

2nd European Burden of Disease Workshop

Choosing outcomes and deriving exposure-response functions: The BEST-COST case study

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17/09/2026

Funded by the European Union

BEST-COST is funded by the European Union's Horizon Europe programme under Grant Agreement No.101095408.

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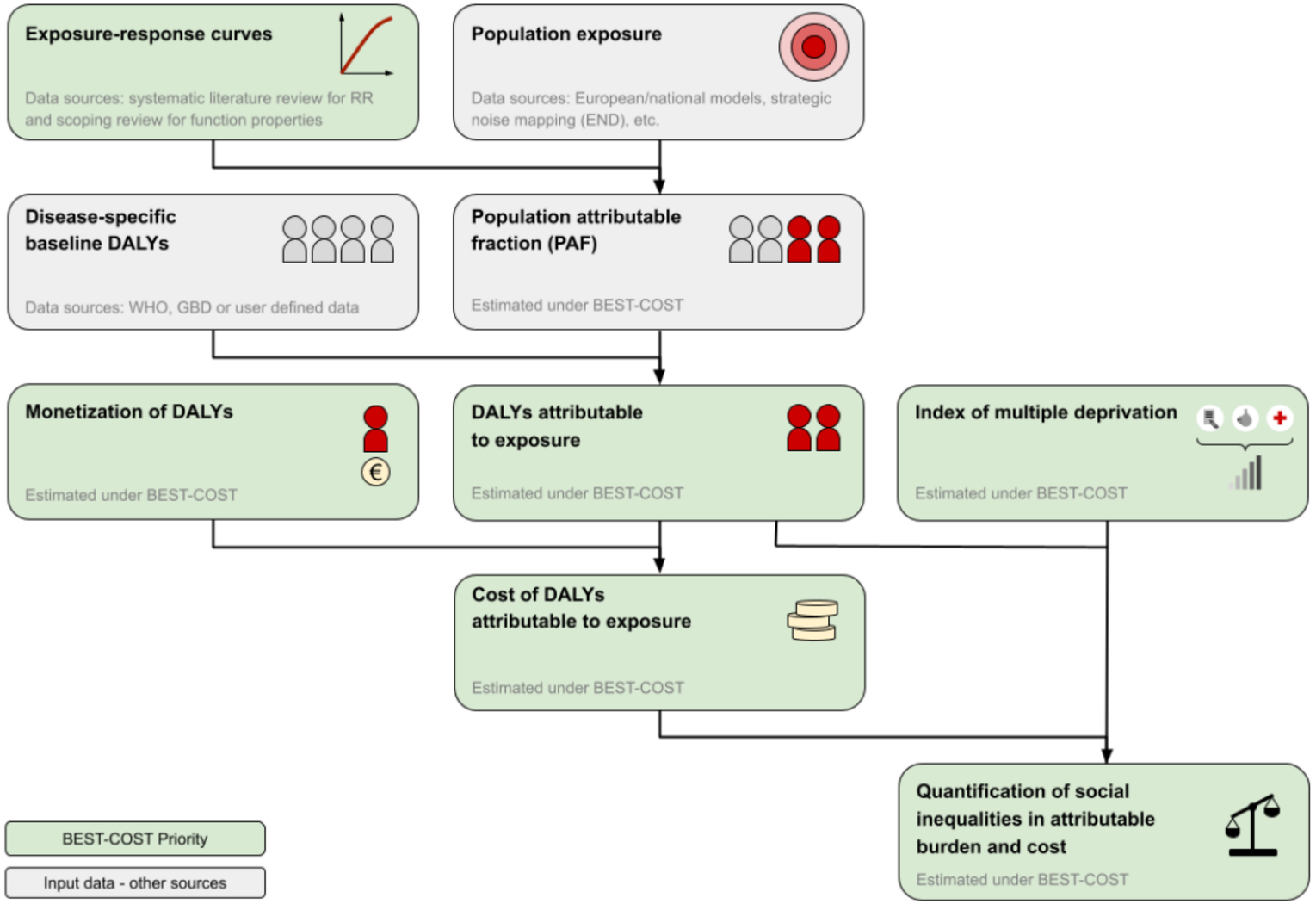


BEST-COST Partners

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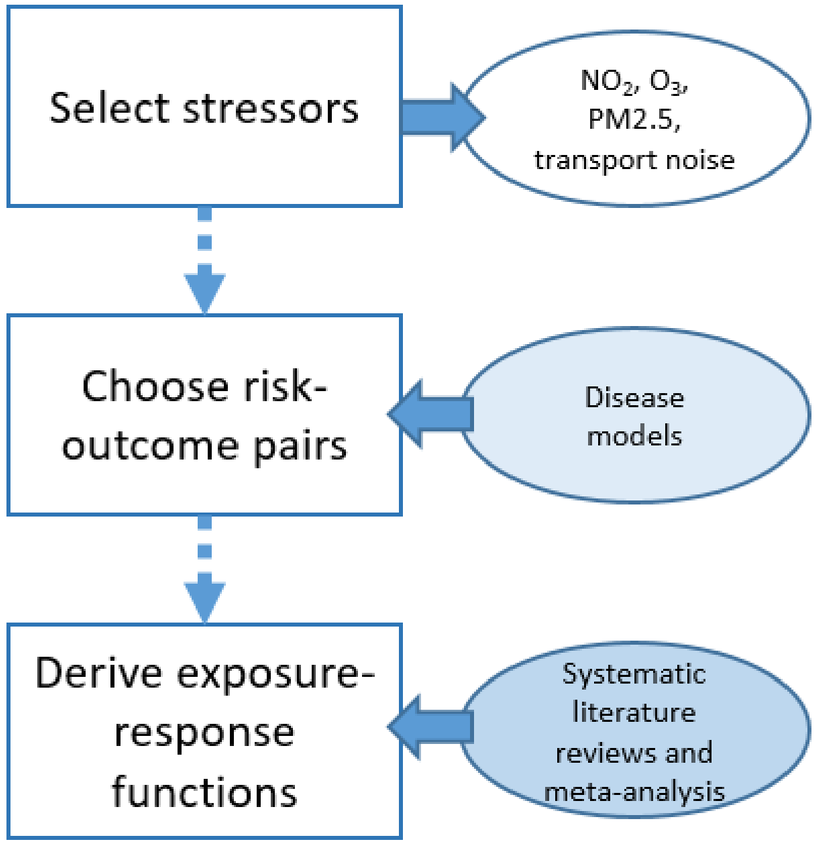
BEST-COST Framework



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WP1: Updating exposure-response functions

Overview of steps to select risk-outcome pairs and derive exposure-response functions



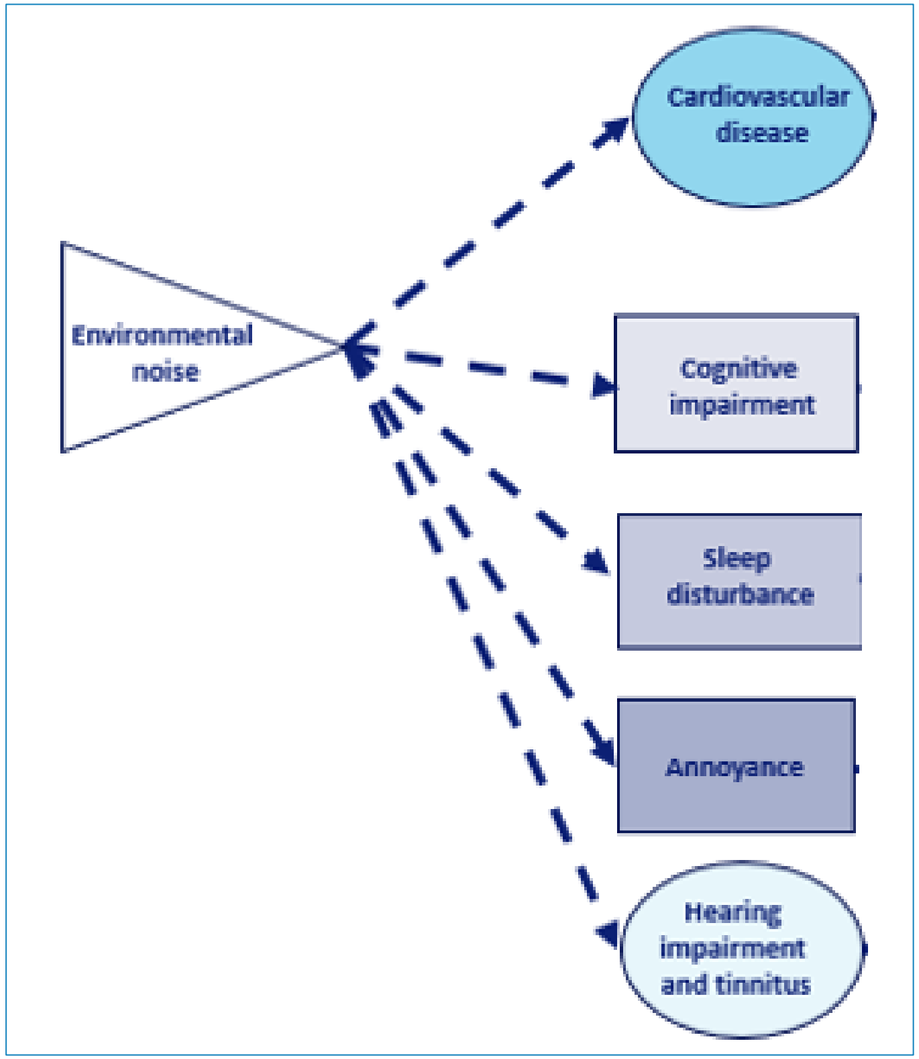
Disease models selection

Choose risk-outcome pairs ← Disease models

Schematic representation that defines health outcomes causally related to the risk factor of interest.

- However, not every health outcome will be included in the disease model.
- Decision rules are needed to determine which health outcomes are included.

Disease model



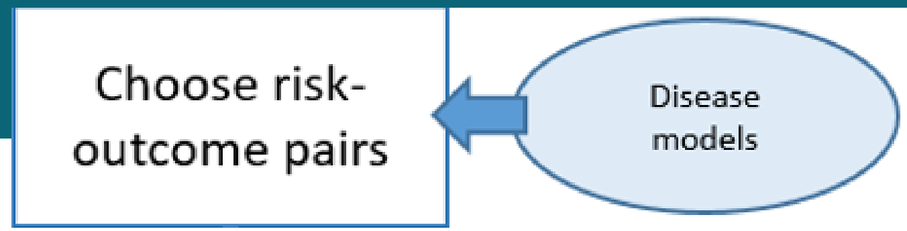
Decision rules BEST COST

- Limit the disease models to long-term exposure and chronic outcomes.
- Only include risk-outcome pairs that have shown convincing or probable evidence.

Evaluation

- Evaluation of recently published (after 2017) papers and reports that have collected evidence on risk-outcome pairs.

Disease models selection

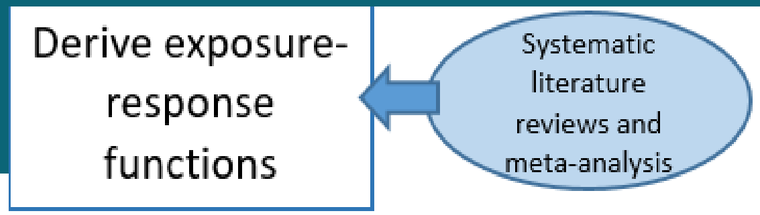


Establish **new exposure-response function** for the following risk-outcome pairs.

- O_3 – Asthma
- $PM_{2.5}$ – Lung cancer
- NO_2 – COPD
- Transport noise (road, railway, aircraft) – IHD
- Transport noise (road, railway, aircraft) – Stroke

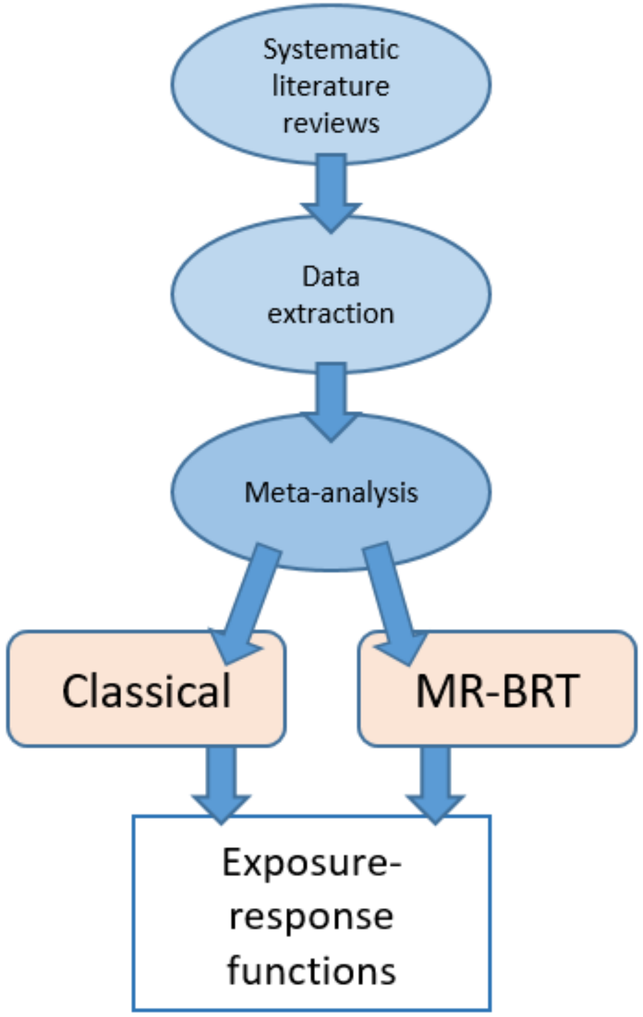
This selection was informed by the strength of evidence and whether any recent systematic literature reviews had been performed.

Meta-analysis: two methods



We used two methods to determine exposure-response functions:

- “classical” meta-analysis
  (used e.g. by WHO – HRAPIE study)
- MR-BRT meta-analysis
  (used by IHME for the Global Burden of Disease study)



Systematic literature review

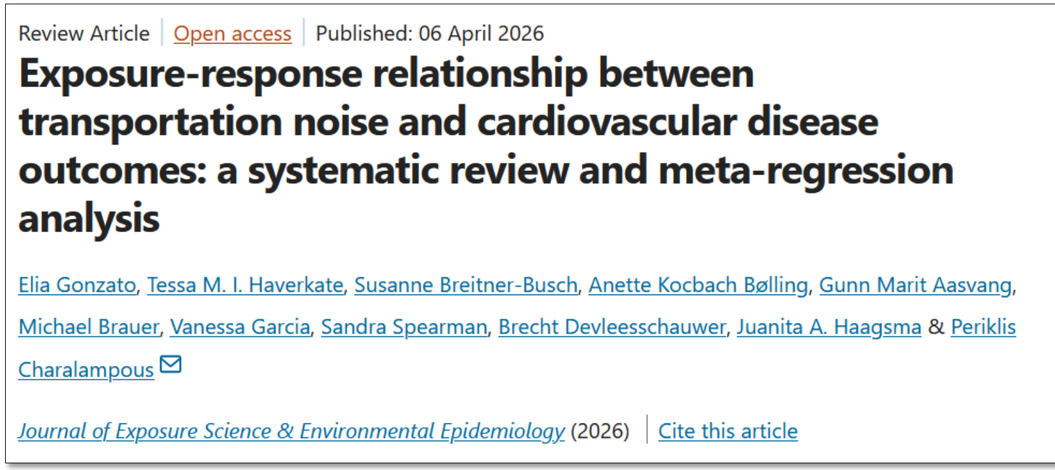
Derive exposure-response functions ← Systematic literature reviews and meta-analysis

One systematic review for each risk-outcome pair

- O_3 – Asthma
- $PM_{2.5}$ – Lung cancer
- NO_2 – COPD

Work in progress

- Transport noise (road, railway, aircraft) – IHD
- Transport noise (road, railway, aircraft) – Stroke



Review Article | Open access | Published: 06 April 2026

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Journal of Exposure Science & Environmental Epidemiology (2026) | Cite this article

In total, more than 11,000 records screened.
More than 90 studies included.

Classical versus MR-BRT

Classical Meta-Analysis:

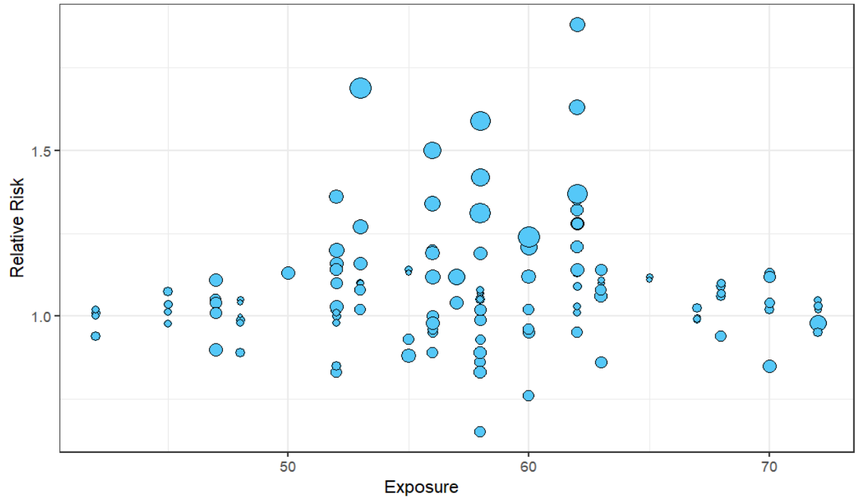
- Often simpler
- assumes a fixed or random effect
- Typically applies linear or simple nonlinear models, and pools data across studies.

MR-BRT:

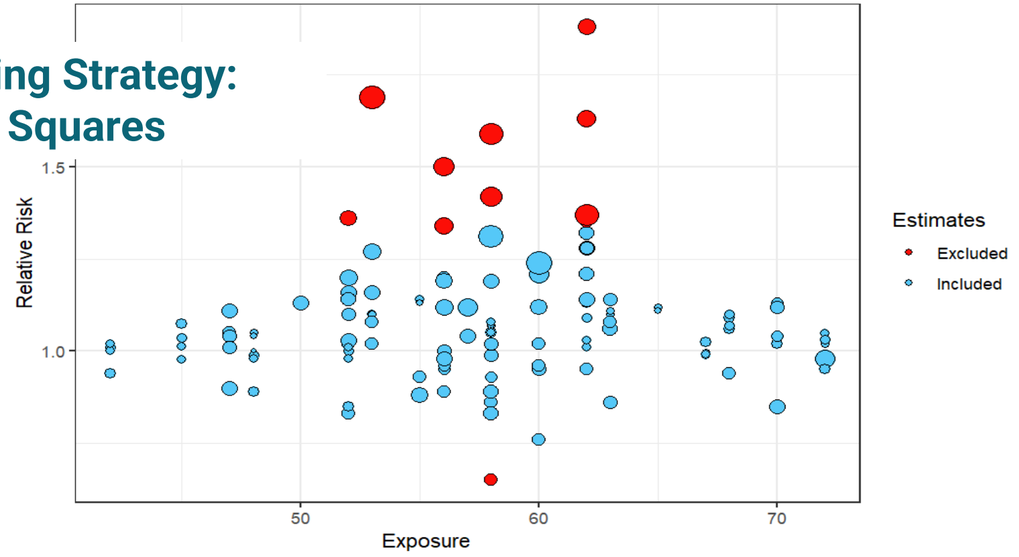
- More complex Bayesian framework
- Allows for flexible non-linear modelling
- Better handling of study-level covariates (e.g. unexplained between study heterogeneity), and uncertainties in the exposure-response relationship.

MR-BRT features

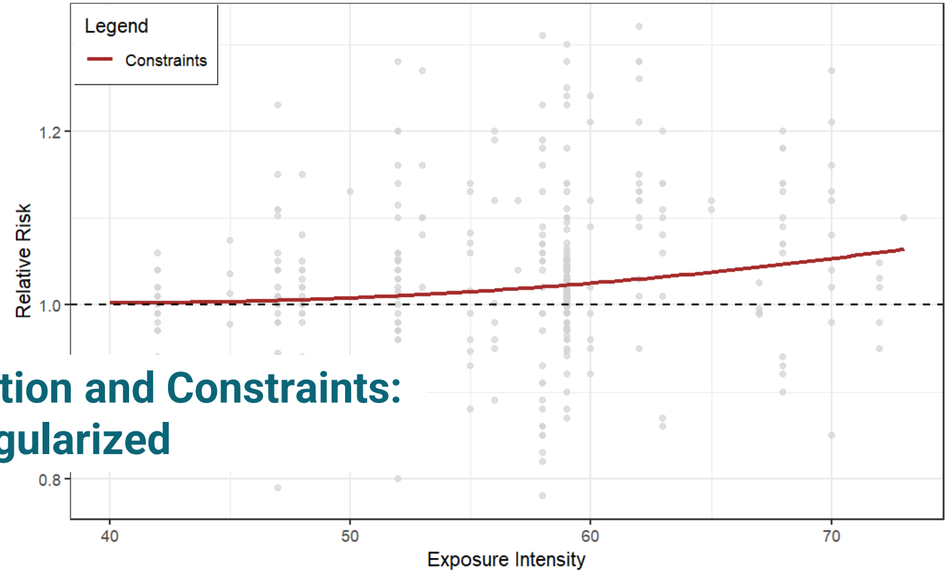
To identify the shape of the relationship



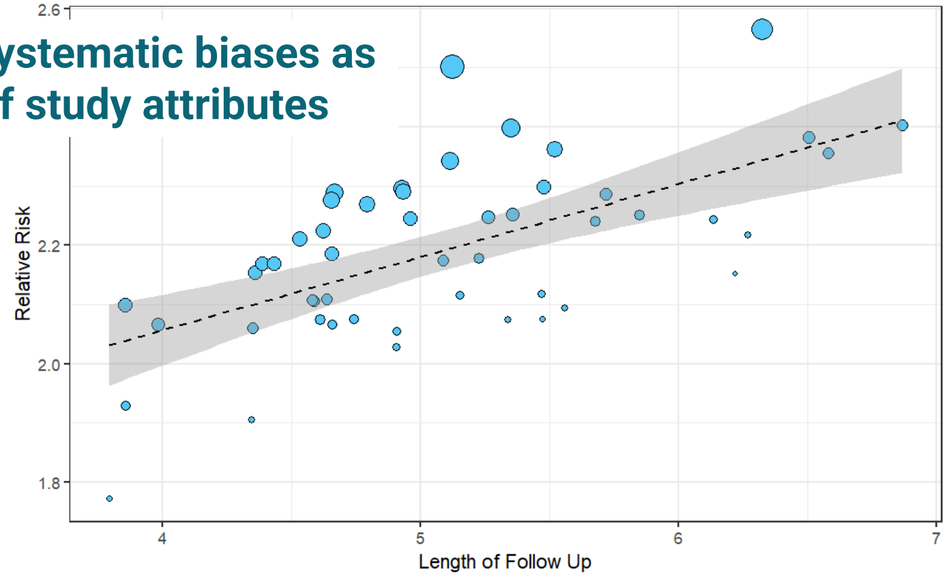
Use Robust Trimming Strategy: Least Trimmed Squares



Apply Regularization and Constraints: Bayesian and Regularized



Adjust for systematic biases as a function of study attributes



BEST-COST updated ERFs

Road traffic noise was associated with 1% increase in the combined risk of **stroke** incidence and mortality (RR = 1.01, 95%CI: 1.00–1.02, *p*-value = 0.04), and with 5% increase under the BoP framework (RR = 1.05, 95%UI: 1.03–1.07).

Railway noise was associated with 1% increase in **myocardial infarction** outcomes (RR = 1.01, 95%CI: 1.01–1.01, *p*-value < 0.0001), and with 16% increase under the BoP framework (RR = 1.16 95%UI: 1.07–1.26).

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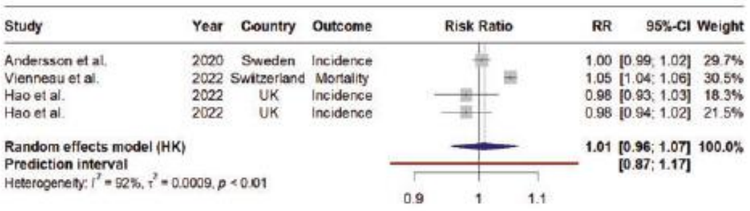
Journal of Exposure Science & Environmental Epidemiology (2026) | Cite this article

CVD outcome	Transportation noise source	RR per 10 dB (95%UI without between-study heterogeneity)	RR per 10 dB (95%UI with between-study heterogeneity)	BPRF	ROS	Star rating	Publication bias	Number of studies	Risk-outcome pair in GBD 2023 study
Myocardial Infarction	Road traffic noise	1.10 (1.05–1.15)	1.10 (0.79–1.56)	0.87	−0.07	☆	No	15	No
	Railway noise	1.16 (1.10–1.22)	1.16 (1.07–1.26)	1.04	0.02	☆☆	Yes	2	No
	Aircraft noise	1.09 (1.06–1.12)	1.09 (1.01–1.18)	1.02	0.01	☆☆	No	4	No
Ischemic Heart Disease	Road traffic noise	1.27 (1.22–1.33)	1.27 (1.16–1.41)	1.00	0.00	☆☆	No	3	No
	Railway noise	–	–	–	–	–	–	–	No
	Aircraft noise	1.07 (0.91–1.25)	1.07 (0.74–1.55)	N/A	N/A		No	2	No
Stroke	Road traffic noise	1.05 (1.04–1.06)	1.05 (1.03–1.07)	1.02	0.01	☆☆	No	10	No
	Railway noise	1.06 (1.02–1.10)	1.06 (0.98–1.16)	1.00	0.00	☆	No	3	No
	Aircraft noise	1.01 (0.96–1.07)	1.01 (0.90–1.15)	N/A	N/A		No	4	No
Ischemic Stroke	Road traffic noise	1.05 (1.02–1.07)	1.05 (0.99–1.11)	1.00	0.00	☆	No	10	No
	Railway noise	1.14 (1.05–1.22)	1.14 (0.95–1.37)	1.00	0.00	☆	No	3	No
	Aircraft noise	1.15 (1.11–1.26)	1.15 (0.92–1.45)	0.98	-0.01	☆	No	3	No

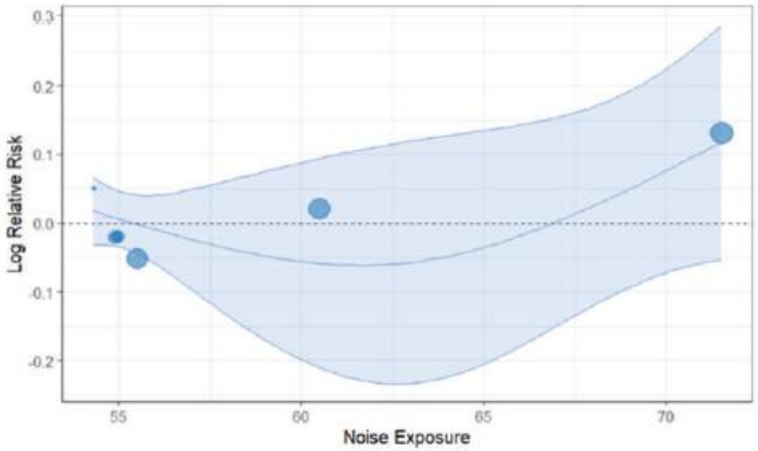
Classical versus MR-BRT: example

Association between long-term exposure to transportation noise sources and ischemic heart disease

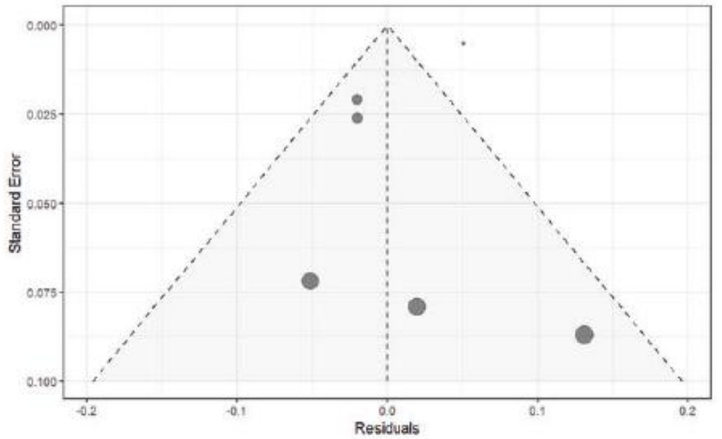
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Traditional meta-analysis framework

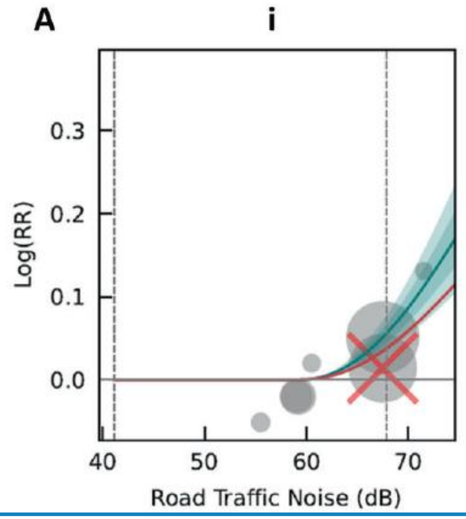
RR = 1.01

Burden of proof framework

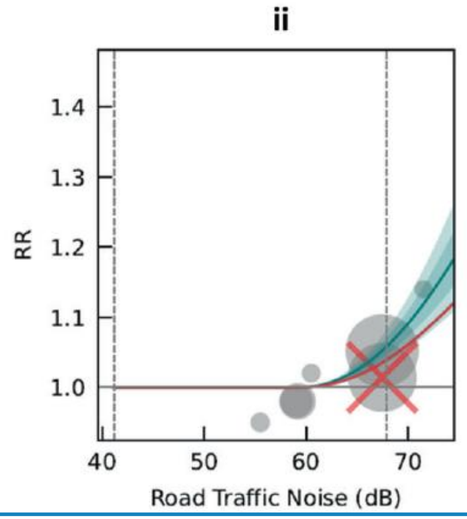
RR = 1.27

★★

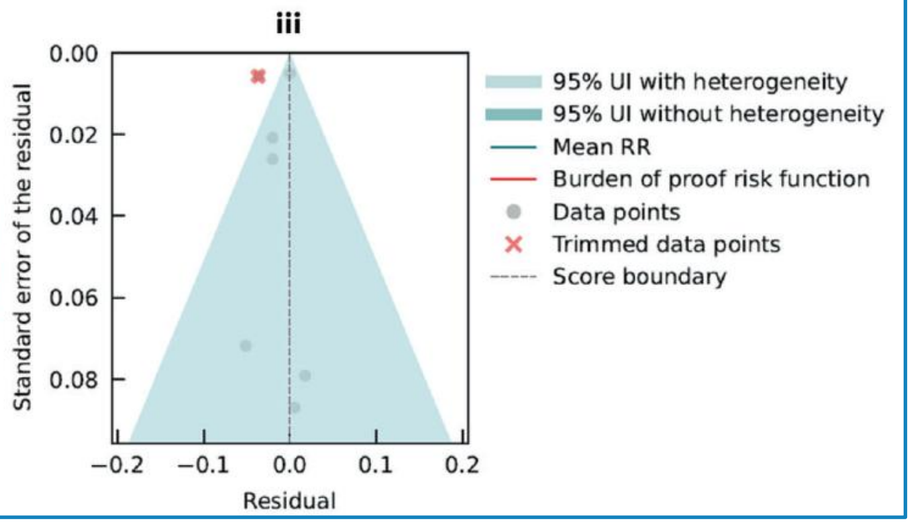
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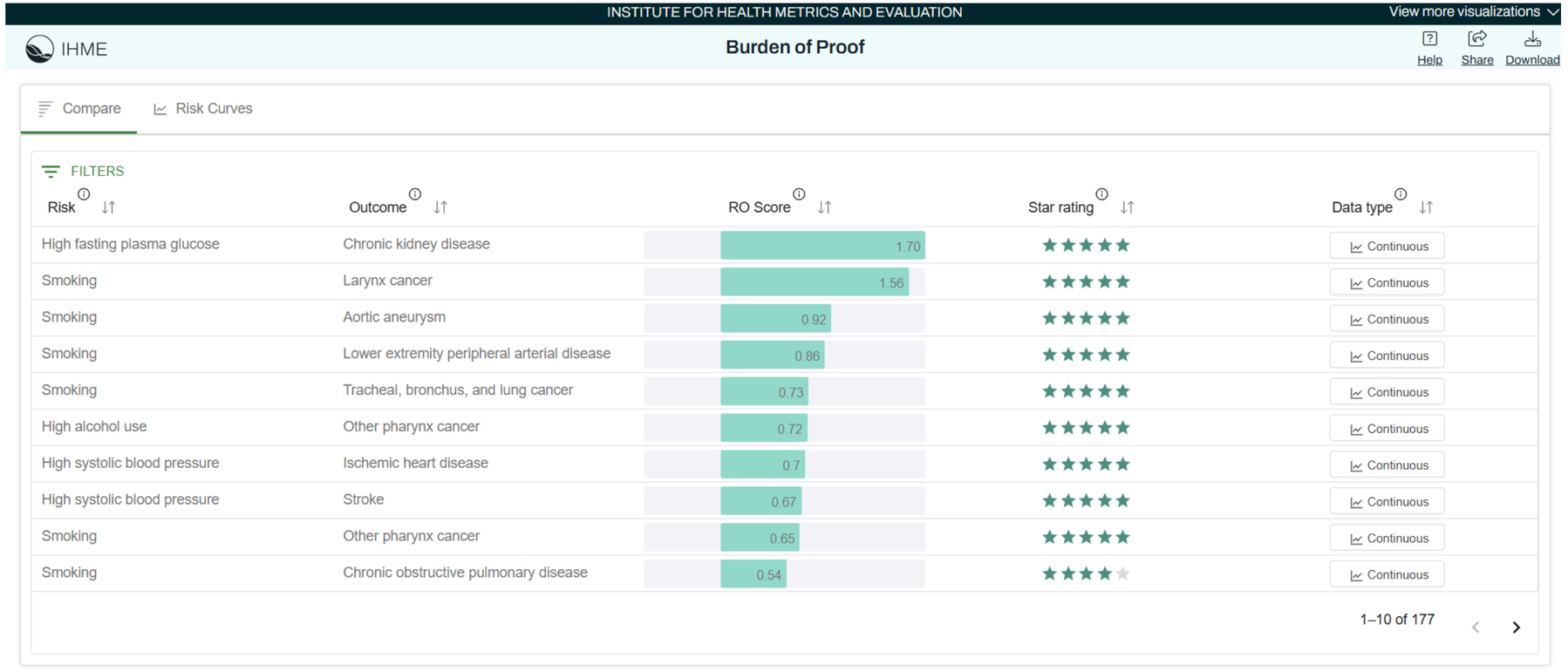


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Burden of Proof

https://vizhub.healthdata.org/burden-of-proof/

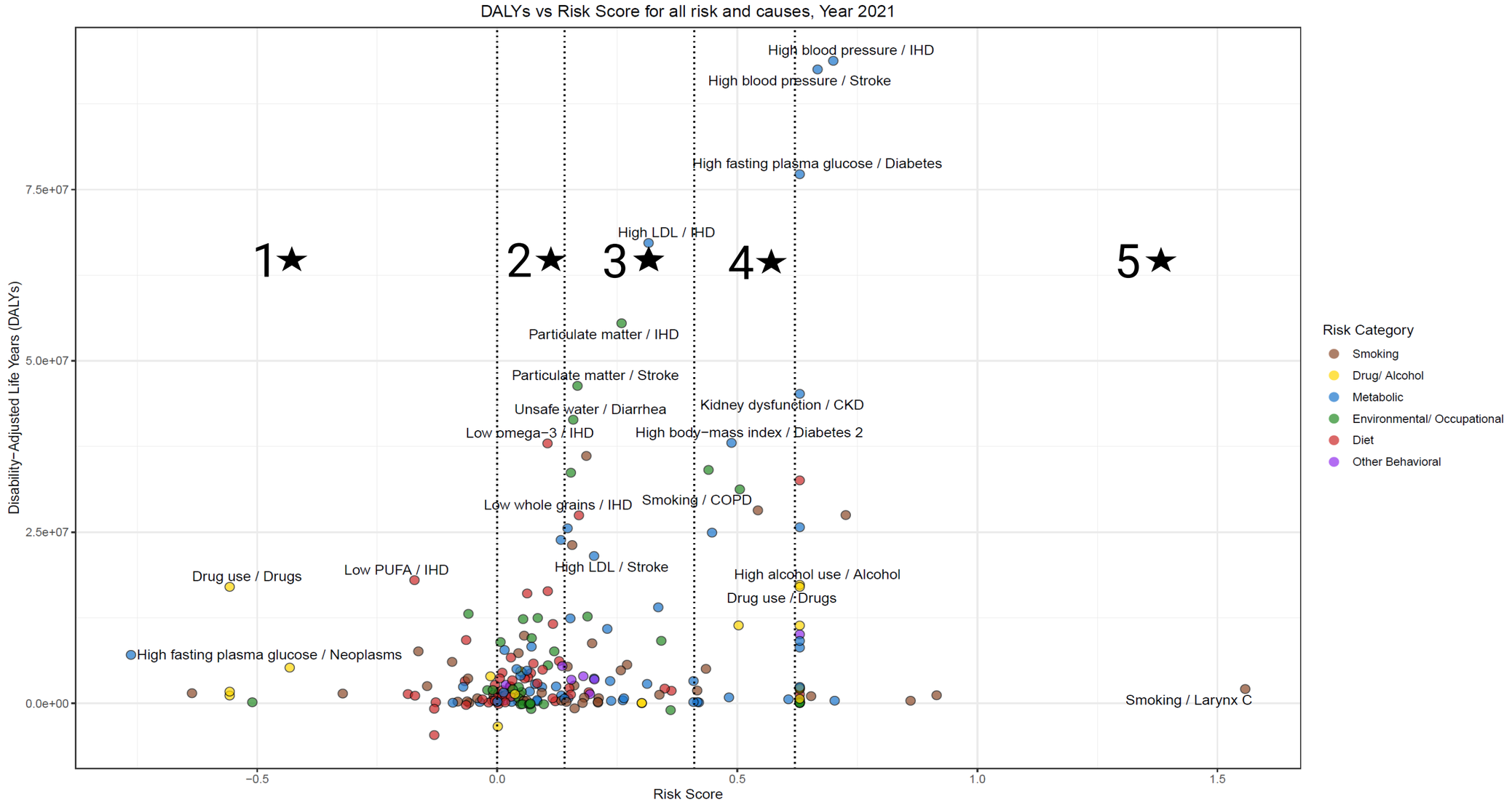


Risk	Outcome	RO Score	Star rating	Data type
High fasting plasma glucose	Chronic kidney disease	1.70	★★★★★	Continuous
Smoking	Larynx cancer	1.56	★★★★★	Continuous
Smoking	Aortic aneurysm	0.92	★★★★★	Continuous
Smoking	Lower extremity peripheral arterial disease	0.86	★★★★★	Continuous
Smoking	Tracheal, bronchus, and lung cancer	0.73	★★★★★	Continuous
High alcohol use	Other pharynx cancer	0.72	★★★★★	Continuous
High systolic blood pressure	Ischemic heart disease	0.7	★★★★★	Continuous
High systolic blood pressure	Stroke	0.67	★★★★★	Continuous
Smoking	Other pharynx cancer	0.65	★★★★★	Continuous
Smoking	Chronic obstructive pulmonary disease	0.54	★★★★☆	Continuous

- The Burden Proof Risk Function is the smallest harmful or protective effect at each level, consistent with evidence.
- Risk-Outcome Score is then converted into five-star rating to help policy makers.

Download and reuse the risk curves

Burden of Proof: scoring system



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If you want more information on the updated ERFs:

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