

Sources and determinants of indoor air pollutants in Europe - results of a systematic review

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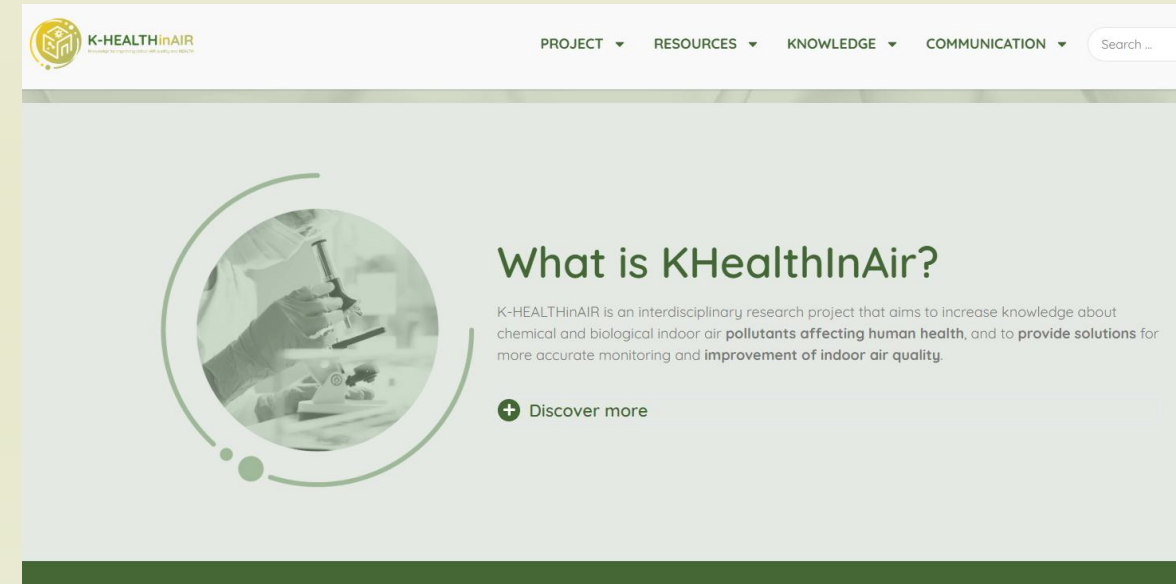
Background

- ⇒ **People spend 80 to 90 % of their time in indoor settings** performing activities of daily living, working, and sleeping;
- ⇒ **Indoor Air Quality** (IAQ) remains relatively understudied, leading to a lack of standards and to regulatory gaps;
- ⇒ Knowledge of the **sources** (responsible for the pollutant presence indoors) and the key **determinants** (influencing the pollutant level indoors) is fundamental → to defining the best risk management approaches at the technical and policy levels

Aim

➡ To **systematically review** the **available evidence** regarding the **sources and determinants of concentrations of indoor air pollutants**, in settings (**schools, homes, lecture halls, hospitals, retirement homes, public transports, canteens**) being studied in the **K-HEALTHinAIR project**.

www.k-healthinair.eu



Methods

- **Geographical region:** European countries
- **Timeframe:** 2013-2023
- **Indoor air pollutants:** particulate matter, volatile organic compounds, nitrogen oxides, carbon dioxide, ozone, radon
- **Search string**

CONTEXT

("indoor air" **OR**
"indoor air pollution"
OR "indoor air
quality")

AND

POLLUTANTS

("VOC" **OR** "particulate matter" **OR**
"formaldehyde" **OR** "carbon
dioxide" **OR** "nitrogen oxides" **OR**
"ozone" **OR** "radon")

AND

SETTINGS

("hospital" **OR** "public transport"
OR "market" **OR** "canteen" **OR**
"residence" **OR** "lecture hall" **OR**
"home" **OR** "school")

Methods

➡ **Databases:** PubMed, Scopus, Web of Science

➡ **Inclusion criteria:** i) English language; ii) study reporting primary data; iii) timeframe 2013–2023; iv) studies developed in European countries

➡ **First-stage screening:** Screening of titles and abstracts by two independent reviewers per reference, with a third reviewer to resolve conflicts

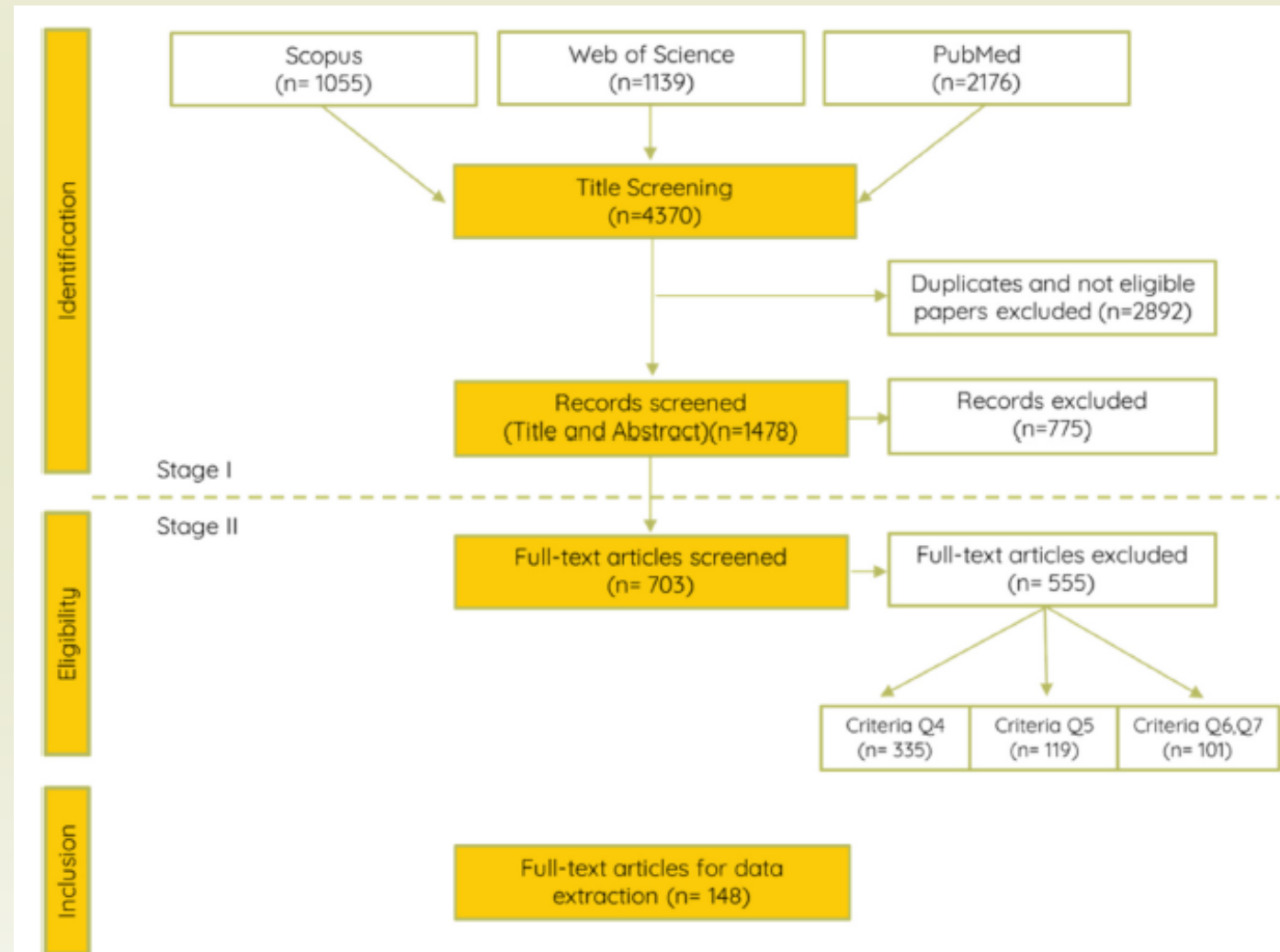


Fig. 2. Workflow and results for stage I and stage II of the systematic literature review.

Methods

➤ **Second-stage screening:** Screening of **full-texts** by two independent reviewers per reference, with a third reviewer to resolve conflicts

➤ **Data extraction:** setting characteristics, study design, pollutants, exceedance of available national legislation and/or guidelines as reported in each study, sources and determinants identified as such

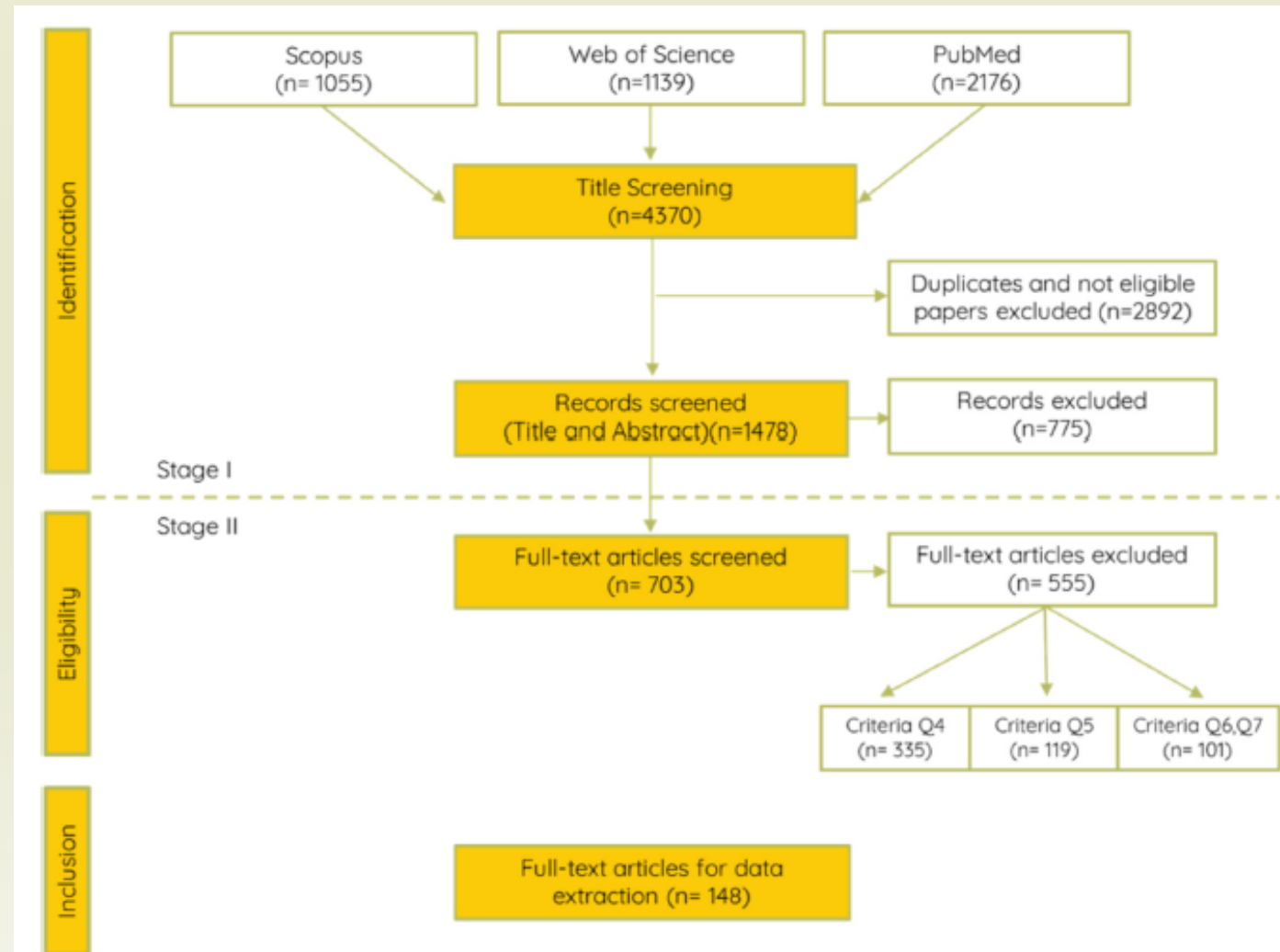
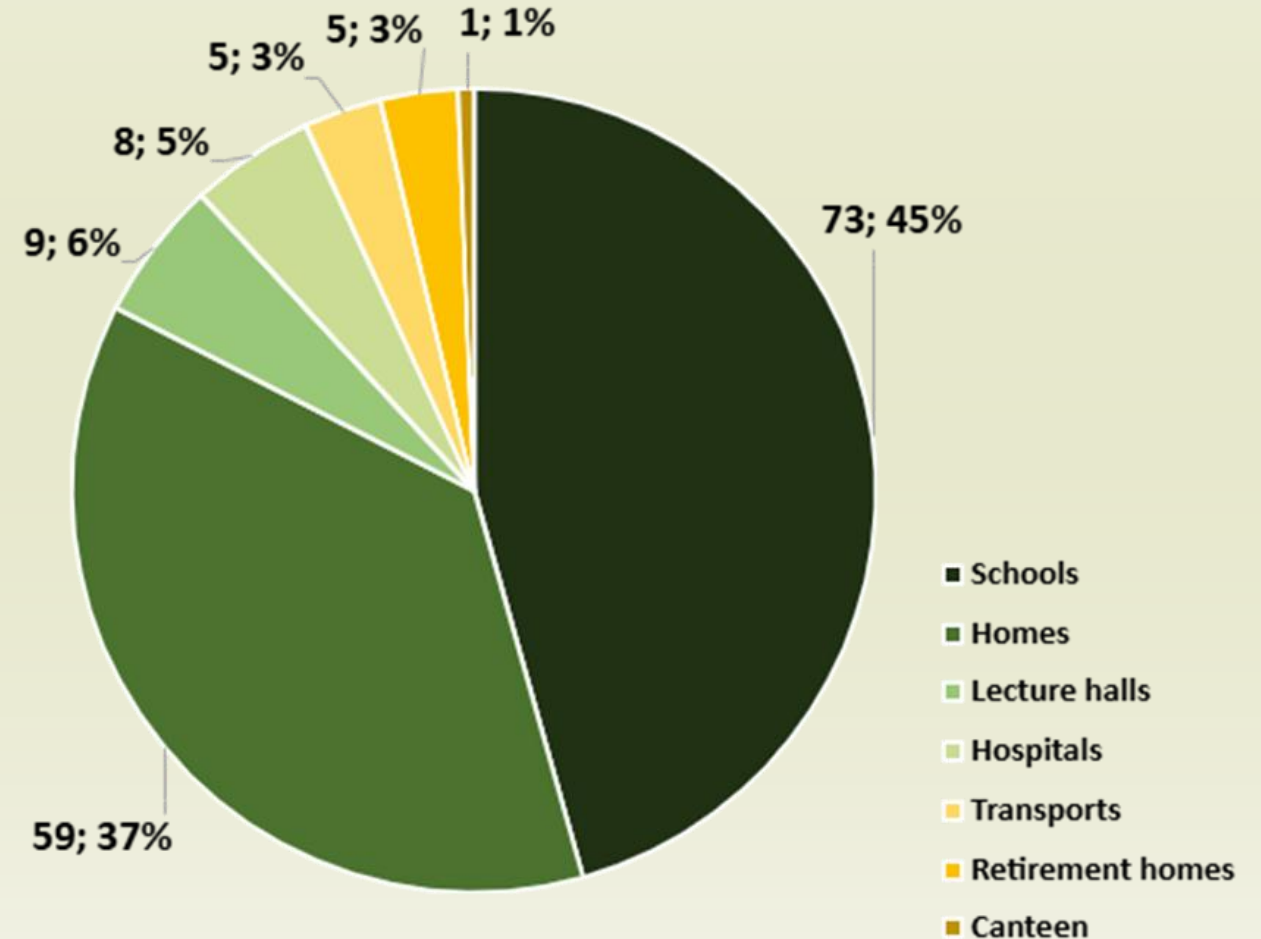







































Fig. 2. Workflow and results for stage I and stage II of the systematic literature review.

Results

- **148** articles
- **Settings:** Schools (45 %), homes (37 %), lecture halls (6 %), hospitals (8, 5 %), retirement homes (5, 3 %), transportation (5, 3 %), canteens (1 %).
- **Study designs:** cross-sectional studies (n=129), cohort studies (n=9), case-control studies (n=10).














Results | Schools

Sources							
Occupancy	Outdoor air	Cleaning products	Class materials	Consumer products	Furniture	Smoking	Resuspension
 	 		  				
Traffic	Organic sources	Floor	Heating				
 	 						
Determinants							
Number of occupants	Ventilation	Room volume	Building characteristics	Classroom orientation	Physical activities	Type of floor	Floor level
   	   	 	 	 		 	 

Results | Homes

Sources							
Occupancy	Outdoor air	Cleaning products	Cooking	Consumer products	Furniture	Smoking	Resuspension
							
Traffic	Organic sources	Floor	Heating	Textiles	Candles Incense		
							
Determinants							
Number of occupants	Ventilation	Heating system	Building characteristics	Season	House type	Type of floor	Floor level
							

Results | Hospitals

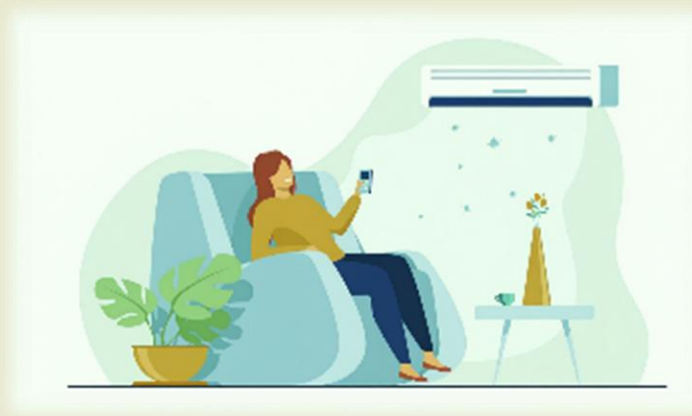
Sources							
Occupancy	Outdoor air	Cleaning products	Human activities	Disinfectants	Furniture	Pharmaceutical products	Medical devices
							
Determinants							
Number of occupants	Ventilation	Room characteristics					
							

Results | Other settings

	Sources	Determinants
Lecture halls	Occupancy Smoking Outdoor air Resuspension	Number of occupants Type of ventilation Building characteristics
Canteens	Cooking	Ventilation Cooking device
Retirement homes	Occupancy Cleaning products Outdoor air	Type of ventilation Number of occupants Season
Public transport	Occupancy Mechanical wear	Type of ventilation Number of occupants Frequency of trains

Take-away messages

Number of studies with a **robust statistical analysis** to identify the sources and the determinants of the presence of indoor air pollutants: 37 % of studies in schools, 46 % of studies in homes, and 38 % of studies in hospitals.



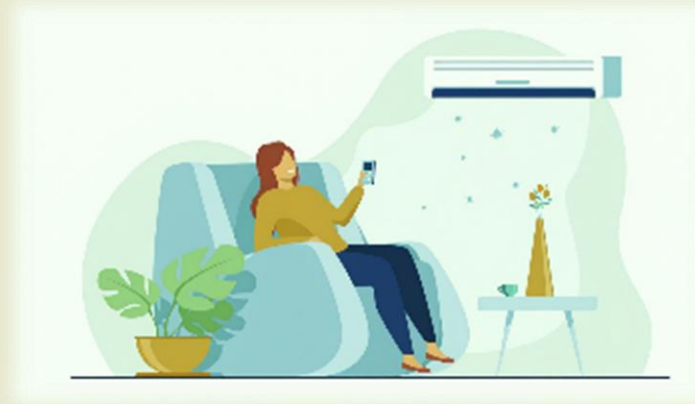
Statistical methods varied from **inferential tests** such as Mann-Whitney, Kruskal-Wallis, to **more complex analyses** using Principal Component Analysis, linear mixed effects and multivariate regression models.

Detailed data collection in indoor environments to perform a **robust and complex analysis** and draw conclusions with sufficiently **strong weight of evidence**.



Take-away messages

No harmonized regulation in Europe defines limits for indoor air pollutants, like those in the Air Quality Directive for outdoor air, despite their recognized importance as determinants of health.



“Indoor Air Quality in All Policies” - IAQ is considered and influenced by policies that are not directly related but will determine indoor air pollutant concentrations in different settings (e.g., 1907/2006/ECD - REACH, which limits the presence of formaldehyde in wood and other materials used indoors).

Lack of harmonization in research protocols and sampling methods across all the studies eligible for this review.



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K-HEALTHinAIR
Knowledge for improving indoor AIR quality and HEALTH

Thank you for your attention!

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