[Webinar] Establishing new exposure-response functions for air pollutants and environmental noise

Long-term exposure to ambient $PM_{2.5}$ and lung cancer

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LUNG CANCER

Lung cancer (LC) is the leading cause of cancer incidence and mortality worldwide, with **2.5 million people diagnosed** with lung cancer and more than **1.8 million people died** from the disease, in 2022 (IARC 2024).

~ 46 million years of life lost (YLL)

~ 46.5 million Disability-Adjusted life years (DALYs)

~ 9.7 million years of life lost (YLL)

~ 9.8 million Disability-Adjusted life years (DALYs)

(GBD 2021)

This health condition is affected by **unmodifiable or partially modifiable** and **modifiable risk factors**.

INTRINSIC RISK FACTOS	EXTRINSIC RISK FACTOS	

Random errors in DNA replication	Endogenous risk factors
	• Biologic aging
	• Genetic susceptibility
	• DNA repair machinery
	• Hormones
	• Growth factors
	• Inflammation
	• etc.
		Exogenous risk factors
		• Lifestyle and behavioural factors: smoking, diet, physical activity, etc.
		• Tumor viruses
		• Radiation
		• Chemical carcinogens:
		  • **Pollution**
		  • Second-hand smoke
		  • Occupational carcinogens
		  • Etcs

NOT MODIFIABLE	**PARTIALLY MODIFICABLE**	**MODIFIABLE**

Adapted from: EEA web report no. 01/2022(doi: 10.2800/086710)

Wu, S., et al., 2018, 'Evaluating intrinsic and non-intrinsic cancer risk factors', Nature Communications 9(1), p. 3490 (DOI: 10.1038/s41467-018-05467-z).

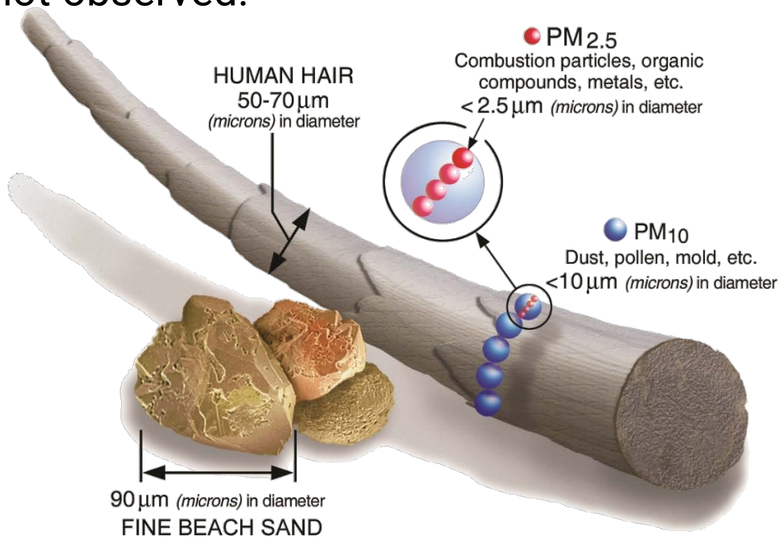
$PM_{2.5}$ AND HEALTH IMPACT

More than **10% of Europe's cancer burden** may be **caused by exposure to air pollution**, carcinogenic chemicals, radon, UV radiation and second-hand smoke.

Particulate matter (PM) is the **leading risk factor** for human health (2,933 DALYs per 10^6 inhabitants) (GBD 2021).

PM is classified by the **International Agency for Research on Cancer** (IARC) as a **group 1 carcinogen**, indicates that no limit value for PM has been established below which health effects are not observed.

PM with a diameter of 2.5 µm or less ($PM_{2.5}$) is **one of the air pollutants more harmful** to human **health.**



SOURCES

IARC. Outdoor air pollution: IARC Monographs on the Evaluation of Carcinogenic Risks to Humans: volume 109. Lyon: International Agency for Research on Cancer; 2015
EEA web report no. 01/2022 (doi: 10.2800/086710)

AIM

To **derive exposure-response relationships** reflecting the **relationship between lung cancer incidence and mortality cases** as function of exposure to ambient particulate matter <2.5 μm in diameter ($PM_{2.5}$).

What is the **relationship** between **$PM_{2.5}$ and the incidence and mortality of lung cancer**?

Is exposure to **$PM_{2.5}$ associated** with an **increased risk of developing lung cancer**?

SYSTEMATIC LITERATURE REVIEW

Coordinated by **Ricardo Assunção**[1,2]

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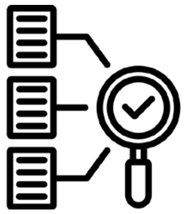
METHODS

SYSTEMATIC LITERATURE REVIEW

INCLUSION CRITERIA

- describing an association between **long-term exposure to ambient $PM_{2.5}$** and **incidence** and **mortality of lung cancer** using a **relative measure of association**
- published over the period **from January 1, 2010**



META-ANALYSIS

Often simpler, **assumes a fixed or random effect**, typically applies **linear or simple nonlinear** models, and pools data across studies.

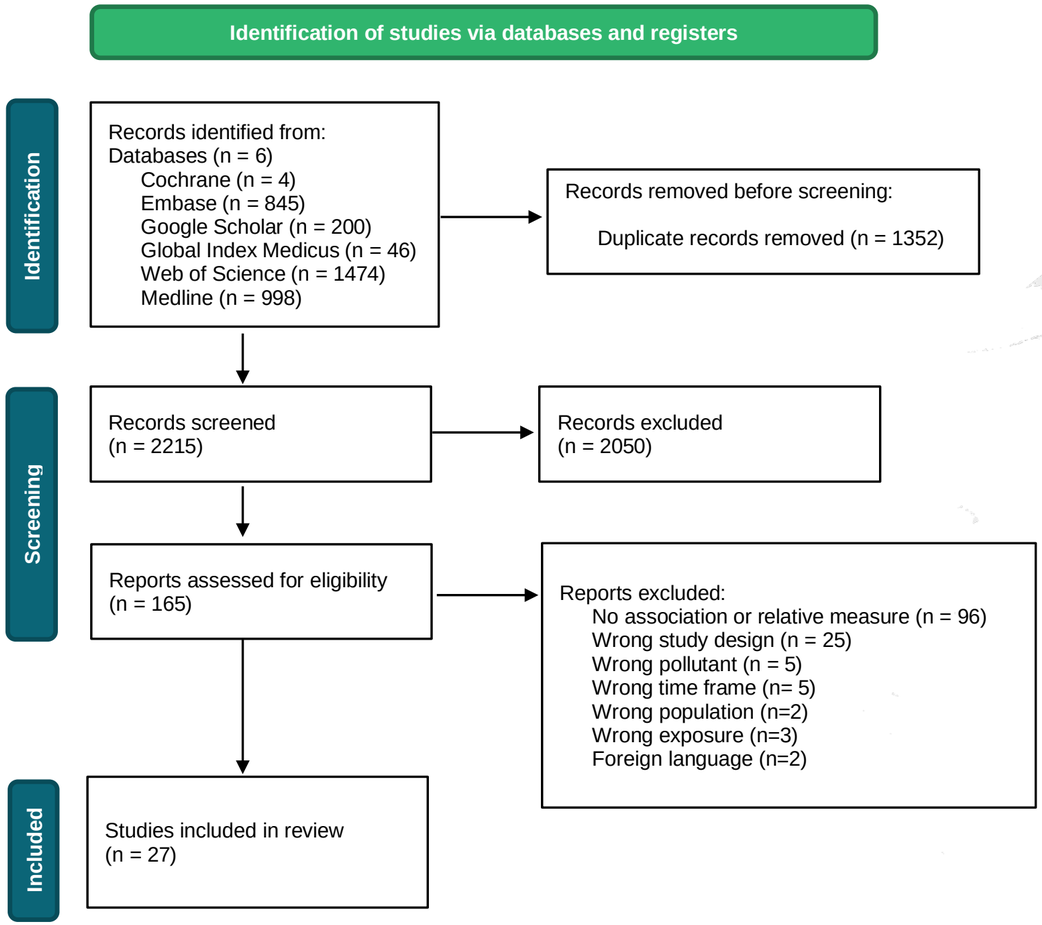
Classical Meta-Analysis — **WHO**

MR-BRT* — **GBD study**

Uses a more complex Bayesian framework, allowing for **flexible non-linear modelling and better handling of study-level covariates** (e.g. unexplained between study heterogeneity), and **uncertainties in the exposure-response relationship.**

*Meta-regression—bayesian, regularised, trimme

RESULTING SYSTEMATIC REVIEW



Prospero ID: CRD42024581503

27 studies were included on the analysis.

9 studies conducted in the European Region.

~ 56% Incidence

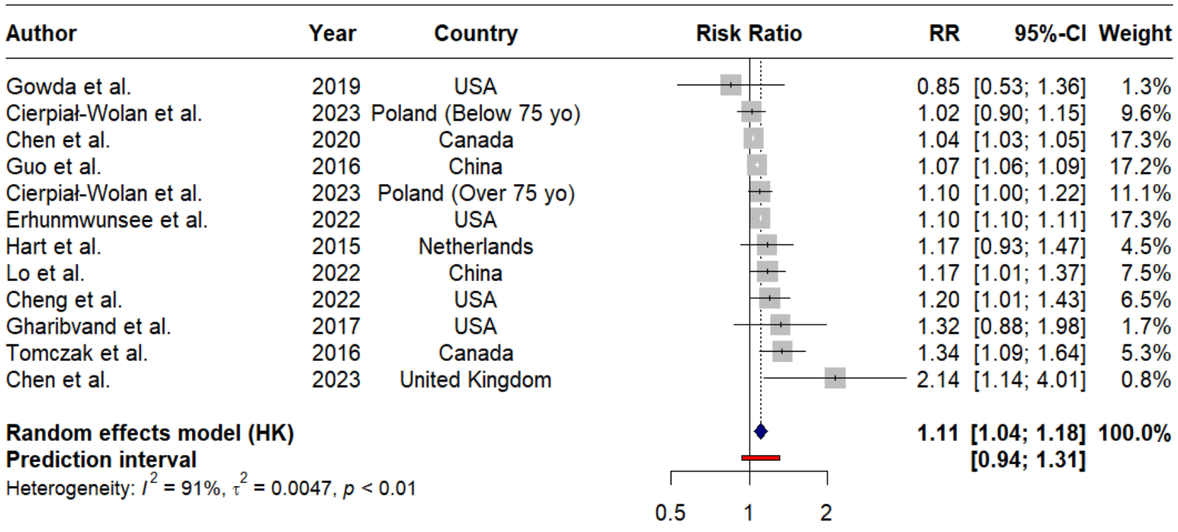
~48% Mortality

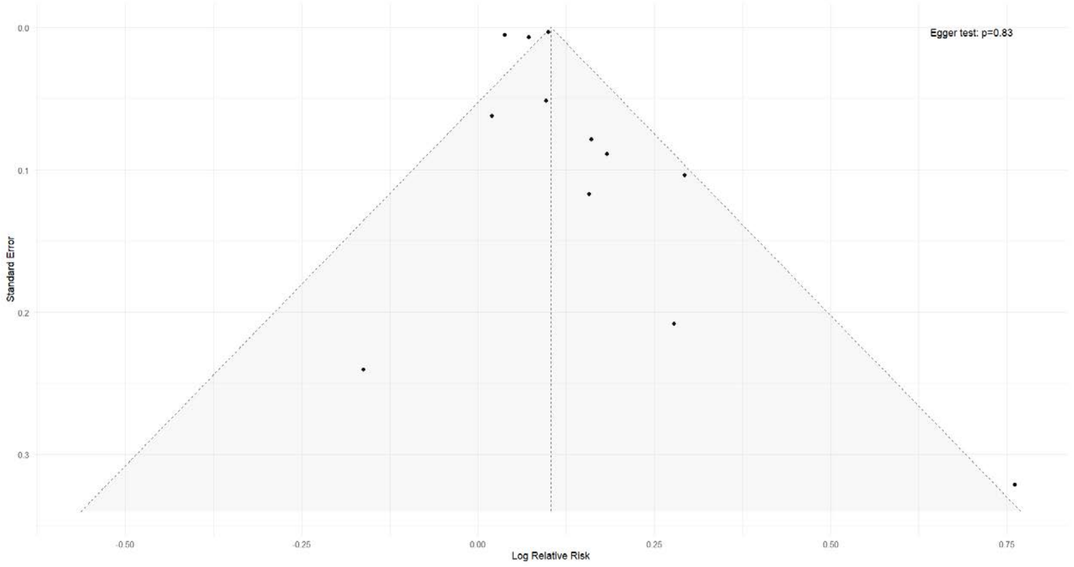
RESULTING ERF $PM_{2.5}$ - LUNG CANCER

Data not published

- **Classical meta-analysis:**

A **10-µg/m³ increase** in long-term exposure $PM_{2.5}$ increases risk of **lung cancer incidence by 11%**, for both sexes.



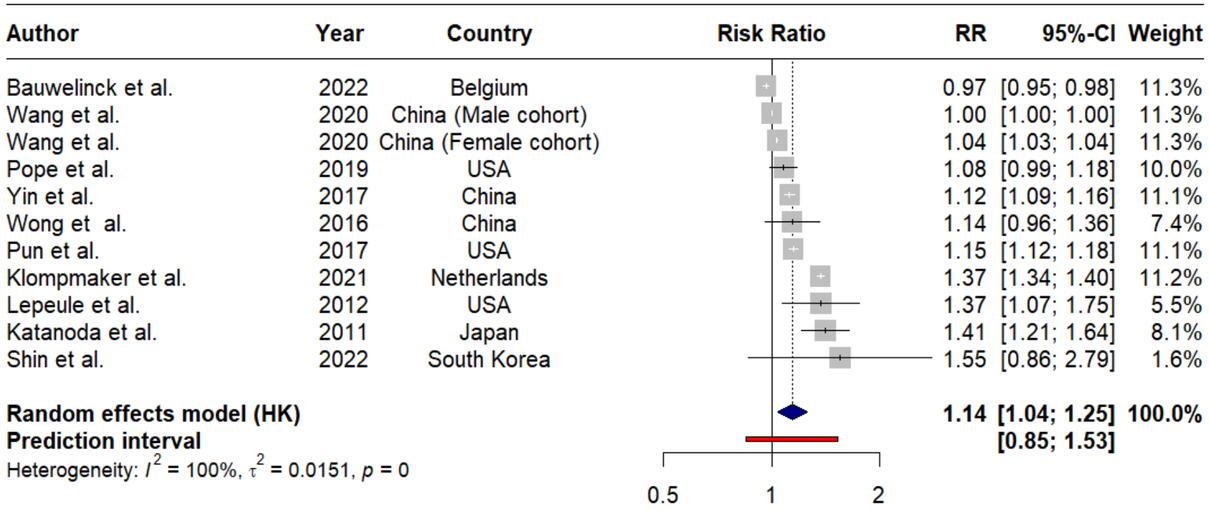


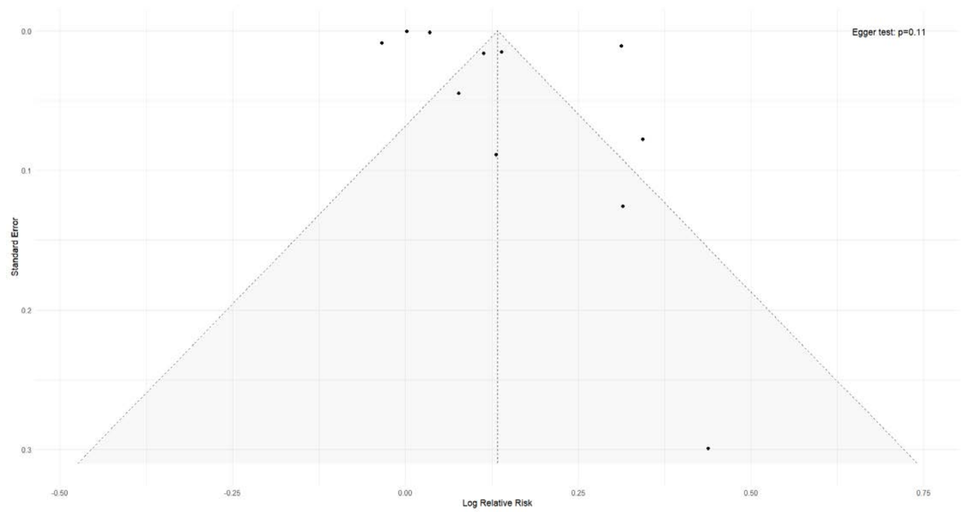
RESULTING ERF $PM_{2.5}$ - LUNG CANCER

Data not published

- **Classical meta-analysis:**

A **10-µg/m³ increase** in long-term exposure $PM_{2.5}$ increases risk of **lung cancer mortality by 14%**, for both sexes.





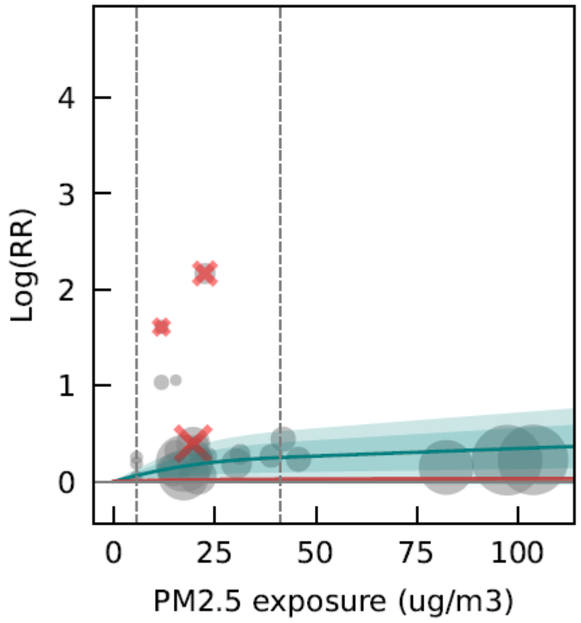
RESULTING ERF $PM_{2.5}$ -LUNG CANCER

Data not published

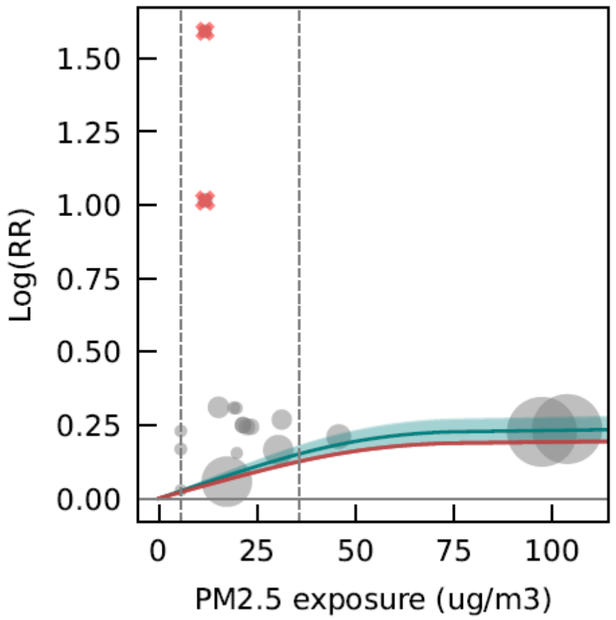
- **Meta-regression—bayesian, regularised, trimme (MR-BRT):**

The estimated effect size for $PM_{2.5}$ exposure on lung cancer mortality and incidence risk is 1.604, with a risk score value of 0.01599, suggesting a statistically significant association and with a star raking of 2.

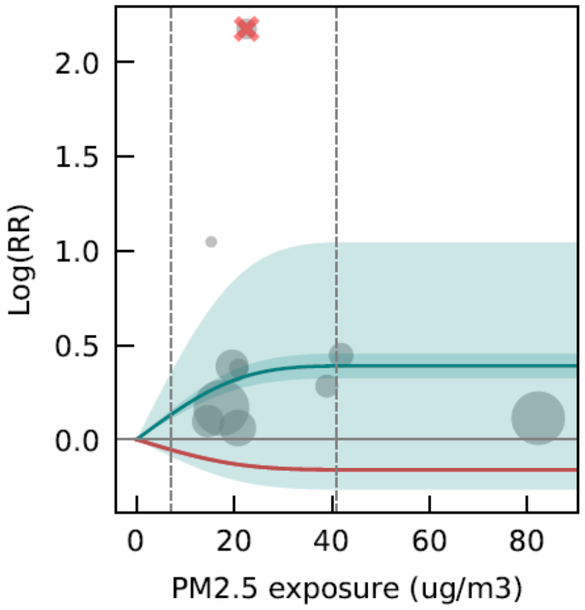
MORTALITY & INCIDENCE



INCIDENCE



MORTALITY



IHME

95% UI with heterogeneity
95% UI without heterogeneity
Mean RR
Burden of proof risk function
Data points
Trimmed data points
Score boundary

BEST COST

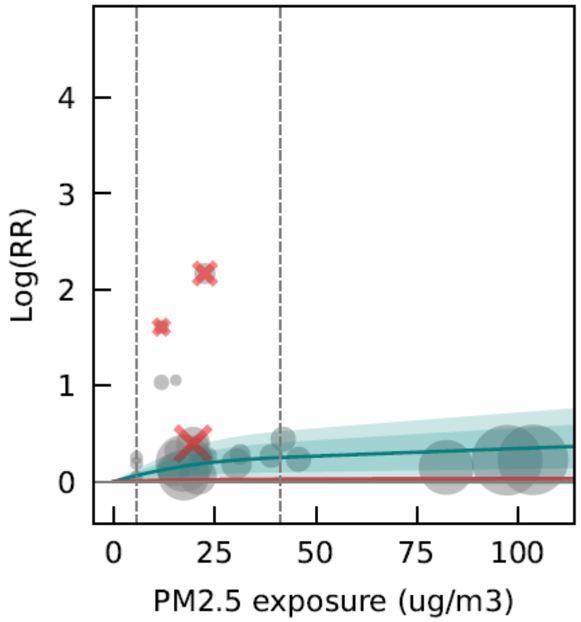
RESULTING ERF $PM_{2.5}$ -LUNG CANCER

Data not published

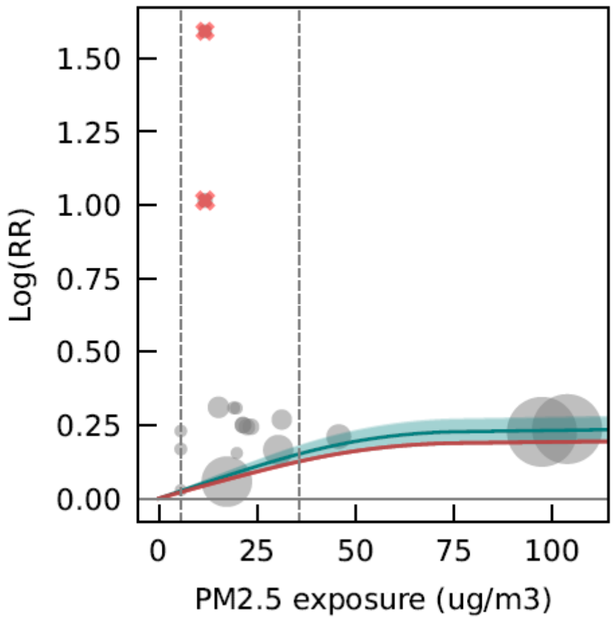
- **Meta-regression—bayesian, regularised, trimme (MR-BRT):**

The estimated effect size for $PM_{2.5}$ exposure on lung cancer risk is 1.001, with a risk score value of 0.07481, and with a star raking of 2.

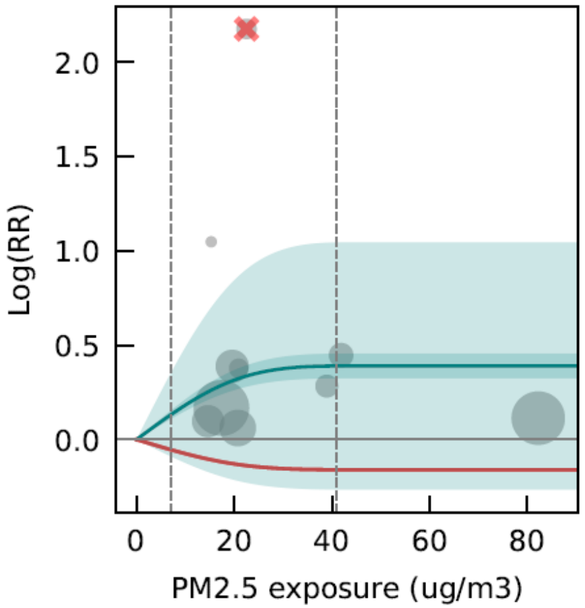
MORTALITY & INCIDENCE



INCIDENCE



MORTALITY



IHME

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Mean RR
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Data points
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Score boundary

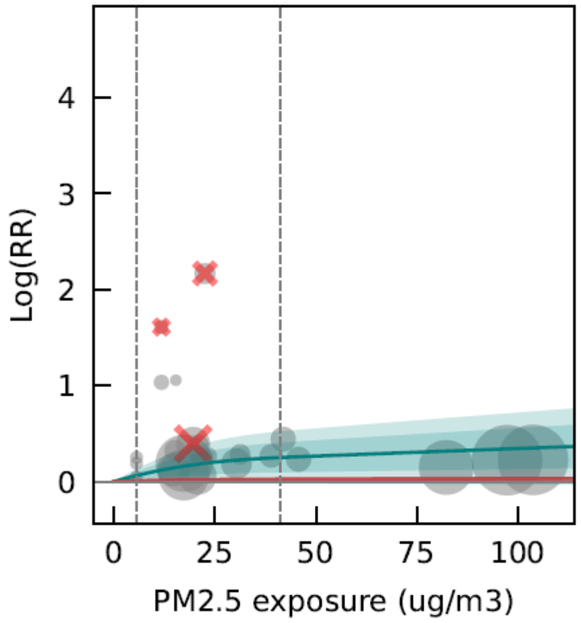
RESULTING ERF $PM_{2.5}$ -LUNG CANCER

Data not published

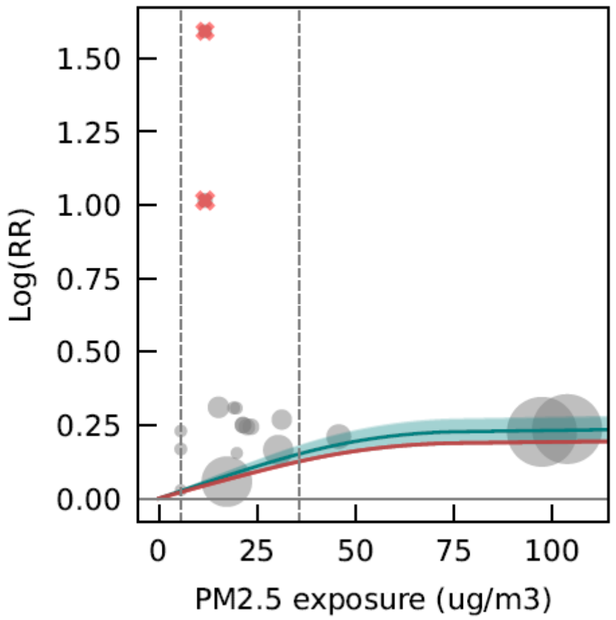
- **Meta-regression—bayesian, regularised, trimme (MR-BRT):**

The estimated effect size for $PM_{2.5}$ exposure on lung cancer risk is 1.845, with a risk score value of 0.09258, and with a star raking of 1.

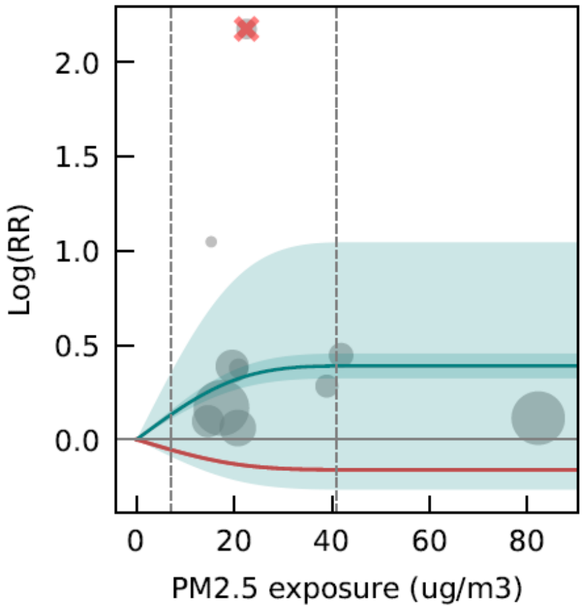
MORTALITY & INCIDENCE



INCIDENCE



MORTALITY



IHME

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Mean RR
Burden of proof risk function
Data points
Trimmed data points
Score boundary

TAKE HOME MESSAGES

Corda et al. (BEST-COST)

	Classical Meta-Analysis		MR-BRT	
	RR (95% IC)	**p-value**	**Coeff**	**Star ranking**
$PM_{2.5}$ - Lung cancer incidence	1.11 (1.04 - 1.18)	0.004	1.001	☆☆
$PM_{2.5}$ - Lung cancer mortality	1.14 (1.04 - 1.25)	0.009	1.845	☆
$PM_{2.5}$ - Lung cancer incidence and mortality	-	-	1.604	☆☆

- A comprehensive investigation to **assess long-term impact and the costs of the exposure.**
- Potential need for **policy updates based on evidence**.
- **Supporting** the development of prevention or intervention programs.

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