Burden-EU webinar

Long-term exposure to ozone and asthma: a systematic review and meta-analysis

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Background

- Ambient air pollution remains a major modifiable environmental stressor

9 out of 10

—people exposed to harmful levels of air pollution exceeding the WHO limits

7 million

—Air pollution related premature deaths annually

—Expected to **double** by 2050

250,000

—Deaths attributable to ozone exposure

4 million

— DALYs

Aim

Evidence

- An ample evidence on short-term exposure to ozone and exacerbation of asthma and mortality *(Bell ML et al. 2005, Di Q. et al. 2017)*

Gap

- The effect of long-term exposure on asthma remains unclear
- The attribution of ambient O3 to asthma burden has not yet been included in the GBD studies

Aim

- To provide an overview of existing evidence on the association between long-term exposure O3 and asthma morbidity and mortality
- To quantify the association between long-term exposure to ozone and risk of asthma

Method

- **A systematic review and meta-analysis**
- Electronic database search supplemented by manual search
  - *PubMed, Embase, Cochrane Central Register of Controlled Trials, Web of Science, : Google Scholar and the World Health Organization – Global Index Medicus*
- **Exposure**: Long-term ozone was defined as the highest seasonal (≥ 6 months) average of 8-hr daily maximum ozone concentrations
- **Outcome**: incidence, prevalence, or mortality related to asthma
- **Study design**: Cohort, case-control or cross-sectional studies
- Double title/abstract screening
- Quality assessment: using JBI tools
- Data extraction using the GBD DEF

Methods

Classical meta-analysis

- Random effects meta-analysis
- Heterogeneity assessment
- Subgroup analysis (only cohort studies)
- Publication bias

Meta-Regression – Bayesian, Ensemble, Regularized, Trimmed (MR-BRT)

- A method used in the GBD estimations

Features

- Bayesian framework: enables uncertainty quantification and borrow information across data points
- Ensemble: combine multiple models
- Use penalization techniques to avoid overfitting
- Trimming for outliers

Results

- Database search: 5947 + 21 manual search
- 39 articles of 29 studies were included
- Sample size: 608 to 5,334,502
- Study design:
  - 15 cross-sectional
  - 9 cohort (6 prospective, 3 retrospective)
  - 5 case control
- Ozone exposure assessment methods:
  - Predictive model (n=14)
  - Physical measurement (n=13)
  - Satellite imaginary (n=2)

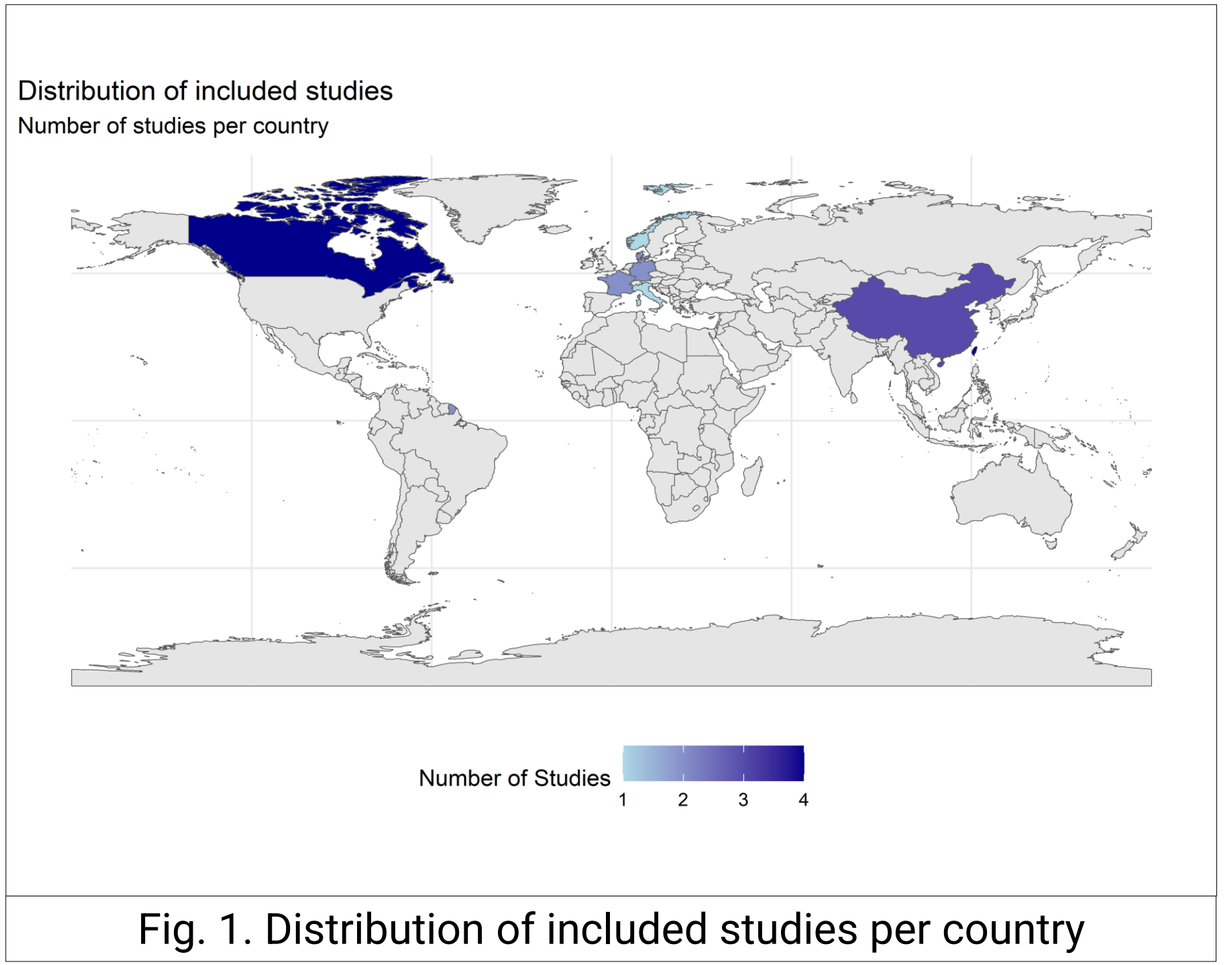
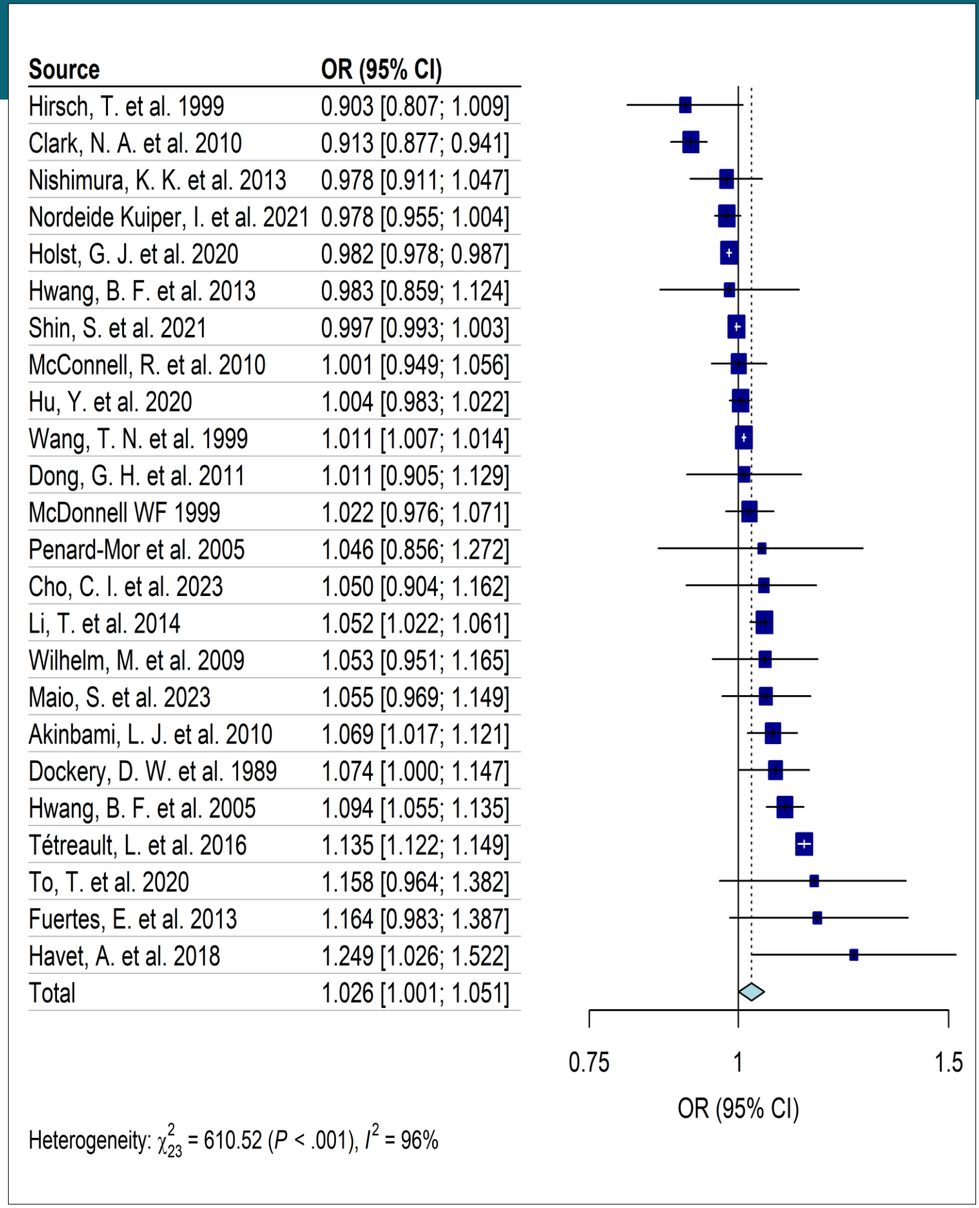


Fig. 1. Distribution of included studies per country

Results

Classical meta-analysis

- All type of studies
- For every 10 µg/m³ increase in long-term ozone exposure, the risk of developing asthma rises by about 2.6%

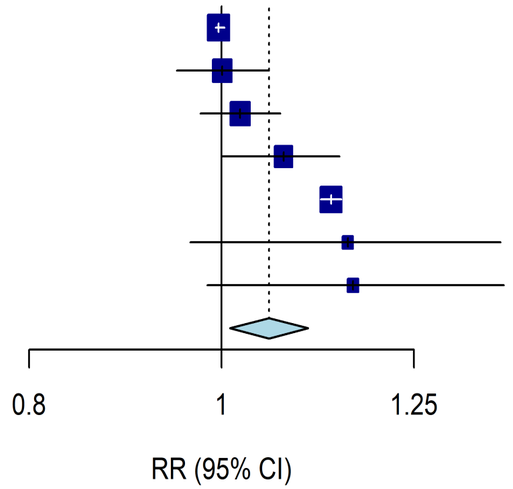


Results

Subgroup analysis

- Only cohort studies (n=7)
- A 5.7% increase in the risk of asthma for every 10 µg/m³ increase in long-term ozone exposure

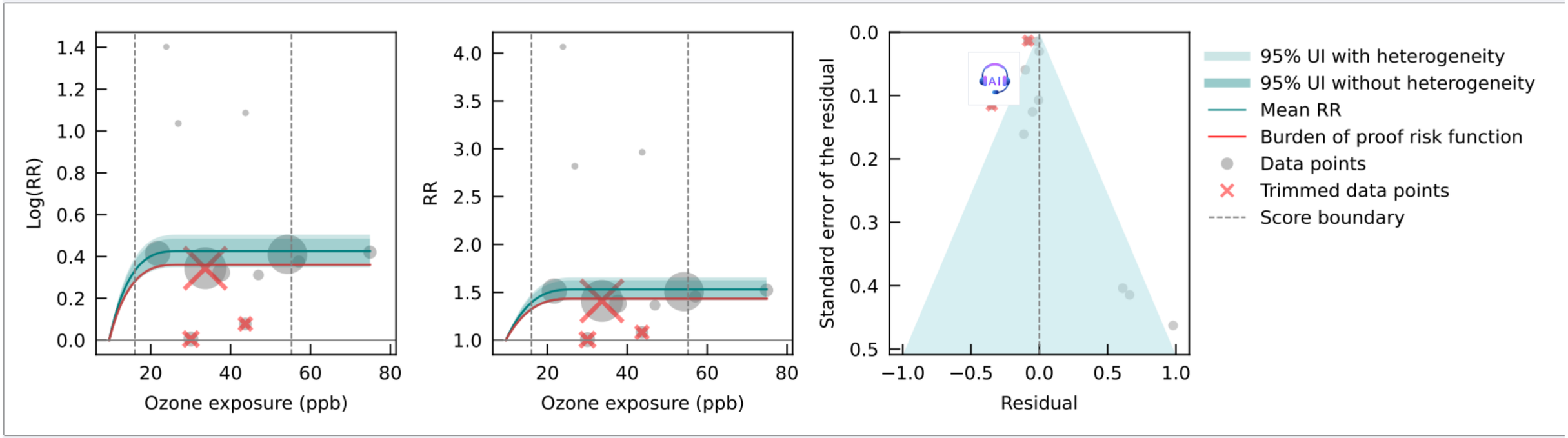
Source	RR (95% CI)
Shin, S. et al. 2021	0.997 [0.993; 1.003]
McConnell, R. et al. 2010	1.001 [0.949; 1.056]
McDonnell WF 1999	1.022 [0.976; 1.071]
Dockery, D. W. et al. 1989	1.074 [1.000; 1.147]
Tétreault, L. et al. 2016	1.135 [1.122; 1.149]
To, T. et al. 2020	1.158 [0.964; 1.382]
Fuertes, E. et al. 2013	1.164 [0.983; 1.387]
Total	1.057 [1.009; 1.106]



Heterogeneity: $\chi^2_6 = 383.06$ ($P < .001$), $I^2 = 98\%$

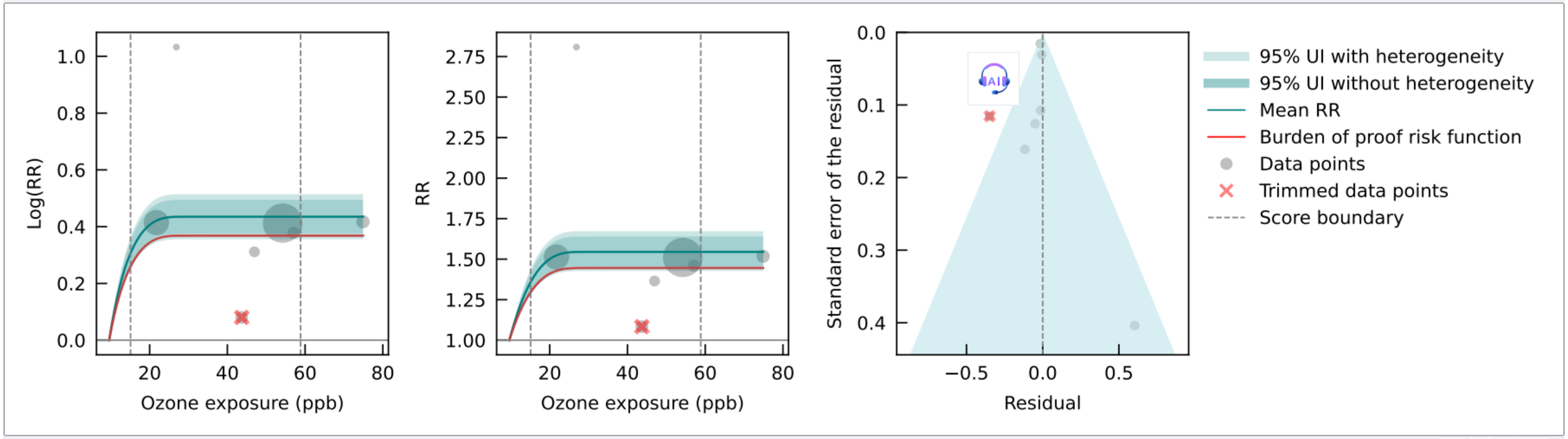
Results

- ERCs using MR-BRT model
- Using all studies



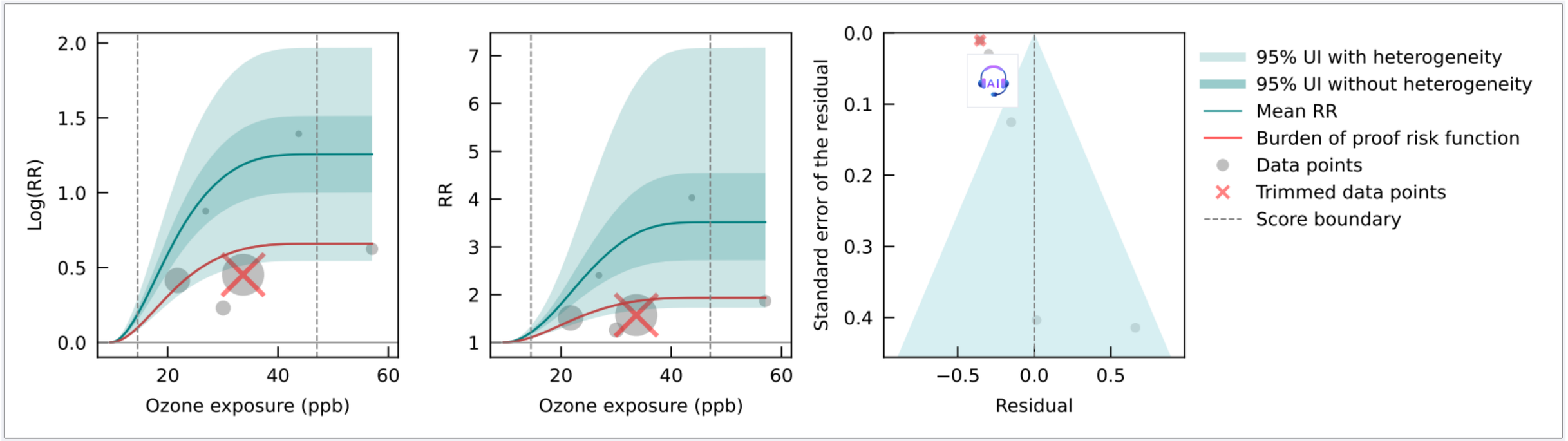
Results

- ERCs using MR-BRT model
- Using only cohort studies



Results

- ERCs using MR-BRT model
- Children and adolescents (using all studies)



Conclusions and implications

- Statistically significant positive association between long-term ozone exposure and risk of asthma
- However, considerable heterogeneity between studies
- Subgroup analysis of only cohort studies showed a stronger association
- Findings underscore the potential public health impact of reducing ozone exposure to mitigate asthma-related outcomes
- The exposure-response function is a valuable for estimating the burden of asthma attributable to long-term ozone exposure

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