

Estimating and Valuing Asthma Impacts of Formaldehyde Exposure to Improve Decision-Making



University of California
San Francisco

Exposure to Improve Decision-Making

Lam, Juleen¹; Sutton, Patrice¹; Padula, Amy M.¹; Cabana, Michael D.¹; Koustas, Erica²; Vesterinen, Hanna²; Whitaker, Evans M.¹; Daniels, Natalyn¹; Woodruff, Tracey J.¹

¹ University of California, San Francisco; ² Scientific Consultant to UCSF

Study Question & PECO Statement

Is **exposure to formaldehyde** associated with diagnosis, signs, symptoms, exacerbation, or other **measures of asthma in humans**?

Population: Humans

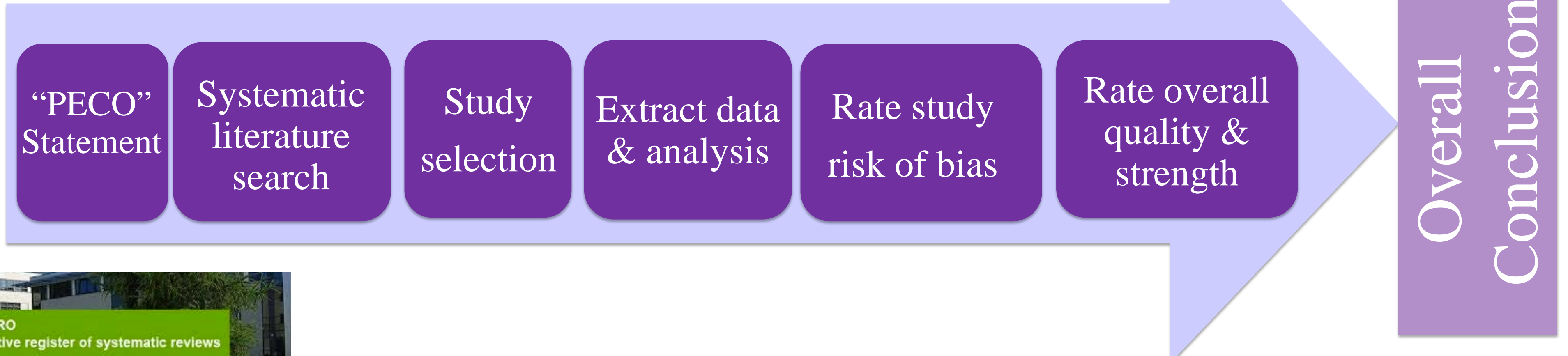
Exposure: Indoor/outdoor inhalation exposure to formaldehyde prior or concurrent to evaluation of asthma

Comparator: Humans exposed to lower levels of formaldehyde than more highly exposed humans

Outcome: Diagnosis of asthma, asthma signs or symptoms, asthma exacerbation (requiring systemic treatment), or indirect measures of asthma



The Navigation Guide: Systematic & transparent method to evaluate environmental health evidence to support evidence-based health and policy recommendations



Protocol developed beforehand and pre-registered in PROSPERO: <http://www.crd.york.ac.uk/PROSPERO> CRD # 42016038766

Systematic Search & Study Selection

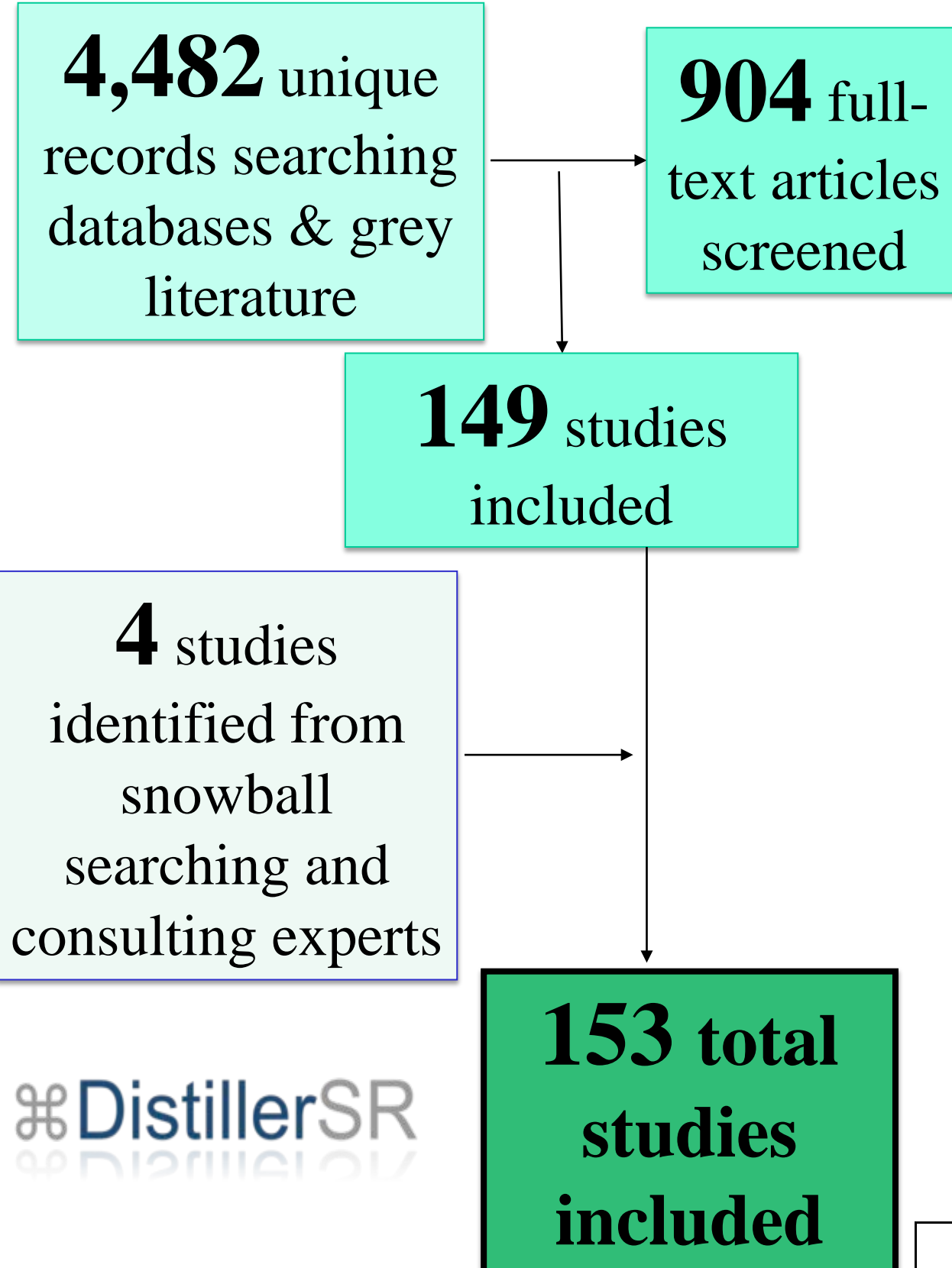


Figure 1. Prisma diagram for screening relevant studies

- Identified **>150 studies** relevant to asthma and asthma-related outcomes (wheezing, breathlessness, pulmonary functions, etc.) [Fig 1]
- Included studies overall had low risk of bias concerns [Fig 2]. Potential biases were related to knowledge of group assignments (i.e., blinding) or source population representation (i.e., selection bias)
- 11 studies** of asthma diagnosis in children were combinable in a meta-analysis, most with overall low risk of bias (internal validity) [Fig 3].
- We estimated an **8% increase in asthma** per 10-fold increase in indoor formaldehyde exposure for children [Table 1]
- Data not amenable to meta-analysis were visually displayed in scatterplots, such as for childhood asthma symptoms [Fig 4]
- A policy reducing indoor formaldehyde exposure by 10 ug/m³ for 100,000 children would result in 80-337 fewer asthma cases. The annual **willingness to pay*** for this policy would range between \$312,000 – 717,000 (2007 USD)

*An economic analysis used to quantify the benefit of a reduction in chemical exposure, based on the maximum dollar amount taken from an individual in exchange for reducing their exposure level

Figure 2. Risk of bias results for meta-analysis studies

Study	Source population	Blinding	Outcome assessment	Confounding	Incomplete outcome	Exposure assessment	Selective reporting	COI	Other
Delfino et al. 2003	Green	Yellow	Green	Green	Green	Green	Green	Green	Green
Hulin et al. 2010	Green	Green	Green	Green	Green	Green	Green	Green	Green
Kim et al. 2007	Green	Green	Green	Red	Green	Green	Green	Green	Green
Kim et al. 2011	Green	Green	Green	Green	Green	Green	Green	Green	Green
Krzyzanowski et al. 1990	Green	Green	Green	Green	Green	Green	Green	Green	Green
Mi et al. 2006	Green	Green	Green	Green	Green	Green	Green	Green	Green
Rumchev et al. 2002	Green	Green	Green	Green	Green	Green	Green	Green	Green
Smedje and Norback 2001	Green	Green	Green	Green	Green	Green	Green	Green	Green
Smedje et al. 1997	Green	Green	Green	Green	Green	Green	Green	Green	Green
Zhao et al. 2008	Green	Green	Green	Green	Green	Green	Green	Green	Green

Table 1. Meta-analysis results for children and asthma diagnosis

	Random-effects model		
	Number of studies	OR (95% CI) per 10- $\mu\text{g}/\text{m}^3$ increase	I ² (%) [p-value]
Asthma	11	1.17 (1.01, 1.35)	26 [0.24]
Indoor	8	1.08 (1.02, 1.14)	0 [0.86]
Ambient	3	2.27 (1.26, 4.09)	0 (0.42)

Figure 3. Risk of bias results across all studies

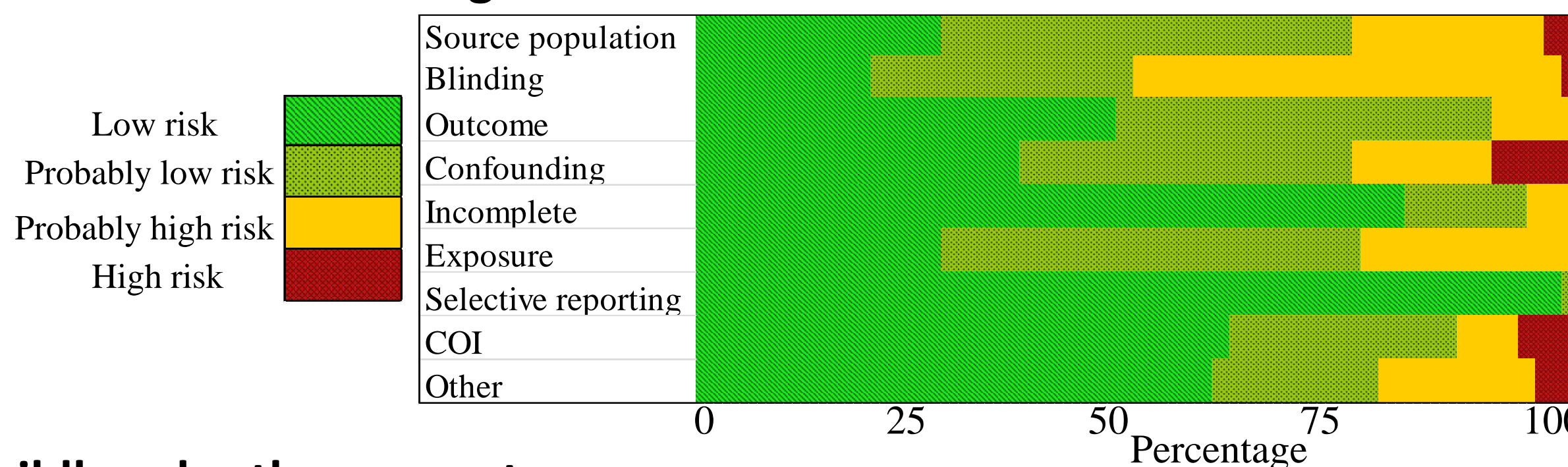
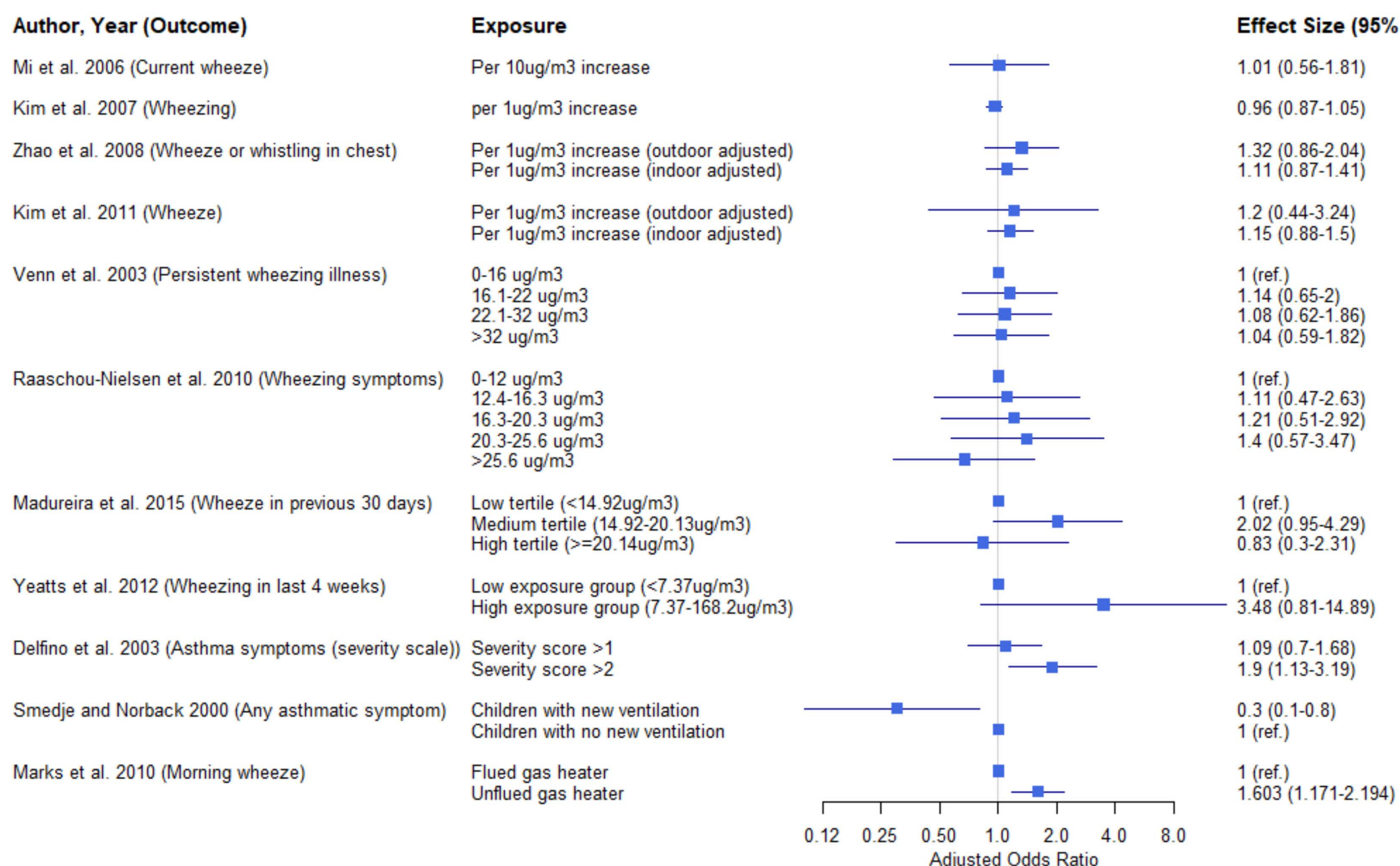


Figure 4. Scatterplot of childhood asthma symptoms



Background

- Formaldehyde is widely prevalent in household building materials
- Formaldehyde is classified as a carcinogen and acute exposure can cause eye, nose, throat and skin irritation

Significance

- Recent EPA regulations (2016) fail to account for asthma outcomes in benefit-cost evaluations, weakening justification for more stringent exposure limits

Next Steps

- Complete quantitative evaluation of data deemed not combinable in a meta-analysis to incorporate data into final rating decisions
- Finalize overall quality/strength ratings for the body of evidence by outcome, separately for children, adults and occupational exposures

Conclusions

- 8% increase in children's asthma diagnosis per 10-fold increase in indoor exposure
- A policy reducing indoor formaldehyde exposure by 10 ug/m³ could be worth up to \$717,000/year per 100,000 children, from reduced diagnoses of asthma
- Use of more robust search methods identified a larger group of studies compared to previous reviews
- Reporting standards and consistent reporting of results would increase the utility of study results in systematic reviews
- Systematic review methods are a powerful tool to support prevention-oriented decisions to efficiently summarize the scientific knowledge and create simple, bottom-line messages regarding the toxicity of environmental chemicals

