



UK Health  
Security  
Agency

# Exposure to Residential Solid Fuel Burning What does it mean for our health?

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# Background

Indoor emissions from household combustion of coal carcinogenic to humans  
(Group 1, IARC)

Low to middle-income countries - significant positive associations between indoor biomass exposure and acute respiratory infection and pneumonia in children

Higher income countries - different exposures, evidence

# What's the evidence for the UK?

Science of the Total Environment 755 (2021) 142187



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Science of the Total Environment

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## Review

### Exposure to indoor and outdoor air pollution from solid fuel combustion and respiratory outcomes in children in developed countries: a systematic review and meta-analysis

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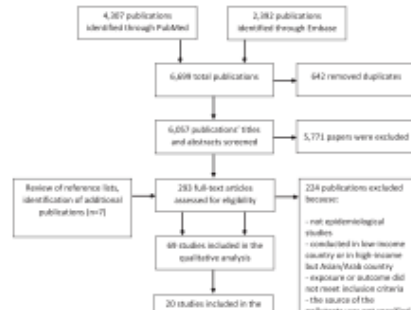
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## HIGHLIGHTS

- Exposure to indoor wood burning is not associated with an increased risk of asthma in developed countries;
- Exposure to indoor wood burning is slightly associated with an increased risk of respiratory infections.
- The relationship between exposure to indoor coal burning and outdoor solid fuels and respiratory outcomes is limited.

## GRAPHICAL ABSTRACT



### A systematic review on solid fuel combustion exposure and respiratory health in adults in Europe, USA, Canada, Australia and New Zealand

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## ARTICLE INFO

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Coal burning

## ABSTRACT

Epidemiological studies performed in low- and middle-income countries have shown a positive association between solid fuel burning exposure and adverse health effects, including respiratory effects in adults. However, the evidence is less clear in other countries. We performed a systematic review of epidemiological studies conducted in Europe, North America (Canada and USA only), Australia and New Zealand on the association between outdoor and indoor exposure to solid fuel (biomass and coal) combustion and respiratory outcomes in adults.

We identified 34 articles. The epidemiological evidence is still limited. Positive associations were found between indoor coal, wood and combined solid fuel combustion exposure and lung cancer risk, although based on a limited number of studies. A significant association was found between indoor solid fuel exposure and COPD risk. Inconsistent results were found considering indoor coal, wood and mixed solid fuel burning exposure and other respiratory outcomes (i.e. lower respiratory infections, upper respiratory infections and other upper respiratory tract diseases, asthma and respiratory symptoms).

# Effects of solid fuel combustion on respiratory health

## Inclusion criteria

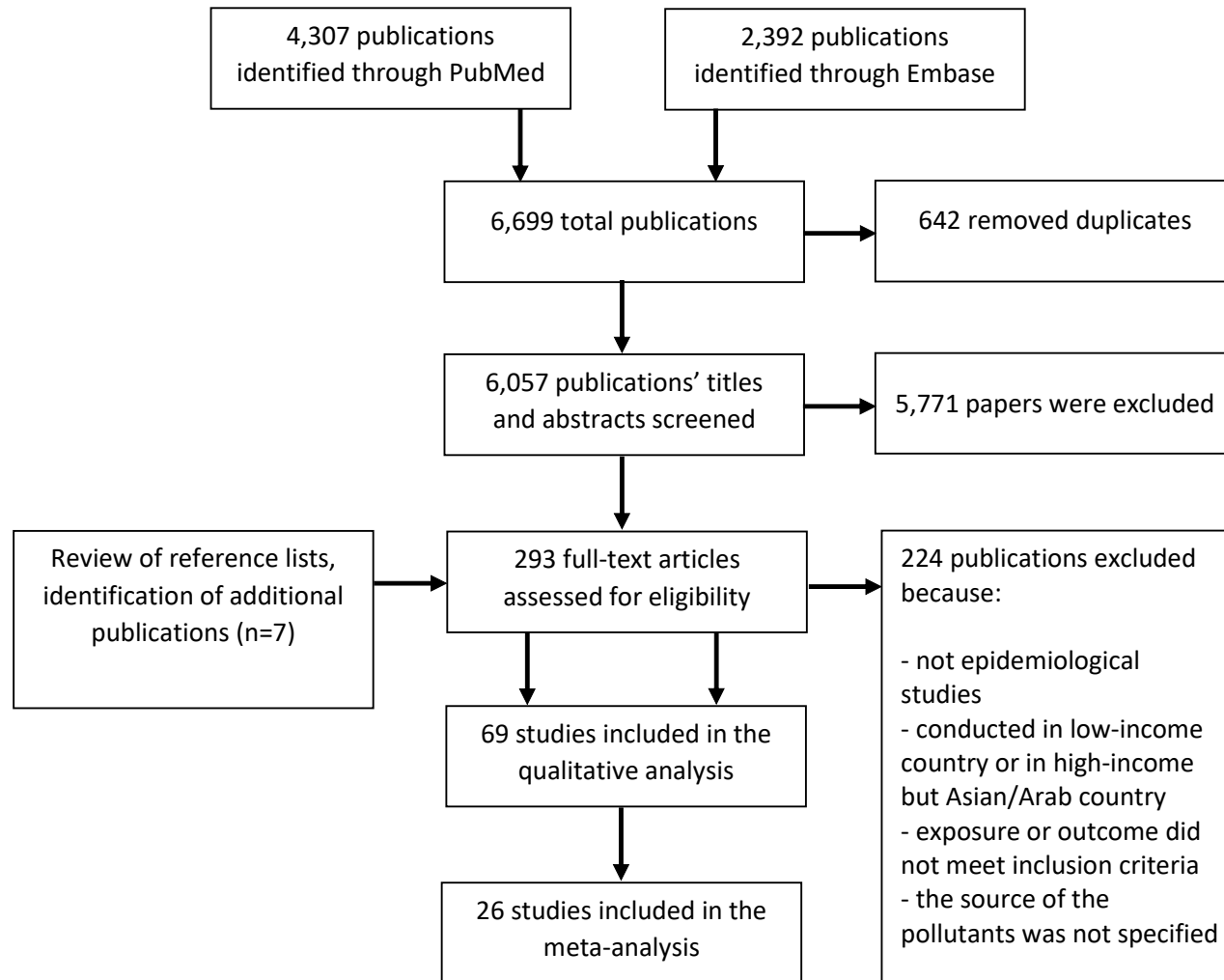
- Indoor and outdoor air pollution from solid fuel combustion (wood, coal)
- Comparator unexposed or lower levels or cleaner fuels
- Respiratory outcomes
- Any study design
- Only in North America, Europe, Australia and New Zealand

## Exclusion criteria

- Exposure included gas and oil
- Skin allergies or skin and respiratory considered together
- Wildfires

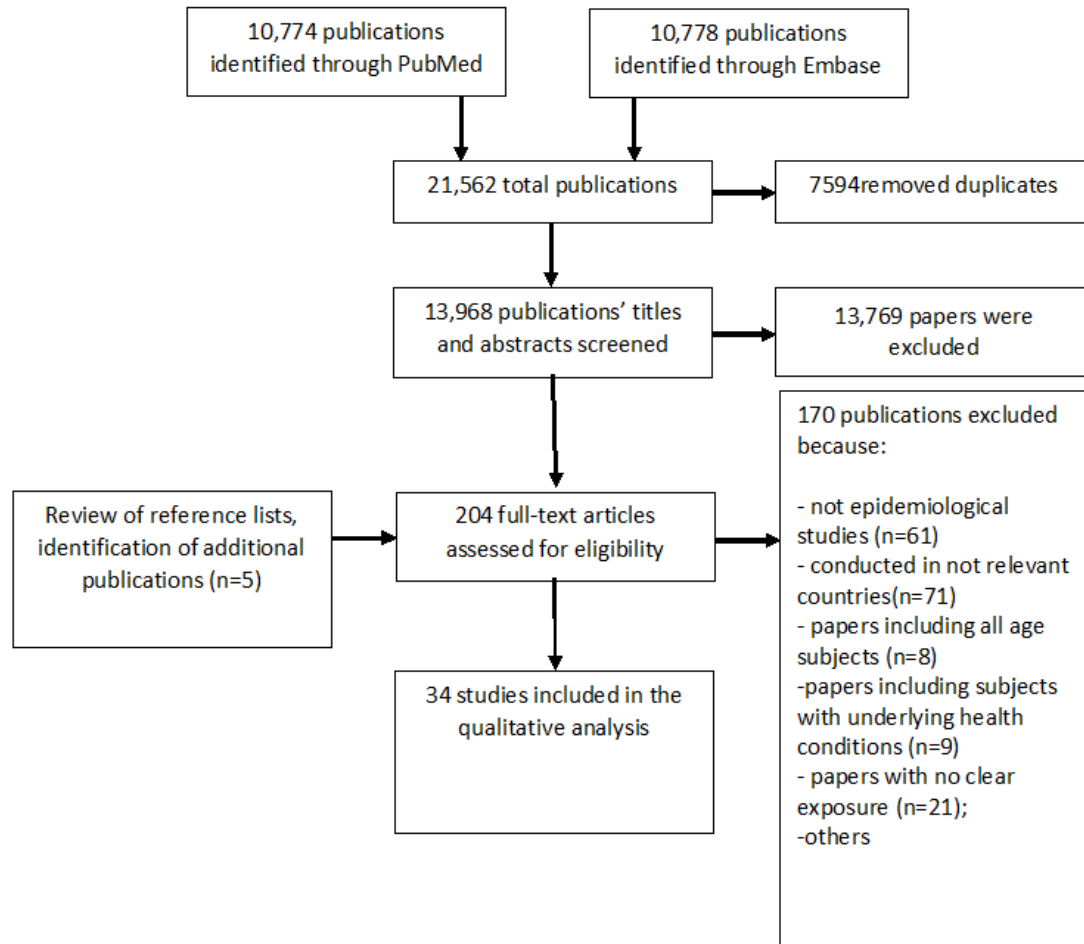
Children at time of exposure but adults at time of outcomes assessed

# Effects of Solid Fuel Combustion Exposure on Children's Respiratory Health



54 indoor  
10 outdoor  
5 both indoor and outdoor

# Effects of Solid Fuel Combustion Exposure on Adults' Respiratory Health



18 indoor  
16 outdoor



# Description of Studies

## Areas

North America

Europe

Australia, New Zealand

Couple were multicentric

## Study Design

Cross sectional (majority of the studies in children)

Prospective cohort

Case control

Few studies: nested case control, quasi- experimental, RCT, ecological

# Assessment of Indoor Exposure and Outcomes

## Exposure

Questionnaires with  
parents/caregivers

Wood, coal, charcoal,  
mixed, device

Few studies measured indoor  
pollutants directly

## Health Outcome

Questionnaire  
Several validated questionnaires  
e.g. International study of asthma  
and allergies in childhood

Some studies - medical  
records



# Assessment of Outdoor Exposures

## Pollutants

- PM<sub>10</sub>
- PM<sub>2.5</sub>
- BS
- SO<sub>2</sub>
- PAHs

## Markers

- Levoglucosan
- Potassium
- Residents concerns
- Density of households using wood burning etc



# Respiratory Outcomes Studied

## Diseases/Mortality

Asthma

Lower Respiratory Infections

Lung cancer, COPD respiratory mortality (Adults)

Other conditions

e.g Allergic rhinitis, hayfever, URI (mainly colds), influenza

## Symptoms

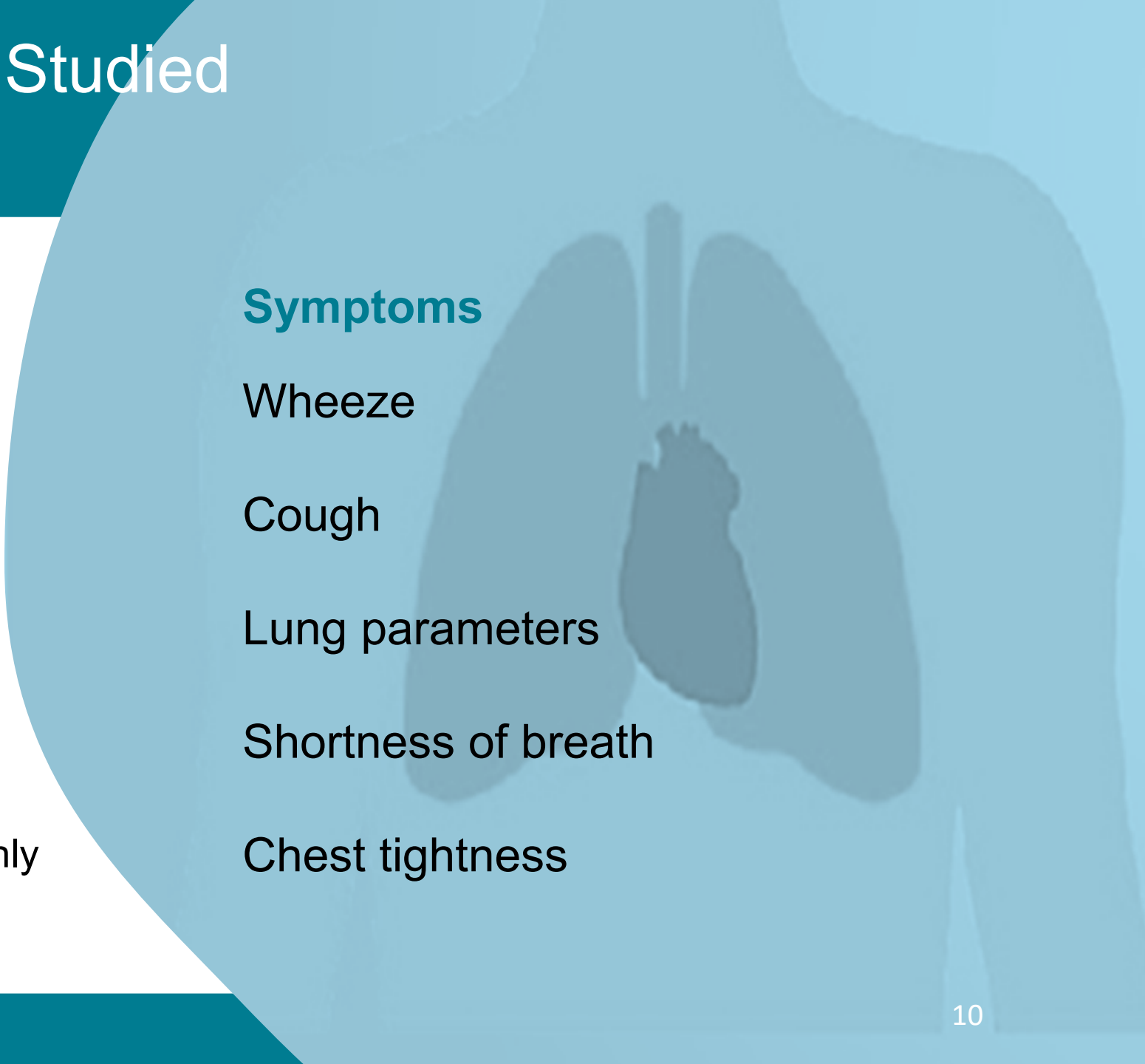
Wheeze

Cough

Lung parameters

Shortness of breath

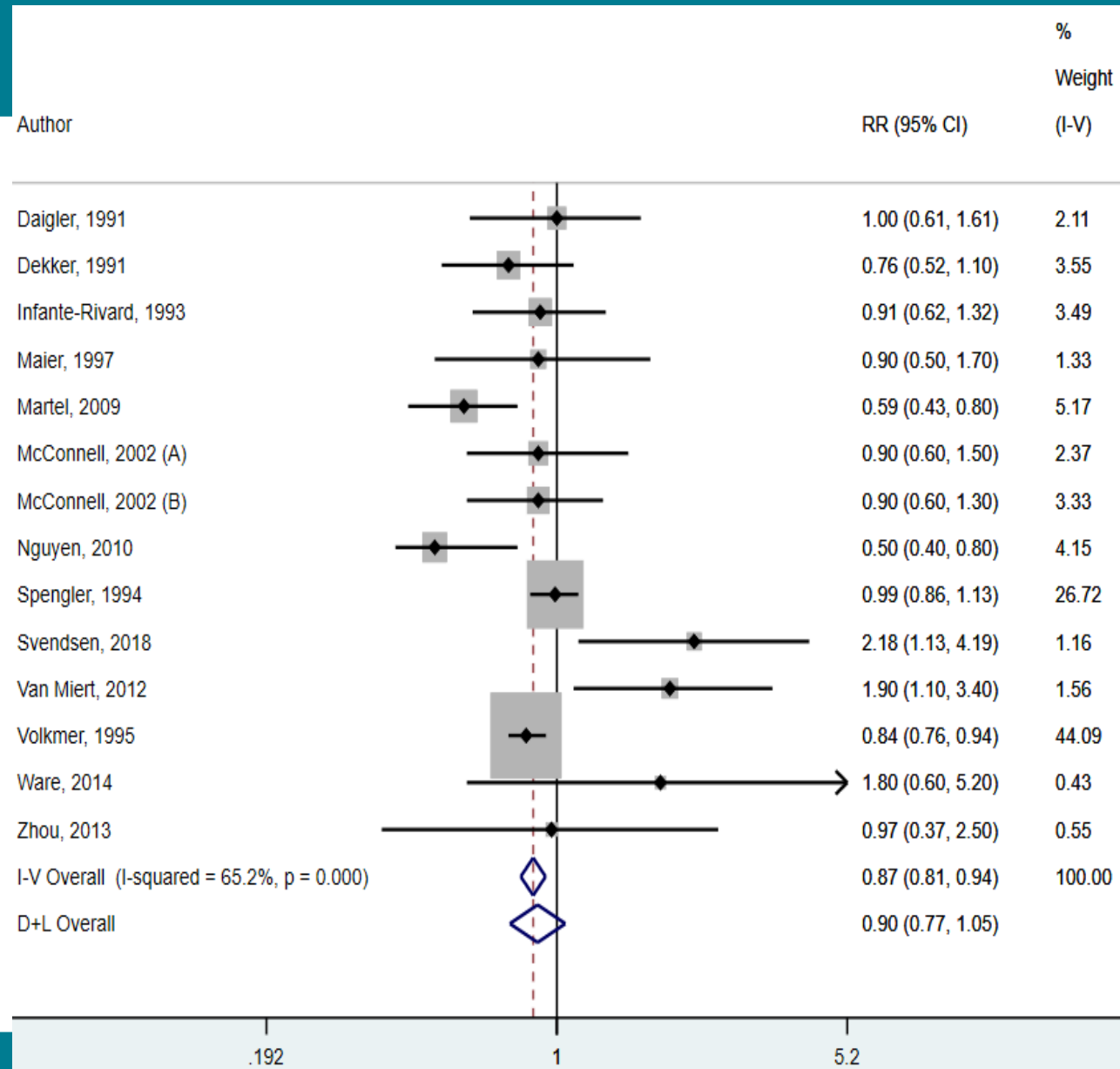
Chest tightness



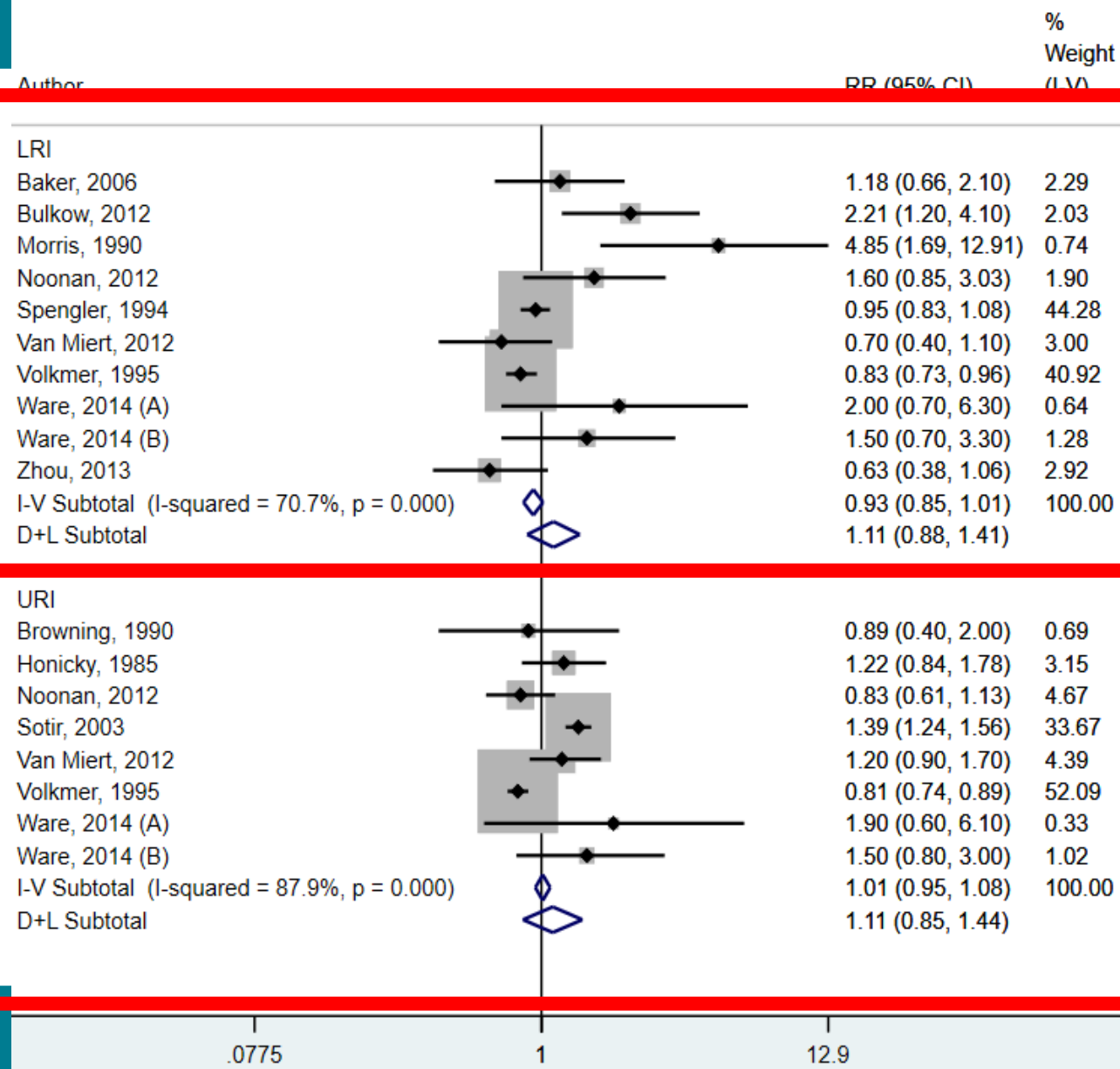
# Evidence for Effects in Children

## Study Findings

# Children's Exposure to Indoor Wood Burning and Asthma Risk



# Children's Exposure to Indoor Wood Burning and Respiratory Infections Risk





# Children's Indoor Exposures and other Respiratory Symptoms

## Wood Burning

- After meta-analyses no associations for Wheeze and Cough
- A few studies evaluated the association between exposure to indoor wood burning and otitis (3 studies), influenza (1 study) and allergic rhinitis (3 studies) with inconsistent results

## Coal Burning

- Asthma (2 studies) showing an increased risk
- LRI (3 studies) inconsistent results
- Other respiratory outcomes (e.g. URI, cough and wheeze) limited results

# Children's Exposure to Outdoor Solid Fuel Burning and Respiratory Health

## Exposure to outdoor wood burning

- Asthma (5 studies) showing no association
- LRI (3 studies) and otitis (3 studies) showing a positive association
- URI (3 studies), influenza (2 studies), and wheeze (3 studies) with inconsistent results

## Exposure to outdoor coal burning

- Only 2 studies considering asthma and lung function found a positive association

# Evidence for Effects in Adults

## Study Findings



# Adults - Indoor Exposure to Solid Fuel Combustion

Fuel	Outcome
Coal	Lung cancer (4 +1 multicentre)
Wood	Lung cancer (1 + 4 pooled case-control)
Mixed	Lung cancer (4) COPD (2)

Inconsistent results were found with other respiratory outcomes



# Adults - Outdoor Exposure to Wood Burning

Few studies

Inconsistent results for respiratory mortality, asthma, COPD and respiratory symptoms

Measurements PM<sub>2.5</sub> (4), PM<sub>10</sub> (4) one Potassium (1) and residents concern (1)

# Adults - Outdoor Exposure to Coal Burning

3 studies , 2 large sample size and long-term follow up

- Areas with high coal burning (E&W), BS and SO<sub>2</sub> - increased lung cancer mortality risk after decades (Hansell et al.,2016)
- Early life exposure to domestic coal burning - significant increased mortality risk of trachea, bronchus and lung cancer in adulthood (Phillips et al., 2018)



# Limitations

## Considerable heterogeneity

- study design
- exposure and outcome assessment
- fuel

## Measurement of pollutants

- Outdoor PM concentrations – contribution from other outdoor sources
- Indoors –
  - Few studies measured pollutants
  - Only 1 or 2 48hr measurement sessions

# Limitations

## Questionnaires

- recall bias
- potential misclassification of exposure and outcome -self-reports

## Health outcomes

- Disease definition
- Most studies exposed or not exposed no dose response

## Lack details on

Device, house conditions, climate differences, and confounding variables

# Research Recommendations

## Measurements

- more objective quantitative measurements of indoor air pollutants emitted from solid fuel combustion

## Data collection

- Information devices, use and frequency
- House characteristics such as ventilation

## Confounder adjustments

- e.g. SES and second-hand smoking in home

# Summary

Air pollutants cause a range of health effects but the extent to which the health effects are due to solid fuel combustion is currently unclear

The epidemiological evidence does show some associations with adverse respiratory effects in both children and adults

*but*

Limited number of available studies

Several limitations

Additional and better studies are needed to identify clear relationships and enable quantification



# References

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