of studies in meta-analysis

*Outcomes selected where the confidence in the evidence for an association with TRAP was judged moderate to high (asthma onset, acute lower respiratory infections), or moderate (remainder)



1.00 = no association

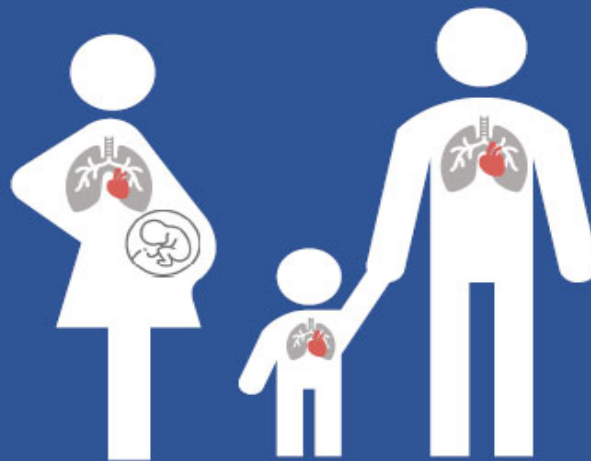
Health outcomes associated with traffic-related air pollution

Birth outcomes:

- Term low birth weight ●
- Small for gestational age ●

In Children:

- Asthma onset ●
- Acute lower respiratory infections ●
- Asthma ever ●
- Active asthma ●



In Adults:

- All-cause mortality
- Circulatory mortality
- Ischemic heart disease mortality
- Lung cancer mortality
- Asthma onset
- Respiratory mortality
- Ischemic heart disease events
- Diabetes

Overall confidence in the evidence for an association with long-term exposure to traffic-related air pollution:

- high
- moderate to high
- moderate

Footnote: health outcomes for which the overall confidence in the evidence was low-to-moderate, low or very low are not in the picture.

Some Key Observations

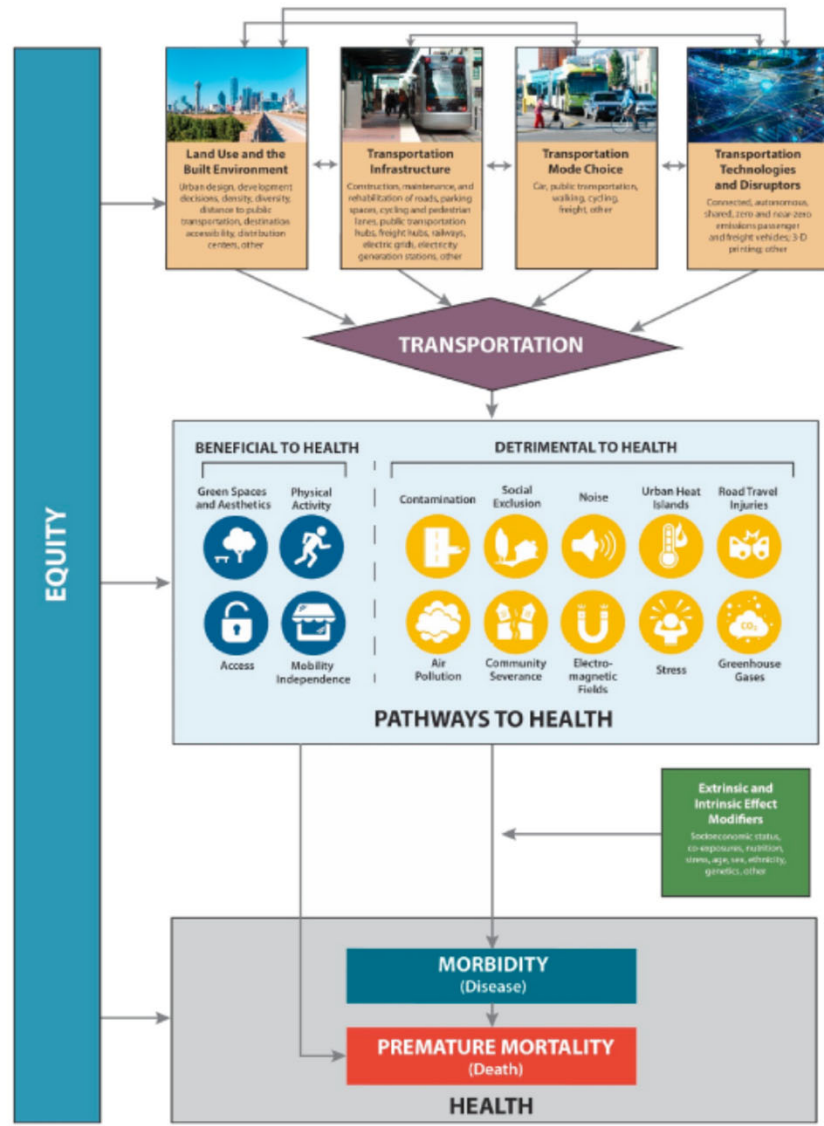
- ✓ This review has 3 times more studies than the 2010 report, though a direct comparison is difficult because of the difference in scope.
- ✓ Only half of the total number of identified studies entered a meta-analysis.
- ✓ The most common reason for a lower confidence judgement was “*imprecision*”, most often for cardiometabolic outcomes.
- ✓ The most common reason for a higher confidence judgement was evidence for a “*monotonic exposure-response relationship*”.
- ✓ Most of the studies were rated as low to moderate “risk of bias” for all but the “confounder” domain, for which about one third of the meta-analyzed studies were rated as high “risk of bias”.
- ✓ Several future research opportunities emerged from this report.

Several Future Research Opportunities

- ✓ More long-term exposure and health studies in low- and middle-income countries; more studies on ultrafine particles and non-tailpipe PM.
- ✓ Evaluate the mechanisms behind the association of TRAP with the selected outcomes by studying biomarkers and subclinical outcomes.
- ✓ Evaluate the role of spatially correlated factors that may either confound and/or modify the health effects of TRAP, most notably socioeconomic status, traffic noise, and factors related to the built environment, such as presence of green space.
- ✓ Evaluate the fuller range of potential impacts of transportation and (new) mobility on public health.
- ✓ Improve methods in systematic reviews and evidence synthesis of observational studies in environmental health.

HEI

And many more...



Glazener et al. 2021. Fourteen pathways between urban transportation and health: A conceptual model and literature review. Journal of Transport & Health

Overall Conclusions

The findings have provided an overall high or moderate-to-high level of confidence in an association between long-term exposure to traffic-related air pollution and the adverse health outcomes

all-cause, circulatory and ischemic heart disease mortality, lung cancer mortality, asthma onset in children and adults, and acute lower respiratory infections in children.

The Panel's confidence in the evidence was considered moderate, low or very low for the other selected outcomes.

In light of the large number of people exposed, the findings indicate that traffic-related air pollution remain an important public health concern and deserve greater attention from the public and from policymakers.

THANK YOU!

Hanna Boogaard

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