National Institute for Health and Care Excellence

Guideline version (Draft)

Indoor air quality at home

[1] Evidence review for associations between individual or building characteristics and exposure levels

NICE guideline <number>

Evidence review

June 2019

Draft for Consultation

These evidence reviews were developed by Public Health Internal Guideline Development team

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ISBN:

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Associations between individual or building characteristics and exposure levels

Review question

What individual or building factors are associated with increased exposure to poor indoor air quality at home?

Introduction

People spend up to 90% of their lives indoors and 60% of that time at home. To minimize the health risks from pollutants occurring in homes, exposures to these pollutants should be controlled. The priority in this is to control the source of the pollutant and so reduce exposure. Often, especially in existing buildings, this may be difficult to achieve, in which case pollutant exposures should be controlled by providing enough ventilation air to dilute and remove the contaminants.

Recent reviews suggest that adequate ventilation results in more than 0.4 air changes per hour (Wargocki 2013) and that home ventilation ratios greater than 0.5 air changes per hour was associated with better health outcomes (Sundell 2010).

The aims of this review are to identify individual and building factors that put people at increased risk of exposure to poor indoor air quality at home

PICO table

Table 1 outlines the PICO elements of the respective review protocols which are available in Appendix A

Table 1: PICO table for individual or building factors

Eligibility criteria	Content
Population	People in all dwellings
Prognostic factors	• Population: ○ Gender ○ Age ○ Socio-economic status ○ Household occupant density ○ Ethnic groups • Lifestyle / behavioural: ○ Pet ownership ○ Method of cooking for example use of gas, hoods, extractors or wood ○ Odourisation (for example plug-in air fresheners and candles) • Health-related: ○ Cardiovascular disease ○ Respiratory disease ○ Neurological disease ○ Allergic disease ○ Disability ○ Pregnancy

Eligibility criteria	Content
	• Building: ○ Dwelling type for example apartment building, family home (house) ○ Building age ○ Tenancy agreement type (for example rented, short-term or long-term) ○ Location (urban / suburban / rural) – or proximity to traffic ○ Fuel for heating ○ Recent refurbishment or DIY ○ Integral garage
Outcomes	Risk ratios, odds ratios of exposure to indoor air pollutants at home

Methods and process

This evidence review was developed using the methods and process described in Developing NICE guidelines: the manual. Methods specific to this review question are described in the review protocol in Appendix A:.

As review questions 1 (individual and building factors associated with exposure to poor indoor air quality at home) and 2 (signs and symptoms should prompt healthcare professionals to consider exposure to poor indoor air quality at home) overlapped, both reviews were carried out using a single search. The results of this search were then parsed as follows

- Studies that examined the association between individual or building characteristics and exposure levels
- Studies that examined the association between sources of pollutants and health outcomes
- Studies that examined the association between exposure levels and health outcomes.

This review is concerned with the association between individual or building characteristics and exposure levels. Please see Evidence review 2 for the association between sources of pollutants or exposure and health outcomes.

Declarations of interest were recorded according to NICE’s 2018 conflicts of interest policy.

Public health evidence

Included studies

33967 references were identified from literature searches outlined in Appendix B. 426 papers were ordered in full-text for questions 1 and 2. Of these 278 were excluded from both reviews and 148 articles in total were included in the two reviews. 15 studies from 16 papers were included in this review while 99 studies from 101 articles and 31 studies from 32 articles were included in evidence review 2.

Excluded studies

The full list of excluded studies and reasons for exclusion are in Appendix K:

Summary of public health studies included in the evidence review

A summary of the characteristics of the included studies are in the following table.

Table 2: Characteristics of included studies

Study (country)	Design	Population	Exposure	Statistic used	Risk of bias
Bornehag 2005 b (Sweden)	Nested case control	390 dwellings	Phthalates	Adjusted Odd Ratio	Low
Couper 1998 (Australia)	Prospective cohort	72 dwellings	Allergens	Geometric Mean Ratio	Low
Dassonville 2009 (France)	Prospective cohort	196 dwellings	Formaldehyde Hexanal Acetyl-aldehyde	β-coefficient	Low
Esplugues 2010 (Spain)	Retrospective cohort	352 dwellings	Nitrogen dioxide	β-coefficient	Low
Garcia-Algar 2003 (Spain)	Prospective cohort	340 dwellings	Nitrogen dioxide	Geometric ratio	Moderate
Garrett 1998 (Australia)	Prospective cohort	90 dwellings	Allergens	β-coefficient	Low
Hansel 2008 (US)	Prospective cohort	150 dwellings	Nitrogen dioxide	β-coefficient	Low
Jedrychowski 2014 (Poland)	Prospective cohort	157 individuals	Polycyclic aromatic hydrocarbons (PAHs)	Adj Odds Ratio	Moderate
Park 2001 (US)	Prospective cohort	111 dwellings	Endotoxin levels	Percentage change relative to reference	High
Raaschou-Nielsen 2011 (Denmark)	Prospective cohort	389 dwellings	Particulate matter	Not stated	High
Reponen 2011 (US)	Prospective cohort	288 dwellings	Damp	Adj Odds ratio	Low
Roda 2011 (France)	Prospective cohort	196 dwellings	Formaldehyde	adj Odds Ratio	Low
Spengler 1996 (US)	Prospective cohort	766 dwellings	Nitrogen dioxide	β-coefficient	High
Van Strien 2002 (The Netherlands)	Prospective cohort	1753 dwellings	Allergens	Adj Odds Ratio	Low
Wickens 2001 (New Zealand)	Prospective cohort	355 dwellings	Allergens	Geometric Mean Ratio	Low

See appendix Appendix D: for full evidence tables.

Quality assessment of public health studies included in the evidence review

For this review question, cohort studies were considered to be of highest quality and case control studies as next best evidence quality. Evidence quality started as 'high' for cohort studies and 'low' for case control studies

See appendix F for full GRADE tables.

Economic evidence

Please see cost-effectiveness review

Economic model

Please see health economic modelling report.

Evidence statements

Population factors

Gender

- No evidence was identified for this prognostic factor

Age

- No evidence was identified for this prognostic factor

Socio-economic status

- No evidence was identified for this prognostic factor

Household occupant density

- This evidence review found moderate quality evidence from 1 study of 196 dwellings showing that an increasing number of occupants was associated with an increase of
    - 0.06 $\mu g/m^3$ in formaldehyde levels per additional person
    - 0.04 $\mu g/m^3$ in hexanal per additional person
    - 0.03 $\mu g/m^3$ in acetyl-aldehyde per additional person
- This evidence review found moderate quality evidence from 1 study of 196 dwellings showing that having more than 3 occupants compared to 3 or less occupants in the household was associated with a twofold risk aOR 2.11 (95%CI 0.96 to 4.64) of having high formaldehyde levels (defined as upper formaldehyde level tertile)
- This evidence review found high quality evidence from 1 study of 72 dwellings showing that having 6 or more occupants was associated with increased levels of house dust mite allergens (GM ratio 3.42 p = 0.013)

Ethnic groups

- No evidence was identified for this prognostic factor

Lifestyle / behavioural factors

Pet ownership

- No evidence was identified for this prognostic factor

Method of cooking for example use of gas, hoods, extractors or wood – Gas

- This evidence review found that having a gas cooker/stove was associated with an increase of:
    - 0.005 $\mu g/m^3$ in formaldehyde levels compared to no gas cooker (moderate quality evidence from 1 study of 196 dwellings)

- 32.23 μg/m^3 (reported as 15.7 ppb) in NO_2 levels compared to no gas cooker (high quality evidence from 1 study of 150 dwellings)
- 13.24 μg/m^3 (reported as 6.45 ppb) in NO_2 levels with use of a gas stove pilot light compared to no gas cooker (low quality evidence from 1 study of 766 dwellings)
- 0.096 ng/m^3 PAH levels with the use of gas cooker in heating season compared to no gas cooker (moderate quality evidence from 1 study of 257 dwellings)
- 0.059 ng/ m^3 in PAH levels with the use of gas cooker in non-heating season compared to no gas cooker (moderate quality evidence from 1 study of 257 dwellings)

- This evidence review found high quality evidence from 1 study of 362 dwellings showing that having a natural gas cooker was associated with an increase of 0.51 μg/m^3 (95%CI 0.26 to 0.77) in NO_2 when compared with electric cooker
- This evidence review found high quality evidence from 1 study of 362 dwellings showing that having a butane gas cooker was associated with an increase of 0.59 μg/m^3 (95%CI 0.33 to 0.86) in NO_2 when compared with electric cooker
- This evidence review found high quality evidence from 1 study of 362 dwellings showing that having a propane gas cooker was associated with an increase of 0.67 μg/m^3 (95%CI-0.23 to 1.57) in NO_2 when compared with an electric cooker
- This evidence review found moderate quality evidence from 1 study of 340 dwellings showing that an increase of:
  - 17% in NO_2 levels was associated with 'sometimes use' of extractor fans when cooking (geometric (GM) ratio 1.17 (95%CI 1.03 to 1.33)) when compared to always use of the extractor fan when cooking
  - 14% in NO_2 levels was associated with no use of extractor fans when cooking (GM ratio 1.14 (95%CI 1.01 to 1.29)) when compared to always use of the extractor fan when cooking

Odourisation (for example plug-in air fresheners and candles)

- No evidence was identified for this prognostic factor

Vacuuming frequency

- This evidence review found that
  - vacuuming carpets less than once a week was associated with a near fivefold increase in house dust mite allergen levels GM ratio=4.79 (moderate quality evidence from 1 study of 72 dwellings) compared to no carpet and vacuuming less than once per week
  - vacuuming carpets more than once a week was associated with a near elevenfold increase in house dust mite allergen levels GM ratio=10.81 (moderate quality evidence from 1 study of 72 dwellings) compared to no carpet and vacuuming less than once per week

Vacuum motor size

- This evidence review found vacuuming with a vacuum with power up to 1000 watts (compared to over 1000 watts) was not associated with an increase in house dust mite (Der p 1) allergen levels GM ratio =1.79 ((95%CI 0.94, 3.42) (moderate quality evidence from 1 study of 355 dwellings)

Clothes drying

- This evidence review found that drying washing outside was associated with a 74% reduction in house dust mite allergen levels GM ratio=0.26 (p = 0.05) (moderate quality evidence from 1 study of 72 dwellings)

Allergen avoidance measure taken

- This evidence review found moderate quality evidence from 1 study of 1,753 dwellings showing that there was no difference between taking allergen avoidance measures and not taking allergen avoidance measures for:
    - house dust mite allergen (Der p 1 + Der f 1) on the child's mattress aOR 1.0 (95%CI 0.9 to 1.2)
    - house dust mite allergen (Der p 1 + Der f 1) on the parent's mattress aOR 1.1 (95%CI 0.9 to 1.3)
    - dog allergen (Can d 1) on the child's mattress aOR 1.0 (95%CI 0.9 to 1.1)
    - dog allergen (Can d 1) on the parent's mattress aOR 0.9 (95%CI 0.8 to 1.1)
    - cat allergen (Fel d 1) on the child's mattress aOR 1.0 (95%CI 0.8 to 1.3)
    - cat allergen (Fel d 1) on the parent's mattress aOR 0.9 (95%CI 0.7 to 1.1)

Bedding (wool)

- This evidence review found high quality evidence from 1 study of 80 dwellings showing that wool bedding was associated with an 0.145 µg/g) in Der p 1 allergen levels on the bed

Mattress - type

- This evidence review found high quality evidence from 1 study of 80 dwellings showing that an inner spring mattress was associated with an 0.250 µg/g) increase in Der p 1 allergen levels on the bed

Mattress - age

- This evidence review found moderate quality evidence from 1 study of 1,753 dwellings showing that
    - a 1 to 2 year old mattress compared with a new mattress was associated with no difference in exposure to house dust mite allergen (Der p 1 + Der f 1) levels on the child's mattress aOR 1.1 (95%CI 0.9 to 1.2)
    - a mattress older than 2 years compared with a new mattress was associated with no difference in exposure to house dust mite allergen (Der p 1 + Der f 1) levels on the child's mattress aOR 1.0 (95%CI 0.9 to 1.2)
    - a 1 to 2 year old mattress compared with a new mattress was associated with no difference in exposure to dog allergen (Can d 1) levels on the child's mattress aOR 1.0 (95%CI 0.9 to 1.1)
    - a mattress older than 2 years compared with a new mattress was associated with no difference in exposure to dog allergen (Can d 1) levels on the child's mattress aOR 0.9 (95%CI 0.8 to 1.1)
    - a 1 to 2 year old mattress compared with a new mattress was associated with no difference in exposure to dog allergen (Can d 1) levels on the parent's mattress aOR 1.0 (95%CI 0.9 to 1.1)
    - a mattress older than 2 years compared with a new mattress was associated with no difference in exposure to dog allergen (Can d 1) levels on the parent's mattress aOR 0.9 (95%CI 0.8 to 1.1)

    - a 1 to 2 year old mattress compared with a new mattress was associated with no difference in exposure to cat allergen (Fel d 1) levels on the child's mattress aOR 0.9 (95%CI 0.8 to 1.1)
    - a mattress older than 2 years compared with a new mattress was associated with no difference in exposure to cat allergen (Fel d 1) levels on the child's mattress aOR 0.9 (95%CI 0.7 to 1.1)
- This evidence review found high quality evidence from 1 study of 1,753 dwellings showing that
    - a 1 to 2 year old mattress compared with a new mattress was associated with an increase in exposure to house dust mite allergen (Der p 1 + Der f 1) levels on the parent's mattress aOR 1.3 (95%CI 1.0 to 1.7)
    - a mattress older than 2 years compared with a new mattress was associated with an increase in exposure to house dust mite allergen (Der p 1 + Der f 1) levels on the parent's mattress aOR 1.4 (95%CI 1.0 to 1.9)
    - a 1 to 2 year old mattress compared with a new mattress was associated with an increase in exposure to cat allergen (Fel d 1) levels on the child's mattress aOR 1.3 (95%CI 1.0 to 1.7)
    - a mattress older than 2 years compared with a new mattress was associated with an increase in exposure to cat allergen (Fel d 1) levels on the child's mattress aOR 1.4 (95%CI 1.0 to 1.9)

Health-related:

Cardiovascular disease

- No evidence was identified for this prognostic factor

Respiratory disease

- No evidence was identified for this prognostic factor

Neurological disease

- No evidence was identified for this prognostic factor

Allergic disease

- No evidence was identified for this prognostic factor

Disability

- No evidence was identified for this prognostic factor

Pregnancy

- No evidence was identified for this prognostic factor

Building characteristics

Dwelling type for example apartment building, family home (house)

- This evidence review found that living in a house (compared to an apartment) was associated with an increase of:
    - 0.18 μg/m^3 in formaldehyde levels (moderate quality evidence from 1 study of 196 dwellings)
    -

    - 0.35 μg/m^3 in hexanal levels (high quality evidence from 1 study of 196 dwellings)
    - cat allergen (Fel d 1) on the parent's mattress aOR 1.3 (95%CI 1.0 to 1.7) (high quality evidence from 1 study of 1753 dwellings)
- This evidence review found moderate quality evidence from 1 study of 1,753 dwellings showing that living in an apartment was not associated (statistically) with a difference in exposure to
    - house dust mite allergen (Der p 1 + Der f 1) on the child's mattress aOR 1.2 (95%CI 0.9 to 1.6)
    - house dust mite allergen (Der p 1 + Der f 1) on the parent's mattress aOR 1.1 (95%CI 0.8 to 1.5) when compared to not living in an apartment
    - dog allergen (Can d 1) on the child's mattress aOR 1.0 (95%CI 0.8 to 1.2)
    - dog allergen (Can d 1) on the parent's mattress aOR 1.1 (95%CI 0.9 to 1.3)
    - cat allergen (Fel d 1) on the child's mattress aOR 1.1 (95%CI 0.8 to 1.6)

Building age

- This evidence review found that:
    - buildings built between 1920 and 1975 (vs post 1975) were associated with an increase in allergen (Der p 1 + Der f 1) levels on the parent's mattress aOR 1.5 (95%CI 1.2 to 1.9) (high quality evidence from 1 study of 1,753 dwellings)
    - buildings built between 1920 and 1975 (vs post 1975) were associated with an increase in allergen (Fel d 1) levels on the parent's mattress aOR 1.2 (95%CI 1.0 to 1.5) (high quality evidence from 1 study of 1,753 dwellings)
    - buildings built after 1990 were associated with increased levels of formaldehyde (defined as upper formaldehyde level tertile) aOR 3.61 (95%CI 1.09 to 11.98) compared to buildings built before 1975. (high quality evidence from 1 study of 196 dwellings)
    - buildings built before 1960 were associated with increased levels of phthalates (DEHP > 0.770mg/g) aOR 2.30 (95%CI 1.17 to 4.52) compared to after 1983 (moderate quality evidence from 1 study with 346 dwellings)
- This evidence review found that:
    - Buildings built before 1955 were associated with predicted decrease in ERMI (Environmental Relative Moldiness Index) (2.9 units 95%CI 0.4 to 5.4) compared to buildings built after 1985 (moderate quality evidence from 1 study of 176 dwellings)
    - A 15.52 μg/m^3 (reported as 7.56 ppb) decrease in NO_2 levels with increasing age of the building (built before 1980 vs after) (low quality evidence from 1 study of 766 dwellings)
- This evidence review found high quality evidence that there was no difference
    - in levels of formaldehyde (defined as upper formaldehyde level tertile) for buildings built between 1975 and 1990 when compared to buildings built before 1975 aOR 1.26 (95%CI 0.41 to 3.92) (moderate quality evidence from 1 study of 176 individuals)
    - In ERMI for buildings built between 1955 and 1985 when compared to buildings built after 1985 (0.6 units (95%CI -1.8 to 2.9) (moderate quality evidence from 1 study of 176 dwellings)
    - In allergen (Der p 1) for buildings built before 1978 (vs post 1978) GM ratio 1.70 (0.80, 3.61) (moderate quality evidence from 1 study of 355 dwellings)

- In allergen (Der p 1 + Der f 1) on the child's mattress for buildings built between 1920 and 1975 (vs post 1975) aOR 1.1 (95%CI 0.9 to 1.4) (moderate quality evidence from 1 study of 1,753 dwellings)
- In allergen (Der p 1 + Der f 1) on the child's mattress for buildings built before 1920 (vs post 1975) aOR 1.2 (95%CI 0.9 to 1.7) (moderate quality evidence from 1 study of 1,753 dwellings)
- In allergen (Der p 1 + Der f 1) on the parent's mattress for buildings built before 1920 (vs post 1975) aOR 1.3 (95%CI 0.9 to 2.0) (moderate quality evidence from 1 study of 1,753 dwellings)
- In allergen (Can d 1) levels on the child's mattress for buildings built between 1920 and 1975 (vs post 1975) aOR 1.1 (95%CI 0.9 to 1.3) (moderate quality evidence from 1 study of 1,753 dwellings)
- In allergen (Can d 1) levels on the child's mattress for buildings built before 1920 (vs post 1975) aOR 0.9 (95%CI 0.7 to 1.2) (moderate quality evidence from 1 study of 1,753 dwellings)
- In allergen (Can d 1) levels on the parent's mattress for buildings built between 1920 and 1975 (vs post 1975) aOR 1.1 (95%CI 0.9 to 1.3) (moderate quality evidence from 1 study of 1,753 dwellings)
- In allergen (Can d 1) levels on the parent's mattress for buildings built before 1920 (vs post 1975) aOR 1.0 (95%CI 0.7 to 1.2) (moderate quality evidence from 1 study of 1,753 dwellings)
- In allergen (Fel d 1) levels on the child's mattress for buildings built between 1920 and 1975 (vs post 1975) aOR 1.1 (95%CI 0.8 to 1.6) (moderate quality evidence from 1 study of 1,753 dwellings)
- In allergen (Fel d 1) levels on the child's mattress for buildings built before 1920 (vs post 1975) aOR 0.9 (95%CI 0.5 to 1.4) (moderate quality evidence from 1 study of 1,753 dwellings)
- In allergen (Fel d 1) levels on the parent's mattress for buildings built before 1920 (vs post 1975) aOR 1.1 (95%CI 0.8 to 1.6) (moderate quality evidence from 1 study of 1,753 dwellings)
- In phthalates (DEHP > 0.770mg/g) for building built between1960 and 1984 (vs after 1983) aOR 1.09 (95%CI 0.55 to 2.18) (low quality evidence from 1 study with 346 dwellings)

Housing size

- This evidence review found the size of the dwelling was associated with:
  - A two-fold increase in risk aOR 2.07 (95%CI 0.94, 4.58) of having high formaldehyde levels (defined as upper formaldehyde level tertile) with a house size larger than 70 m^2 compared to a house smaller than 70 m^2 (moderate quality evidence from 1 study of 196 dwellings).
  - A 12.64 $\mu g/m^3$ (reported as 6.16 ppb) increase in NO_2 levels per decreasing size of the house (low quality evidence from 1 study of 766 dwellings).
- This evidence review found that the size of the dwelling was associated with a decrease of:
  - 0.01 $\mu g/m^3$ in formaldehyde levels per m^2 increase in room area (high quality evidence from 1 study of 196 dwellings)
  - 0.004 $\mu g/m^3$ in hexanal levels per m^2 increase in room area (moderate quality evidence from 1 study of 196 dwellings)
  - 0.0006 $\mu g/m^3$ in acetyl-aldehyde levels per m^2 increase in room area (moderate quality evidence from 1 study of 196 dwellings)

- 0.123 µg/m^3 (reported as 0.06 ppb) in NO_2 levels per increase in kitchen to bed distance (very low quality evidence from 1 study of 766 dwellings).

Tenancy agreement type (for example rented, short-term or long-term)

- No evidence was identified for this prognostic factor

Location

- This review found low quality evidence that a
  - 36% increase in particulate matter$_{2.5}$ levels was associated with being located within 5km of the city centre compared to a rural area (moderate quality evidence from 1 study of 389 dwellings reported effect size (statistic not stated) = 1.36 (95%CI 1.23 to,1.49)
  - 21% increase in particulate matter$_{2.5}$ levels was associated with being located between 5 and 10 km of the city centre compared to a rural area (moderate quality evidence from 1 study of 389 dwellings reported effect size (statistic not stated) = 1.21 95%CI 1.10 to 1.34).
- This review found low quality evidence that
  - A 4% decrease in particulate matter$_{2.5}$ levels was associated with being in provincial town compared to a rural area (low quality evidence from 1 study of 389 dwellings reported effect size (statistic not stated) = 0.96 95%CI 0.87 to 1.05).

Location – proximity to heavy traffic

- This review found moderate quality evidence from 1 study of 389 dwellings showing that a
  - 77% increase in particulate matter$_{2.5}$ levels was associated with very heavy traffic compared to local traffic area (reported effect size (statistic not stated) = 1.77 (95%CI 1.35 to 2.31)
  - 22% increase in particulate matter$_{2.5}$ levels was associated with heavy traffic compared to local traffic (reported effect size (statistic not stated) = 1.22 (95%CI 1.03 to 1.43)
  - 19% increase in particulate matter$_{2.5}$ levels was associated with some traffic compared to local traffic (reported effect size (statistic not stated) = 1.19 (95%CI 1.07 to 1.32))

Heating - Gas

- This evidence review found that having gas heating was associated with a:
  - 16% increase in NO_2 levels (GM ratio 1.16 (95%CI 0.87 to 1.57) when compared to electric central heating whereas no central heating was associated with a 29% increase in NO_2 levels compared to electric central heating (GM ratio 1.29 (95%CI 1.01 to 1.66) (moderate quality evidence from 1 study of 340 dwellings)
  - 2.58 µg/m^3 increase in NO_2 levels (reported as 6.13 ppb) with gas heating (low quality evidence from 1 study of 150 dwellings)
  - 29.59 µg/m^3 increase in NO_2 levels (reported as 14.4 ppb) with cooker/stove use for heating (high quality evidence from 1 study of 150 dwellings)
  - 9.03 µg/m^3 increase in NO_2 levels (reported as 4.4 ppb) with the use of a gas heater for heating (moderate quality evidence from 1 study of 150 dwellings)
  - 25,43 µg/m^3 increase in NO_2 levels (reported as 12.4 ppb) with gas heating (high quality evidence from 1 study of 150 dwellings)

  - 1.49 times higher level of NO_2 (GM ratio 1.49 (95%CI 1.14 to 1.94) in dwellings with a gas fire (moderate quality evidence from 1 study of 340 dwellings)
- This evidence review found moderate quality evidence from 1 study of 196 dwellings showing that having gas heating was associated with a
  - 0.003 μg/m^3 decrease in formaldehyde levels

Heating - Fireplace / wood burning fire

- This evidence review found that having a fireplace or wood-burning fire was associated with a:
  - 0.26 μg/m^3 increase in formaldehyde levels (moderate quality evidence from 1 study of 196 dwellings)
  - 0.04 μg/m^3 increase in acetyl-aldehyde levels (moderate quality evidence from 1 study of 196 dwellings)
- This evidence review found that having a fireplace or wood-burning fire was associated with
  - A 4.68 μg/m^3 (reported as 2.28 ppb) decrease in NO_2 levels (low quality evidence from 1 study of 766 dwellings)
  - No difference in terms of increased risk of exposure (no levels reported) to particulate matter in the child's bedroom aOR 1.00 (95%CI 0.87 to 1.14) (very low quality evidence from 1 study of 389 dwellings) compared to no use of a fireplace or wood-burning fire

Recent refurbishment or DIY

- This review found that:
  - A 6% decrease in particulate matter$_{2.5}$ levels was associated with current interior rebuilding or renovation (low quality evidence from 1 study of 389 dwellings) compared to no interior rebuilding or renovation.

Integral garage

- This evidence review found very low quality evidence that having an attached garage was associated with a:
  - 1.01 μg/m^3 (reported as 0.49 ppb) increase in NO_2 levels compared to no attached garage. (very low quality evidence from 1 study of 766 dwellings)

Physical condition of the dwelling

- No evidence was identified for this prognostic factor

Wall coverings

- This evidence review found that
  - The use of paint or fibre-cloth wall covering for 1 year or more was associated with increased levels of formaldehyde (defined as upper formaldehyde level tertile) aOR 5.34 (95%CI 1.84, 15.46) compared to no use of these wall coverings (high quality evidence from 1 study of 196 dwellings)
  - The use of paint or fibre-cloth wall covering for less than 1 year was associated with increased levels of formaldehyde (defined as upper formaldehyde level tertile) aOR 5.14 (95%CI 1.76 to 15.03) compared to no use of these wall coverings (high quality evidence from 1 study of 196 dwellings).
  - the use of wallpaper for 1 year or less was associated with a 0.004 μg/m^3 decrease in formaldehyde levels (moderate quality evidence 1 study of 196 dwellings).

Water heating

- This evidence review found high to moderate quality evidence that water heating using
  - Natural gas (vs electric) was associated with an increase of 0.15 µg/m^3 in NO_2 (moderate quality evidence from 1 study of 362 dwellings)
  - Butane gas (vs electric) was associated with an increase of 0.46 µg/m^3 in NO_2 (high quality evidence from 1 study of 362 dwellings)
  - Propane gas (vs electric) was associated with a decrease of 0.09 µg/m^3 in NO_2 (moderate quality evidence from 1 study of 362 dwellings)
  - Oil / diesel (vs electric) was associated with an increase of 0.16 µg/m^3 in NO_2 (moderate quality evidence from 1 study of 362 dwellings)

Brick cladding

- This evidence review found that brick cladding was associated with an 0.155 µg/g) increase in Der p 1 allergen levels on the bed (moderate quality evidence from 1 study of 80 dwellings)

Concrete floor in basement

- This evidence review found very low quality evidence that having a concrete floored basement was associated with a 62% increase in allergen levels (% change 62 (95%CI -6 to180) compared to no concrete floor in the basement (very low quality evidence from 1 study of 111 dwellings)

Flooring - Carpeting

- This evidence review found that carpeting as a floor covering was associated with a:
  - 0.4 µg/m^3 increase in acetyl-aldehyde levels (high quality evidence from 1 study of 196 dwellings).
- This evidence review found that carpeting as a floor covering was associated with a
  - 0.04 µg/m^3 decrease in formaldehyde levels (moderate quality evidence from 1 study of 196 dwellings).
- This evidence review found moderate quality evidence that tufted carpet was not associated with a difference in exposure to house dust mite allergen (Der p 1) when compared to woven carpet (GM ratio 2.34 (95%CI 0.55, 9.03) (moderate quality evidence from 1 study of 355 dwellings)
- This evidence review found moderate quality evidence from 1 study of 1,753 dwellings showing that a carpeted floor in bedrooms was not associated with a difference in exposure to
  - house dust mite allergen (Der p 1 + Der f 1) on child's mattress when compared to no carpet aOR 1.1 (95%CI 0.9 to 1.2)
  - house dust mite allergen (Der p 1 + Der f 1) on parent's mattress when compared to no carpet aOR0.9 (95%CI 0.8 to 1.1)
  - Dog allergen (Can d 1) on child's mattress when compared to no carpet aOR 1.0 (95%CI 0.8 to 1.1)
  - Dog allergen (Can d 1) on parent's mattress when compared to no carpet aOR 0.9 (95%CI 0.7 to 1.1)
  - Cat allergen (Fel d 1) on child's mattress when compared to no carpet aOR 0.9 (95%CI 0.7 to 1.1)

- Cat allergen (Fel d 1) on parent's mattress when compared to no carpet aOR 0.8 (95%CI 0.7 to 0.9)

Flooring - Depth of carpet underlay

- • This evidence review found high quality evidence that thin carpet underlays (less than 8mm) increased the exposure to house dust mite (Der p 1) allergens when compared to thick underlay (8 to 13 mm) (GM ratio 2.90 (95%CI 1.12, 7.46) (high quality evidence from 1 study of 355 dwellings)

Flooring – Pressed wood / parquet

- This evidence review found having wood-pressed or varnished parquet flooring was associated with a:
  - Near four-fold increase in risk aOR 3.70 (95%CI 1.06 to 12.96) of having high formaldehyde levels (defined as upper formaldehyde level tertile) with recent (1 year or less) wood pressed or varnished parquet floor (high quality evidence from 1 study of 196 dwellings)
  - a near two-fold increase in risk aOR 1.98 (95%CI 0.87 to 4.51]) with less recent (1 year or more) wood pressed or varnished parquet floor (moderate quality evidence from 1 study of 196 dwellings)
  - 0.14 $\mu g/m^3$ increase in formaldehyde levels (high quality evidence from 1 study of 196 dwellings)
  - 0.36 $\mu g/m^3$ increase in hexanal levels (high quality evidence from 1 study of 196 dwellings)

Flooring – PVC

- This evidence review found having PVC flooring was associated with
  - A near fourfold increase in risk aOR = 3.85 (95%CI 2.37 to 6.24) of exposure to Phtlatates BBzP > 0.150 mg/g with PVC flooring (Moderate quality evidence from 1 study of 346 dwellings)
  - A near two-fold increase in risk aOR = 1.85 (95%CI 1.15 to 2.98) of exposure to phthalates DEHP > 0.770mg/g with PVC flooring (Moderate quality evidence from 1 study of 346 dwellings)

Insulation

- This evidence review found moderate quality evidence from 1 study of 355 dwellings showing that insulation was not associated with an increase in house dust mite (Der p 1) allergen levels GM ratio = 0.52 (95%CI 0.27 to 1.03)

Ventilation-related factors

Double-glazing

- This evidence review found high quality evidence that double glazing was associated with
  - A near three-fold chance of having increased levels of formaldehyde (defined as upper formaldehyde level tertile) aOR 2.76 (95%CI 1.22 to 6.28) compared to buildings with no double-glazing (high quality evidence from 1 study of 196 dwellings)
- This evidence review found moderate quality evidence that double glazing was not associated with a difference in exposure to

  - house dust mite allergen (Der p 1 + Der f 1) on the child's mattress aOR 0.8 (95%CI 0.7 to 1.0) (moderate quality evidence 1 study of 1,753 dwellings)
  - house dust mite allergen (Der p 1 + Der f 1) on the parent's mattress aOR 0.9 (95%CI 0.7 to 1.0) (moderate quality evidence from 1 study of 1,753 dwellings)
  - dog allergen (Can d 1) on the child's mattress aOR 0.9 (95%CI 0.8 to 1.0) (moderate quality evidence from 1 study of 1,753 dwellings)
  - dog allergen (Can d 1) on the parent's mattress) aOR 0.9 (95%CI 0.8 to 1.0) (moderate quality evidence from 1 study of 1,753 dwellings)
  - cat allergen (Fel d 1) on the child's mattress aOR 0.9 (95%CI 0.7 to 1.1) (moderate quality evidence from 1 study of 1,753 dwellings)
  - cat allergen (Fel d 1) on the parent's mattress aOR 0.9 (95%CI 0.8 to 1.1) (high quality evidence from 1 study of 1,753 dwellings)

Central air conditioning

- This review found high quality evidence that the use of central air conditioning was associated with a decrease in in ERMI score aOR -2.5 units (95%CI -4.7 to -0.4) (high quality evidence from 1 study of 176 individuals)

Mechanical ventilation

- This evidence review found high to moderate quality evidence that an increase:
  - Of 0.22 $\mu g/m^3$ in formaldehyde levels was associated with the use of mechanical ventilation (high quality evidence from 1 study of 196 dwellings)
  - A near two-fold increase aOR 1.74 (95%CI 0.72, 4.21) in the chance of high formaldehyde levels (defined as upper formaldehyde level tertile) with the use of mechanical ventilation (moderate quality evidence from 1 study of 196 dwellings)
- This evidence review found high quality evidence that:
  - A 0.13 $\mu g/m^3$ decrease in acetyl-aldehyde levels was associated with the use of mechanical ventilation (high quality evidence from 1 study of 196 dwellings)
- This evidence review found moderate quality evidence that there was no statistical difference between lack of mechanical ventilation and presence of mechanical ventilation for:
  - house dust mite allergen (Der p 1 + Der f 1) on the child's mattress aOR 0.9 (95%CI (95%CI 0.7 to 1.1) (moderate quality evidence for 1 study of 1,753 dwellings)
  - house dust mite allergen (Der p 1 + Der f 1) on the parent's mattress aOR 1.0 (95%CI (95%CI 0.8 to 1.3) (moderate quality evidence for 1 study of 1,753 dwellings)
  - dog allergen (Can d 1) on the child's bed aOR 0.8 (95%CI (95%CI 0.7 to 1.0) (moderate quality evidence from 1 study of 1,753 dwellings)
  - dog allergen (Can d 1) on the parent's bed aOR 1.0 (95%CI (95%CI 0.9 to 1.1) (moderate quality evidence from 1 study of 1,753 dwellings)
  - cat allergen (Fel d 1) on the child's bed aOR 0.9 (95%CI (95%CI 0.7 to 1.1) (moderate quality evidence from1 study of 1,753 dwellings)
  - cat allergen (Fel d 1) on the parent's bed aOR 1.0 (95%CI (95%CI 0.8 to 1.2) (moderate quality evidence from 1 study of 1,753 dwellings)

Opening windows

- This evidence review found high quality evidence from 1 study of 196 dwellings showing that opening windows for more than 1 hour per day was associated with a reduction in formaldehyde aOR 0.89 (95%CI 0.81 to 0.99)

Extractor fan use

- This evidence review found moderate quality evidence from 1 study of 340 dwellings showing that an increase of:
  - 17% in NO_2 levels was associated with ‘sometimes use’ of extractor fans when cooking (geometric (GM) ratio 1.17 (95%CI 1.03 to 1.33) when compared to always use of the extractor fan when cooking
  - 14% in NO_2 levels was associated with no use of extractor fans when cooking) (GM ratio 1.14 (95%CI 1.01 to 1.29) when compared to always use of the extractor fan when cooking

Moisture (sign of poor ventilation)

- This evidence review found low to moderate evidence that:
  - Visible dampness was associated with a 16% increase in NO_2 levels (GM ratio 1.16 (95%CI 1.01 to 1.37) when compared to no visible dampness (moderate quality evidence from 1 study of 340 dwellings)
  - Water damage was associated with a 22% increase in allergen levels (% change 22 (95%CI -3 to 54) compared to no water damage (very low quality evidence from 1 study of 111 dwellings)
  - Mould in the bathroom was associated with a twofold increase in house dust mite allergen levels (GM ratio 2.11 p = 0.048) (high quality evidence from 1 study with 72 dwellings)
  - Visible mould growth was associated with 0.148 µg/g increase in house dust mite (Der p 1) allergen levels (moderate quality evidence from 1 study of 80 dwellings)
- This evidence review found moderate quality evidence that there was no difference between damp stains anywhere vs no damp stains for:
  - house dust mite allergen (Der p 1 + Der f 1) on the child’s mattress aOR 1.1 (95%CI 1.0 to 1.3) (high quality evidence for 1 study of 1,753 dwellings)
  - house dust mite allergen (Der p 1 + Der f 1) on the parent’s mattress aOR 1.2 (95%CI 0.9 to 1.4) (moderate quality evidence for 1 study of 1,753 dwellings)
  - dog allergen (Can d 1) on the child’s mattress aOR 1.0 (95%CI 0.9 to 1.2) (moderate quality evidence from 1 study of 1,753 dwellings)
  - dog allergen (Can d 1) on the parent’s mattress aOR 0.9 (95%CI 0.8 to 1.0) (moderate quality evidence from 1 study of 1,753 dwellings)
  - cat allergen (Fel d 1) on the child’s mattress aOR 1.1 (95%CI 0.9 to 1.4) (moderate quality evidence from1 study of 1,753 dwellings)
  - cat allergen (Fel d 1) on the parent’s mattress aOR 1.0 (95%CI 0.9 to 1.2) (moderate quality evidence from 1 study of 1,753 dwellings)

Humidity (sign of poor ventilation)

- This evidence review found high quality evidence that humidity was associated with a
  - 0.15 $\mu g/m^3$ increase in formaldehyde levels per 10% increase in humidity (high quality evidence from 1 study of 196 dwellings)
  - 0.01$\mu g/m^3$ increase in hexanal levels per 10% increase in humidity (high quality evidence from 1 study of 196 dwellings)
  - 0.008 $\mu g/m^3$ increase in acetyl-aldehyde levels (high quality evidence from 1 study of 196 dwellings).
- This evidence review found high quality evidence that humidity was associated with a

- 0.02 colony forming units (cfu) /g increase of house dust (Der p1) allergens per 1% increase in relative humidity (high quality evidence from 1 study 80 dwellings)

Dehumidifier use (sign of humidity)

- This evidence review found that dehumidifier use was associated with a 31% decrease in allergen levels (% change -31 (95%CI -49 to -6) compared to no dehumidifier use (low quality evidence from 1 study of 111 dwellings)

Recommendations

Research recommendations

What are the health risks associated with indoor pollutants from building materials in residential properties? See PICO in appendix L.1.1

Rationale and impact

Link to be added

The committee's discussion of the evidence

Interpreting the evidence

The outcomes that matter most

The committee agreed that exposure to different pollutants, such as NO_2, PM, VOCs, PAHs, are associated with negative health outcomes especially when vulnerable groups for example people with pre-existing conditions are considered. The committee agreed that any pollution poses a risk to health and as such considered that any factor associated with any increase in exposure to pollutants regardless of the mechanism of action, were of equal importance. The committee also noted that indoor air quality can be affected by both building and behavioural factors and by interplays between these factors.

The committee noted that some building factors, for example, home size, location, construction materials, storey, age and type of property, identified in the evidence review may not be within the immediate control of many occupiers particularly tenants in local authority, other social or private properties. These occupiers would need to alert the landlord once problems arise as their tenancy agreement may not permit them to do minor repairs, decorate or change furnishings and fittings.

Other factors, such as furnishing, use of fittings and individual behaviours associated with exposure to indoor air pollutants were considered within the control of occupiers but the committee acknowledged that people with limited resources such as those living in deprived areas or with lower socio-economic status may not have the resources to access support or the financial means to pay for repairs. Also, people living in 'fuel poverty' may not be able to take on board the professional advice to avoid heating single rooms at a time or heating the home for specific periods as these behaviours can lead to damp and mould.

The committee were also mindful that some of the associations, such as between double glazing and formaldehyde exposure, could be misinterpreted and these need careful consideration as it is not the double glazing that is the source of the pollution but more the fact that it may not be installed or used correctly.

The committee noted that some of the studies examined some factors such as tenancy status, increased household occupancy, physical condition of the building which could be interpreted as proxies for lower socio-economic status

The quality of the evidence

The committee acknowledged the certainty of the evidence was mixed but also noted that this was largely due to different context in each study, such as differences in populations, in terms of different ages, and the myriad of ways of reporting on the same outcome as well as the variability of methods to measure the different exposures.

The committee noted that there was no evidence for many of the individual factors specified in the review protocol for example age, gender, ethnic groups and so the committee relied on their experience and other review questions for indirect evidence on these factors. The committee noted some studies reported conflicting, for example mattress age and allergen levels, in part because of how the data was split in the analysis. The committee also noted that some studies reported no association with the factors examined and exposure levels. The committee also agreed that some of the significant associations identified in the literature review may be random statistical associations as there was paucity of explanatory information about how these factors, such as brick cladding, impact on indoor air quality. Without any plausible explanation of the association the committee were minded to give less importance to this evidence especially where insufficient detail was reported in the paper for the committee to understand or explain the association. This was also the case where evidence from the same study was unexpected, for example, lower NO2 levels reported for ‘no use of extractor fans’ than ‘sometime use of extractor fans’. The committee discussed the study specific thresholds used in some studies (for example, tertiles or quartiles) and that these may not have any relevance beyond indicating that association between the factors and increased exposure to pollutants.

The committee agreed that other factors associated with poor indoor air quality including the specific mattress type (inner spring) or bedding type (wool) are less common in the UK than in the countries where these studies were carried out and so these factors were not deemed to be relevant.

A limitation the committee considered was the use of subjective measures (for example using self-reported questionnaires rather than objective measurements for exposure. Self-reporting is often limited by recall and subjectivity. The committee agreed that this should be reflected in the quality assessment of the evidence by downgrading if a study used self-reported outcomes.

The committee also noted that the studies used different statistical measures, such as beta coefficients, adjusted Odds Ratios adjusted Risk Ratio and Geometric Mean ratios, and the variables adjusted for was not consistent. This limited the opportunity to pool estimates of the associations between factors of interest and exposure levels. However, a member of the committee highlighted that where point estimates from different studies showed an association but some of the confidence intervals crossed the line of no effect that the latter is a measure of uncertainty which is reflected in the overall certainty. However the committee considered that this doesn’t change the positive association shown in the many of the included studies and this was factored into their decision making.

The building factors considered are likely to be location specific, for which UK data are therefore most relevant. However, data from other countries with similar climates, building regulations and construction materials are likely to add to the general patterns of association. However, the committee noted that even within the UK, there is variation in terms of weather patterns such as colder regions and wetter regions and so the committee were happy to accept evidence from non-UK studies. The committee agreed that limiting this review to countries with broadly similar climates to the UK was unlikely to result in relevant studies being excluded,

The committee noted that or many prognostic data no association was found between building characteristics and exposure level. When discussing the evidence, the topic experts also noted that the relationship between building age and size with more recent homes being smaller in terms of room size and volume.

The committee were also wary that some of the building factors showing an association could be mis-used and reiterated that local context was crucial when using this information. For example, a retired person living on their own who is cash-poor but property rich may be at risk if they cannot afford repairs or only heat some rooms in their home.

Benefits and harms

The committee noted that there are two key considerations in ensuring good air quality in the home. The first step is to avoid or reduce emissions of air pollutants by controlling the sources of the pollutants and the second is to use ventilation strategies to dilute the pollutants.

It is important to recognise causes of poor indoor air pollution as then action can be taken by professionals involved in enforcing standards or where possible by the occupants resulting in good health and wellbeing. If the causes are not recognised or acted upon, they are likely to worsen and could impact on the health of the occupants. The committee accepted that given the evidence of clear associations between exposure to poor air quality and health that any information on sources of indoor air pollutants and way to reduce this exposure would be of health benefit to people living in these conditions. This covers physical health as well as the wider construct of self-esteem and pride in one's home.

The committee identified a list of housing factors for use as a guide. If other factors are also present, then the risk to health is increased. Some of these factors, for example, small floor space, may not be modifiable but, action may be taken to increase ventilation by installing extractor fans. Other factors in the list may be modifiable physical disrepair, for example, by doing remedial work. This information would also be of benefit to those responsible for the upkeep of homes and those with enforcing standards in both construction industry and in enforcing standard in the rented sector. There is also benefit for those involved in planning new residential developments as this the opportunity to ensure that the construction materials specified and are low-emission and that the designs encourage a good ventilation rate.

The committee agreed noted the reduce exposure that was associated with increased ventilation such as use of air-conditioning and opening windows. Also, of interest were factors including moisture or humidity which were associated with increased levels of pollutants. The committee interpreted these as signs of poor ventilation and agreed improving ventilation would remedy these, The committee then noted that the use of dehumidifiers was associated with a decrease in allergen level but agreed that these products should be viewed as a 'sticking plaster' as they do not solve the original issue of poor ventilation.

Evidence showed that some lifestyle or behavioural factors such as vacuuming especially vacuuming frequently, cooking with gas without using an extractor fan, air-drying clothes indoors or using a second-hand mattress were associated with increase in indoor pollutants levels. The committee noted that some of these may be easy to remedy but others (such as air-drying clothes indoors) may be outside the control of some people particularly those on low income.

Evidence also showed that larger properties will have lower pollutant levels than smaller ones because there is more air space to dilute any pollutants. Pollution in smaller dwellings (for example, bedsits or studio flats) where rooms are shared between living and sleeping may be more significant as occupants are exposed to poor indoor air quality for greater proportion of time. Also, smaller dwellings can cope with less moisture than larger ones.

The committee agreed that highlighting sources of pollution may cause anxiety to some people especially if they cannot directly act against them. Topic experts also reiterated that action taken on one pollutant may also inadvertently cause another problem for indoor air quality. For example, if an individual opens the window to reduce exposure to indoor pollutants, they may allow ingress of outdoor air pollution.

The committee were also concerned that there needs to be a balance between the need for airtightness for energy efficiency purposes and need for adequate ventilation. The committee appreciated that improving energy efficiency through airtightness reduces the energy use but also the natural airflow and therefore might lead to increased moisture indoors leading to damp and mould.

The committee highlighted that people, particularly vulnerable people, may be visited by staff from several local authority agencies as well as NHS and social care workers. These visits could be an opportunity for staff to find and report on poor housing conditions, including poor indoor air quality, particularly if there were inspection protocols in place. While there was no published evidence on inspection protocols, the committee heard expert testimony that meters or sensors to measure pollutant levels were becoming increasingly common and could be used alongside visual inspections and checklists. Information on any health risks people face could then be shared, in line with good practice (subject to national and local data sharing arrangements)

Cost effectiveness and resource use

No cost-effectiveness review was conducted for this question as it was not an effectiveness question.

Other factors the committee took into account

The committee noted that the proportion of non-decent homes in the UK housing stock has declined over time but up to 1 in 5 homes in the UK are classed as non-decent. This is broken down by tenure status as follows

- 2.912,000 (19.4%) for owner occupier properties,
- 1,301,000 (26.8%) for private landlord properties,
- 290,000 (11.9% of all stock) for social landlord properties and
- 221,000 properties (13.6% of all stock) for local authority properties.

This means that those who live in privately rented properties are more likely to be exposed to poor indoor air quality as the HHSRS includes consideration of damp/mould, VOC's and combustion products in its ratings

The committee agreed that living in a safe and secure home has a huge impact on health and mental wellbeing. For example, living in a damp home may impact on social interaction as people may be too embarrassed by damp spots and mould to invite friends to visit.

The committee noted that in the UK, home inspections are carried out by the local authority health environmental officer (EHO) if a problem has been identified and reported. There were also concerns that individuals, especially those in vulnerable groups, may not be fully aware of the risks of poor indoor quality at home and ways to ensure good indoor air quality.

This is compounded by the fact that those living in 'socially deprived' areas and properties may also be disadvantaged by other related factors such as overcrowding, lack of facilities including clothes dryers or outdoor space to dry clothes, fuel poverty limiting the occupier's ability to provide constant heating to reduce the risk of damp and mould. Evidence did not directly link overcrowding to socially deprived areas but the committee based on experience felt that this is usually the case. For example, extended families with uncles, aunts, cousins living together or a group of friends living together to save money on rent, people who sofa-surf. The committee noted that overcrowding increased exposure to several pollutants and this would potentially have a negative impact on health.

The committee considered that current best practice on the use existing regulatory powers to ensure homes are safe was an important factor. This will help address health inequalities as many people on a low income or other vulnerable groups live in rented accommodation.

The committee also accepted topic expert advice that awareness of poor indoor air quality and the associated risk to health was low amongst many professionals and so the committee drafted recommendations to raise awareness sources of indoor air pollutants and the advice to give to minimise exposure. The committee stressed that advice should be given in a positive manner so that occupants, especially those on low incomes, are not stigmatised.

The committee also drafted recommendations for local authorities to provide advice to all involved, including occupants, on sources of pollution, how to control emissions if the sources cannot be removed and how to use ventilation appropriately to minimise risk of elevated levels of indoor air pollutants.

The committee also agreed this advice to both professional groups and the general public should include contact details or organisation who can provide support and advice as well as how to seek a referral for a HHSRS assessment.

The clean air strategy 2019 was highlighted. This strategy makes it mandatory for local authorities to use existing air quality strategies or develop new ones to raise awareness of the effects poor indoor air quality.

Based on their experience, the committee agreed that it would be helpful if local authorities regularly checked existing and new strategies to ensure that every opportunity is taken to prioritise air quality at home. This could include checking whether data collected during home visits identifies other neighbouring properties at risk.

The committee noted the lack of evidence on properties other than houses or apartments, for example mobile homes used as a permanent residence, hostels and university accommodation or even residential care, for example nursing homes, care homes and children's homes.

The committee noted that there is little evidence specific to indoor pollutants from building materials. Evidence about exposure level that may be associated with the use of building materials in new and old buildings would improve understanding and inform occupants, designers and architects of these materials and so the committee drafted a research recommendation on this topic,

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Appendices

Appendix A: Review protocols

Review protocol for associations between individual or building characteristics

Field	Content
Review questions	What individual or building factors are associated with increased exposure to poor indoor air quality at home?
Type of review question	Prognosis and risk stratification
Objective of the review	To identify individual and building factors that put people at increased risk of exposure to poor indoor air quality at home.
Eligibility criteria – population	People in all dwellings
Eligibility criteria –prognostic factors	Prognostic factors: Population: Gender Age Socio-economic status Household occupant density Ethnic groups Lifestyle / behavioural: Pet ownership Method of cooking for example use of gas, hoods, extractors or wood Odourisation (for example plug-in air fresheners and candles) Health-related: Cardiovascular disease Respiratory disease Neurological disease Allergic disease Disability Pregnancy Building: Dwelling type for example apartment building, family home (house) Building age Tenancy agreement type (for example rented, short-term or long-term) Location (urban / suburban / rural) – or proximity to traffic Fuel for heating Recent refurbishment or DIY

Field	Content
	Integral garage
Outcomes and prioritisation	Risk ratios, odds ratios of exposure to indoor air pollutants at home defined or reported in the paper
Eligibility criteria – study design	Inclusion: Prospective and retrospective cohort studies where confounders or variables have been addressed. Exclusion: Systematic reviews of observational studies will not be included but may be used as a source of primary studies Cross-sectional studies
Other inclusion exclusion criteria	Inclusion: English language only Published peer-reviewed studies only Studies conducted in developed economies similar to the UK Studies conducted from 1970 onwards Exclusion: Conference abstract, letter, opinion piece, review articles
Proposed sensitivity/sub-group analysis, or meta-regression	Not relevant for this type of review question
Selection process – duplicate screening/selection/analysis	All abstracts will be duplicate screened as a reliability check. Any disagreement will be resolved by discussion, or if necessary, a third independent reviewer. Data extraction and critical appraisal will be checked by a second reviewer. Any disagreements will be resolved by the two reviewers and escalated to a third reviewer if agreement cannot be reached. The inclusion list will be double checked with PHAC to ensure no studies are excluded inappropriately
Information sources – databases	A systematic search of relevant databases will be carried out to identify relevant studies and evidence. Appropriate limits will be applied. Database functionality will be used, where available, to exclude: • Non-English language papers • Animal studies • Editorials, letters, news items and commentaries • Conference abstracts and posters • Theses and dissertations • Duplicates Websites will be browsed or searched to focus on relevant evidence. The bibliographies of relevant reports and findings may also be used to capture evidence. The following databases will be searched: MEDLINE and MEDLINE in Process (OVID)

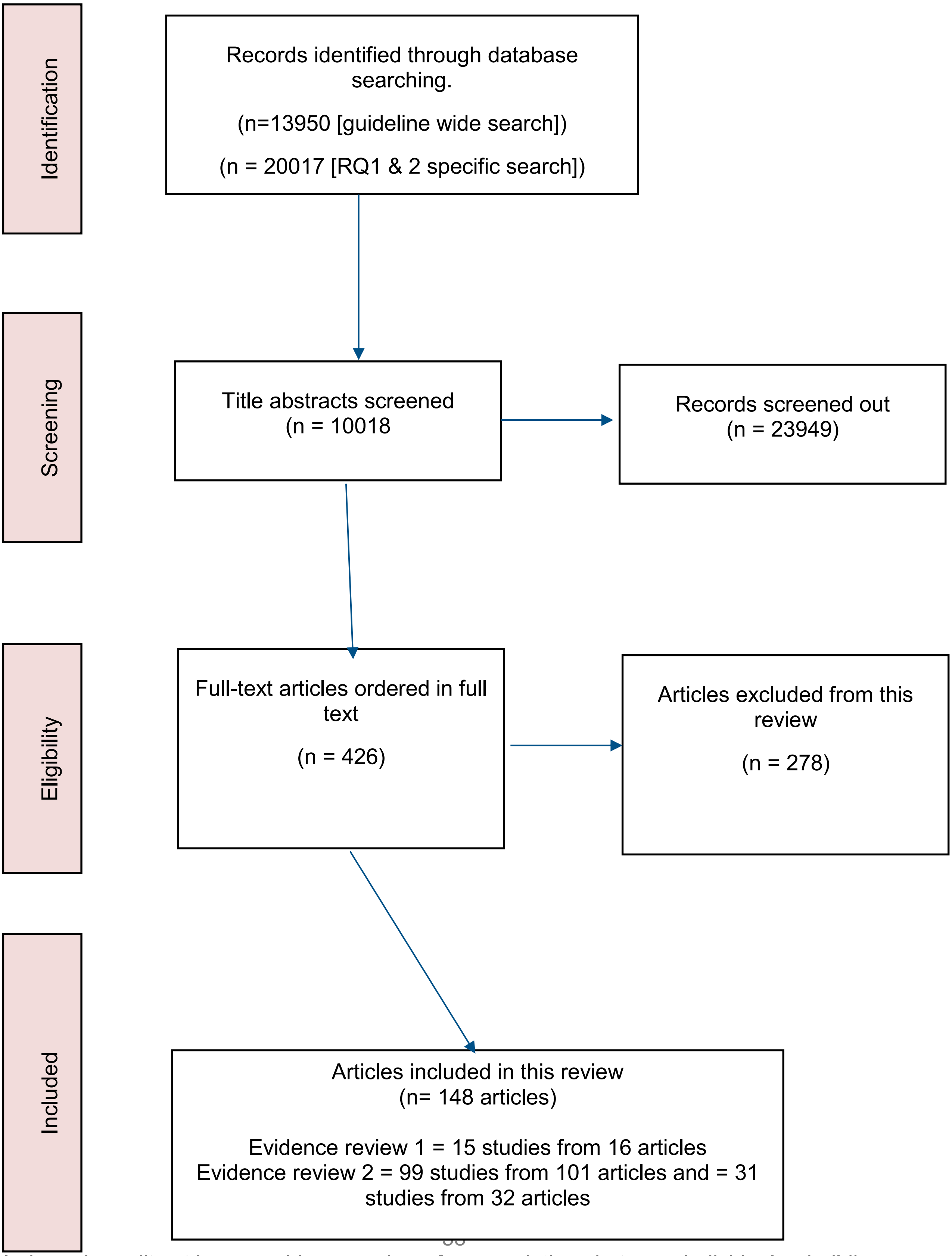
Field	Content
	Embase (OVID) Health Management Information Consortium (HMIC) (OVID) Social Policy and Practice (OVID) CENTRAL (Wiley) Cochrane Database of Systematic Reviews (Wiley) DARE (Wiley) Greenfile (EBSCO) NHS EED (legacy database) (Wiley) EconLit (OVID) OpenGrey Web of Science

Field	Content
	The following websites will be searched: Google and Google scholar (with appropriate limits and looking specifically for reports or evaluations of interventions related to indoor air quality)
Data management (software)	Where feasible data management will be undertaken using EPPI-reviewer software. Where appropriate, quantitative analysis shall be performed using R software Where appropriate, qualitative data will be summarised using an appropriate qualitative synthesis approach, for example, narrative synthesis.
Methods for assessing bias at outcome/study level	The risk of bias across eligible studies will be assessed using the standard methodology checklist for prognostic studies. For details please see section 6.4 of Developing NICE guidelines: the manual The Grading of Recommendations Assessment, Development and Evaluation (short GRADE) developed by the GRADE working group http://www.gradeworkinggroup.org/ will be used to assess the quality of evidence across outcomes. Where necessary, GRADE will be modified to meet the needs of the review question. GRADE-CERQUAL will be used for qualitative findings.
Criteria for quantitative synthesis	Data from eligible studies will be extracted for inclusion in evidence tables. For details please see section 6.4 of Developing NICE guidelines: the manual
Methods of quantitative analysis – combining studies and exploring (in)consistency	Data from eligible studies shall be meta-analysed (combined) if studies are judged to be similar enough in terms of population, prognostic factors, outcomes, study design or risk of bias. Where appropriate, inconsistency will be incorporated by performing random-effect analyses If the studies are found to be too heterogeneous to be pooled statistically, a narrative synthesis will be conducted.
Meta-bias assessment – publication bias, selective reporting bias	For details please see section 6.2 of Developing NICE guidelines: the manual.
Confidence in cumulative evidence	For details please see sections 6.4 and 9.1 of Developing NICE guidelines: the manual

Appendix B: Literature search strategies

Please see search strategies here

Appendix C: Public health evidence study selection



Appendix D: Public health evidence tables

D.1.1 Bornehag 2005 b

Bibliographic reference	Bornehag CG, Lundgren B, Weschler CJ, et al 2005) Phthalates in indoor dust and their association with building characteristics. Environmental health perspectives 113(10), 1399-404
Study design	Nested case control
Objective	To examine associations between the concentration of phthalates in dust from homes and building characteristics.
Setting/Study location	Varmland, Sweden
Number of dwellings and participants	Number of dwellings: 390 Number of participants: 400 participants (198 symptomatic and 202 non-symptomatic)
Selected population	No
Building and Participant characteristics	Building characteristics: Location: unclear Dwelling type: not reported Building age: built before 1960, 45.9%; 1961 to 1983, 40.3%; 1984 onwards, 13.9% Type of ownership/tenancy: not reported Type of ventilation: Natural (including kitchen fan), 65.9%; Mechanical exhaust, 23.8%; mechanical exhaust and supply, 10.2% Flooring material in child's bedroom PVC 211 (54.4) Wood/parquet 120 (30.9) Laminate 39 (10.1) Linoleum 13 (3.4) Wall-to-wall carpet 4 (1.0) Participant characteristics: Not reported
Inclusion criteria	Cases and controls were selected from children participating in a cohort study. Cases had to have reported at least 2 symptoms of the following symptoms within the last 12 months (at the first follow-up assessment): wheezing without a cold, rhinitis without a cold or eczema Controls had to have reported no symptoms at any follow-up period. All participants would not have built their homes because of moisture problems, changed residence since the first follow-up assessment.
Exclusion criteria	Not reported
Building factor/exposure	Phthalates = (n-butyl benzyl phthalate (BBzP) and di(2-ethylhexyl) phthalate (DEHP)
Building factor/exposure assessment	Samples of dust were collected from moldings and shelves in the children's bedroom during heating season from October 2001 to April 2002.
Outcome	Levels of (BBzP) and (DEHP)

Bibliographic reference	**Bornehag CG, Lundgren B, Weschler CJ, et al 2005) Phthalates in indoor dust and their association with building characteristics. Environmental health perspectives 113(10), 1399-404**		
Results	Building characteristics	aOR (95%CI) for BBzP > 0.150 mg/g	aOR (95%CI) for DEHP > 0.770mg/g
	PVC as flooring No Yes	 1.0 3.85 (2.37, 6.24)	 1.0 1.85 (1.15, 2.98)
	Vinyl as wall material No Yes	 1.0 NS	 1.0 NS
	Type of building Single-family house Multifamily house	 1.0 NS	 1.0 NS
	Construction period Before 1960 1960–1983 After 1983	 NS NS 1.0	 2.30 (1.17, 4.52) 1.09 (0.55, 2.18) 1.0
	Ventilation rate in child's bedroom 1st quartile 2nd quartile 3rd quartile 4th quartile	 NS NS NS 1.0	 NS NS NS 1.0
	Water leakage in previous 3 years No Yes	 1.0 1.84 (1.05, 3.22)	 1.0 NS
Follow up	Not reported		
Newcastle-Ottawa Scale	Selection Representativeness of the exposed cohort • selected group – children between the age of 1 and 6 from Varmland, Sweden Selection of the non-exposed cohort • drawn from the same community as the exposed cohort Ascertainment of exposure • Independently assessed (trained inspectors) Demonstration that outcome of interest was not present at start of study • Yes Comparability Comparability of cohorts on the basis of the design or analysis • Analysis was performed adjusting for sex, smoking in the family, and inspector's observations of moisture-related problems. Outcome Assessment of outcome • Objective measures Was follow-up long enough for outcomes to occur		

Bibliographic reference	Bornehag CG, Lundgren B, Weschler CJ, et al 2005) Phthalates in indoor dust and their association with building characteristics. Environmental health perspectives 113(10), 1399-404
	• Yes Adequacy of follow up of cohorts • complete follow up - all subjects accounted for **Overall risk of bias: Low**
Source of funding	**Government:** The Swedish Research council for Environment, Agricultural sciences, and Spatial Planning, **Charity:** Swedish Asthma and Allergy Associations Research foundation, and the Swedish Foundation for Health Care Sciences and Allergy Research, **Industry:** European Council for Plasticisers and Intermediates.
Comments	None

D.1.2 Couper 1998

Bibliographic reference	Couper D, Ponsonby A L, and Dwyer T (1998) Determinants of dust mite allergen concentrations in infant bedrooms in Tasmania. Clinical and experimental allergy: journal of the British Society for Allergy and Clinical Immunology 28(6), 715-23	
Study design	Prospective cohort study	
Objective	To determine if high exposure to house mite allergen during the first year of life increases the risk of subsequent asthma and mite sensitization	
Setting/Study location	Australia	
Number of participants	80 infants (eight sets of twins) from 72 homes.	
Selected population	No	
Participant characteristics	Individual characteristics	
	Age	1 month
	Sex	Not reported
	Race / ethnicity	Not reported
	SES	Not reported
	Building characteristics	Not reported
Inclusion criteria	Infants participating in the TIHS Those babies that were at higher risk of SIDS (scoring system details in the paper) Multiple births were included	
Exclusion criteria	Infants with severe neonatal disease/major congenital abnormality Those infants who would not be resident in Tasmania at 1 month of age Infants for adoption	
Type of pollutant / exposure	Der p 1 and Der f 1 mite allergens	
Pollutant / exposure assessment	Concentration (micrograms of allergen per gram of fine dust) For samples taken from a defined area, the density in micrograms of allergens per square metre was also calculated.	
Outcome	Geometric Mean Ratio (p-value)	

Bibliographic reference	**Couper D, Ponsonby A L, and Dwyer T (1998) Determinants of dust mite allergen concentrations in infant bedrooms in Tasmania. Clinical and experimental allergy: journal of the British Society for Allergy and Clinical Immunology 28(6), 715-23**	
Results	Mould in bathroom	2.11 (0.048)
	Dry washing on outside line	0.26 (0.050)
	≥ 6 occupants	3.42 (0.013)
	Carpet and vacuum<1/week vs no carpet and vacuuming < 1/week	4.79
	Carpet and vacuum ≥1/week vs no carpet and vacuuming < 1/week	10.81
Follow up	Not reported	
Risk of bias (Newcastle-Ottawa Scale)	Selection Representativeness of the exposed cohort • truly representative of the average dwelling in the community Selection of the non-exposed cohort • drawn from the same community as the exposed cohort Ascertainment of exposure • structured interview Demonstration that outcome of interest was not present at start of study • No Comparability Comparability of cohorts on the basis of the design or analysis • study controls for construction material • study controls for any additional factors including location, cleaning behaviours, maternal smoking, floor covering Outcome Assessment of outcome • independent assessment Was follow-up long enough for outcomes to occur • Yes Adequacy of follow up of cohorts • complete follow up - all subjects accounted for **Overall risk of bias: Low**	
Source of funding	Not reported	
Comments	Geometric mean ratio is interpreted as the estimated multiplicative effect of that variable on geometric mean allergen for example mould in bathroom=2.11 means that homes with mould in bathrooms have 2.11 times allergen levels that homes without mould in bathrooms	

D.1.3 Dassonville 2009

Bibliographic reference	**Dassonville C, Demattei C, Laurent AM et al. (2009) Assessment and predictor determination of indoor aldehyde levels in Paris newborn babies' homes. Indoor Air 19 (4): 314-23. doi: 10.1111/j.1600-0668.2009.00594.x**
Study design	Prospective cohort study
Objective	To assess indoor airborne aldehyde levels using passive devices
Setting/Study location	Paris, France
Number of dwellings and participants	Number of dwellings: 196 Number of participants: 196 infants

Bibliographic reference	**Dassonville C, Demattei C, Laurent AM et al. (2009) Assessment and predictor determination of indoor aldehyde levels in Paris newborn babies' homes. Indoor Air 19 (4): 314-23. doi: 10.1111/j.1600-0668.2009.00594.x**
Building and Participant characteristics	Building characteristics: Location: urban and suburban Dwelling type: apartments, 91.8%; houses, 8.2% Building age: before 1945, 39%; 1945 to 1960, 12%; 1961 to 1975, 21%; 1976 to 1990, 10%; >1990, 18%y767yh tyuio0 Type of ownership/tenancy: not reported Double glazing: not reported Fuel for heating/cooking: gas, 58%; electric, 42% Participant characteristics: Age: not reported Smokers living in the property: 58% Allergies: not reported
Inclusion criteria	Dwellings of healthy new-borns, who were participating in a birth cohort study were included. Infants were selected from 5 maternity hospitals in Paris. All infants were singleton full-term new-borns with a birth weight > 2.5 kg and an uncomplicated birth and neonatal period. Parents had to reside in the Paris area or its close suburbs, and mothers had to speak French.
Exclusion criteria	Not reported
Building factor/exposure	Type of house, number of inhabitants, area per room, type of flooring, carpeting, presence of wallpaper, type of heating, fuel for cooking, relative humidity, mechanical ventilation
Building factor/exposure assessment	Building factors were ascertained by asking participants to complete an interviewer-administered questionnaire.
Outcome	Formaldehyde, hexanal and acetaldehyde levels in the infant's bedroom
Results	

Building characteristic	β		
	Form-aldehyde	Hexanal	Acetyl-aldehyde
Type of home			
House vs. apartment	0.18	0.35 a	N/A
Number of inhabitants			
Per person increase	0.06	0.04	0.03
Area per room			
Per m^2 increase	-0.01a	-0.004	-0.0006
Flooring			
Wood pressed products or varnished parquet flooring ≥1 year vs. no	0.14 a	0.36 a	N/A
Carpet present vs. none	-0.04	N/A	0.4
Wallpaper			
Presence of wall paper <1 year vs. no	-0.004	N/A	N/A
Heating			
Wood burning fire at home (yes vs. no)	0.26	N/A	0.04
Gas heating (yes vs. no)	-0.003	N/A	N/A
Central vs. electronic converter	N/A	N/A	-0.03
Fuel for cooking			

Bibliographic reference	**Dassonville C, Demattei C, Laurent AM et al. (2009) Assessment and predictor determination of indoor aldehyde levels in Paris newborn babies' homes. Indoor Air 19 (4): 314-23. doi: 10.1111/j.1600-0668.2009.00594.x**
	Gas cooker (yes vs. no) 0.005 N/A N/A Relative humidity Per 10% increase 0.15 a 0.01 0.008 Type of ventilation Mechanical ventilation (ys vs. no) 0.22 a N/A -0.13 a p<0.05 (statistically significant)
Follow up	1 year
Study methods	Methods: A questionnaire was administered by a trained interviewer at the time of air sampling aldehyde levels in the home. The questionnaire included questions about home characteristics, occupant habits and living conditions. Environmental measurements were performed every 3 months. Aldehyde levels were collected using a passive sampler placed in the infant's bedroom for 7 days. After 7 days of exposure, each sampling cartridge was refrigerated until aldehyde levels were analyses. Detection limits were 0.2 μg/m^3 for acetaldehyde and hexanal, and 0.8 μg/m^3 for formaldehyde. Statistical analysis: Multivariate linear regression
Newcastle-Ottawa Scale	Selection Representativeness of the exposed cohort • selected group – healthy new-borns, delivered at 5 maternity hospitals in Paris Selection of the non-exposed cohort • drawn from the same community as the exposed cohort Ascertainment of exposure • Investigator-administered questionnaire Demonstration that outcome of interest was not present at start of study • No Comparability Comparability of cohorts on the basis of the design or analysis • Yes – authors state that that a Generalised estimating equation linear regression model was produced "taking into account multiple visits with measurement of comfort parameters and CO2" Outcome Assessment of outcome • independent assessment Was follow-up long enough for outcomes to occur • Yes Adequacy of follow up of cohorts • complete follow up - all subjects accounted for **Overall risk of bias: low**
Source of funding	**Government:** This study was supported by the Agence Française de Sécurité Sanitaire Environnementale, and the Institut de Veille Sanitaire
Comments	

D.1.4 Esplugues 2010

Bibliographic reference	**Esplugues A, Ballester F, Estarlich M, et al (2010) Indoor and outdoor concentrations and determinants of NO_2 in a cohort of 1-year-old children in Valencia, Spain. Indoor Air 20(3), 213-223**	
Study design	Retrospective cohort study	
Objective	To assess the main determinants of personal indoor and outdoor NO_2 exposure levels of children 1 year of age	
Setting/Study location	Spain	
Number of participants	360 infants 352 dwellings	
Selected population	No	
Participant characteristics	Individual characteristics	
	Age	1 year
	Sex	Not reported
	Race / ethnicity	Not reported
	SES reported as maternal Social class I II III IV V	 29 (8.24%) 38 (10.80%) 87 (24.72%) 136 (38.64%) 62 (17.61%)
	Building characteristics	
	Location City center Suburban area Country	 289 (82.10%) 55 (15.63%) 8 (2.27%)
	Cooking Electric Natural gas Butane gas Propane gas	 147 (41.76%) 121 (34.38%) 77 (21.88%) 7 (1.99%)
	Type of heating Central heating Space heater Gas space heater Wood burning stove	 124 (36.80%) 188 (55.79%) 13 (3.86%) 12 (3.56%)
	Type of water heater Electric Natural gas Butane gas gas Oil/diesel	 49 (13.92%) 173 (49.15%) 95 (26.99%) 15 (4.26%) 20 (5.68%)
Inclusion criteria	All children 1 year of age in the Valencia cohort	
Exclusion criteria	Not reported	
Type of pollutant / exposure	indoor NO_2	

Bibliographic reference	**Esplugues A, Ballester F, Estarlich M, et al (2010) Indoor and outdoor concentrations and determinants of NO_2 in a cohort of 1-year-old children in Valencia, Spain. Indoor Air 20(3), 213-223**	
Pollutant / exposure assessment	To measure NO_2 levels, box-type passive samplers were installed in the living room. The exposure time for each sampler was 2 weeks.	
Outcome	B coefficient and 95% confidence intervals	
Results		B coefficient (95% CI) in μg/m^3
	Type of cooking range	
	Electric	Reference
	Natural gas vs Electric	0.51 (0.26, 0.77)
	Butane gas vs Electric	0.59 (0.33, 0.86)
	Propane vs Electric gas it was	0.67 (-0.23, 1.57)
	Type of water heater	
	Electric	Reference
	Natural gas 0.35	0.15 (-0.17, 0.48)
	Butane gas 0.00	0.46 (0.16, 0.76)
	Propane gas 0.78	-0.09 (-0.74, 0.56)
	Oil/diesel	0.16 (-0.30, 0.61)
Follow up	1 year	
Risk of bias (Newcastle-Ottawa Scale)	Selection Representativeness of the exposed cohort a) truly representative of the average infant in the community Selection of the non-exposed cohort b) drawn from the same community as the exposed cohort Ascertainment of exposure c) Self-report Demonstration that outcome of interest was not present at start of study d) Yes Comparability Comparability of cohorts on the basis of the design or analysis e) study controls for outdoor NO_2 f) study controls for additional factor – season of sampling Outcome Assessment of outcome g) Objective sampling Was follow-up long enough for outcomes to occur h) Yes Adequacy of follow up of cohorts i) complete follow up - all subjects accounted for j) subjects lost to follow up unlikely to introduce bias - small number lost **Overall risk of bias: Low**	
Source of funding	**Government:** Fondo de Investigaciones Sanitarias, Ministerio de Sanidad y Consumo, Spain, Conselleria de Sanitat Generalitat Valenciana, the Enrique Najera 2006 prize	
Comments		

D.1.5 Garcia-Algar 2003

Bibliographic reference	**Garcia-Algar O, Zapater M, Figueroa, and Vall O (2003) Sources and concentrations of Indoor Nitrogen Dioxide. J Air Waste Manag Assoc 53 (11): 1312-7.**
Study design	Prospective cohort study
Objective	To describe indoor nitrogen dioxide concentrations in Barcelona and evaluate how indoor and outdoor sources of nitrogen dioxide contribute to these levels.
Setting/Study location	Barcelona, Spain
Number of dwellings and participants	Number of dwellings: 340 Number of participants: not reported
Building and Participant characteristics	Building characteristics: Location: urban Dwelling type: not reported Building age: ≤25 years, 30%; >25 years, 70% Type of ownership/tenancy: not reported Double glazing: 84.7% Fuel for heating: gas, 11%; electric, 4.5%; none, 84.5% Participant characteristics: Age: not reported Smokers living in the property: 65% Allergies: not reported
Inclusion criteria	Dwellings were selected from those included in an existing cohort study assessing the effects of pre-and postnatal environmental factors on the development of atopy and asthma. Dwellings were selected from 4 areas within Barcelona, representing 80% of the total extension of the city.
Exclusion criteria	Not reported
Building factor/exposure	Presence of a gas fire, type of central eating, visible dampness, use of an extractor fan, outdoor nitrogen dioxide levels.
Building factor/exposure assessment	Building factors were ascertained by asking participants to complete an interviewer-administered questionnaire.
Outcome	Indoor nitrogen dioxide levels
Results	Building characteristic — Geometric ratio (95% CI) Presence of a gas fire — 1.49 (1.14, 1.94) Type of central heating vs. electric: gas — 1.16 (0.87, 1.57) none — 1.29 (1.01, 1.66) Visible dampness — 1.16 (1.01, 1.37) Per unit increase outdoor NO_2 — 1.01 (1.01, 1.02) Extractor fan use vs. always: sometimes — 1.17 (1.03, 1.33) never — 1.14 (1.01, 1.29)
Follow up	Up to 30 days
Study methods	Methods: An interviewer-administered questionnaire was completed by parents of study participants (new-borns) to determine the characteristics of the homes. Indoor nitrogen dioxide was measured by using a passive filter badge. They were placed on one of the living room walls, 1.7 to 2 metres above the ground, far away from a window or air conditioner. Filter badges were left in the dwellings for 7 to 15 days; after which, they were collected and sent to an

Bibliographic reference	**Garcia-Algar O, Zapater M, Figueroa, and Vall O (2003) Sources and concentrations of Indoor Nitrogen Dioxide. J Air Waste Manag Assoc 53 (11): 1312-7.**
	independent institution for chemical analysis. Outdoor nitrogen dioxide concentrations were obtained from fixed monitoring stations maintained by the local authority (Directorate General for Environmental and Natural Policy). Statistical analysis: The distribution of indoor and outdoor nitrogen dioxide levels (expressed as parts per billion) was best described by the lognormal distribution. Thus, statistical analysis was based on natural log(ln)-transformed data. The geometric mean of indoor and outdoor nitrogen dioxide concentrations was reported. As opposed to the arithmetic mean which considers the sum of numbers, the geometric mean uses multiplication and is defined as the nth root of the product of n numbers. Multiple linear regression was performed to assess associations. It is unclear how predictor variables were chosen and entered into the model.
Newcastle-Ottawa Scale	Selection Representativeness of the exposed cohort • truly representative of the average household in the community Selection of the non-exposed cohort • drawn from the same community as the exposed cohort Ascertainment of exposure • Interviewer administered questionnaire Demonstration that outcome of interest was not present at start of study • No Comparability Comparability of cohorts on the basis of the design or analysis • Unclear what factors were controlled for Outcome Assessment of outcome • independent assessment Was follow-up long enough for outcomes to occur • Yes Adequacy of follow up of cohorts • complete follow up - all subjects accounted for **Overall risk of bias: moderate** (concerns over lack of detail on variable adjusted for)
Source of funding	Not reported
Comments	No additional comments

D.1.6 Garrett 1998

Bibliographic reference	**Garrett M H, Hooper B M, and Hooper M A (1998) Indoor environmental factors associated with house-dust-mite allergen (Der p 1) levels in south-eastern Australian houses. Allergy: European Journal of Allergy and Clinical Immunology 53(11), 1060-1065**
Study design	Prospective cohort
Objective	To investigate indoor environmental factors associated with house-dust- mite-allergen levels Der p 1
Setting/Study location	Australia
Number of participants	148 children (80 dwellings)

Bibliographic reference	**Garrett M H, Hooper B M, and Hooper M A (1998) Indoor environmental factors associated with house-dust-mite allergen (Der p 1) levels in south-eastern Australian houses. Allergy: European Journal of Allergy and Clinical Immunology 53(11), 1060-1065**	
Selected population	No	
Participant characteristics	Individual characteristics	
	Age	Families with children aged 7-14 years
	Sex	Not reported
	Race / ethnicity	Not reported
	SES	Not reported
	Building characteristics	%
	Single family dwellings	100
	Fitted carpets in bedrooms Fitted carpets in living rooms Fitted carpets in kitchens	97 98 6
	Indoor relative humidity of all houses- winter (July) Indoor relative humidity of all houses- early autumn (March-April)	Mean % 53 62
Inclusion criteria	All households contained at least 1 child between 7-14 years old	
Exclusion criteria	Not reported	
Type of pollutant / exposure	Der p 1 allergen	
Pollutant / exposure assessment	Dust samples for assessment of house dust mite allergen (Der p 1) were collected from the beds, bedroom floors and living rooms. Bed samples included dust from pillow, doona (continental pillow), mattress, and blankets. Bedroom floor samples were a mixture of dust from various parts of the floor. Living room samples included dust from the floor and any soft furniture. All samples collected during 2 minute vacuuming of 1.0 m^2	
Outcome	β-coefficient (SE)	
Results	Relative humidity, % Brick cladding Inner-spring mattress Visible mould growth Wool beddings	0.020 (0.006) 0.155 (0.051) 0.250 (0.065) 0.148 (0,052) 0.145 (0.033)
Follow up	First visit March-April 1994 with the following on a 2 monthly cycle finishing in January-February 1995.	
Risk of bias (Newcastle-Ottawa Scale)	Selection Representativeness of the exposed cohort • truly representative of the average dwelling in the community Selection of the non-exposed cohort • drawn from the same community as the exposed cohort Ascertainment of exposure • structured interview	

Bibliographic reference	**Garrett M H, Hooper B M, and Hooper M A (1998) Indoor environmental factors associated with house-dust-mite allergen (Der p 1) levels in south-eastern Australian houses. Allergy: European Journal of Allergy and Clinical Immunology 53(11), 1060-1065**
	Demonstration that outcome of interest was not present at start of study • Yes Comparability Comparability of cohorts on the basis of the design or analysis • study controls for brick cladding Outcome Assessment of outcome • independent assessment Was follow-up long enough for outcomes to occur • Yes Adequacy of follow up of cohorts • complete follow up - all subjects accounted for **Overall risk of bias: Low**
Source of funding	Not reported
Comments	

D.1.7 Hansel 2008

Bibliographic reference	**Hansel NN, Breysse PN, McCormack MC et al. (2008) A longitudinal study of indoor nitrogen dioxide levels and respiratory symptoms in inner-city children with asthma. 116(10):1428-32.**
Study design	Prospective cohort study
Objective	To estimate the effect of indoor NO_2 concentrations on asthma morbidity in an inner-city population while adjusting for other indoor pollutants.
Setting/Study location	Baltimore, USA
Number of dwellings and participants	Number of dwellings: 150 Number of participants: not reported
Building and Participant characteristics	Building characteristics: Not reported Participant characteristics: Allergies: all had asthma
Inclusion criteria	Dwellings of children participating in a cohort study in Baltimore were included. All children were residents of inner-city Baltimore, defined as 9 contiguous ZIP codes. Participants were identified from a random sample of children between 2 and 6 years, with physician diagnosed asthma, who had a healthcare encounter for asthma in the previous 12 months.
Exclusion criteria	Not reported
Building factor/exposure	Gas stove, and gas heater
Building factor/exposure assessment	Building sources and potential sources of indoor nitrogen dioxide were ascertained by asking participants to complete an interviewer-administered questionnaire.
Outcome	Indoor nitrogen dioxide levels
Results	Building characteristic β (95% CI) Gas stove 15.7 (6.9, 24.6) Gas heater 4.4 (-2.8, 11.6)

Bibliographic reference	Hansel NN, Breysse PN, McCormack MC et al. (2008) A longitudinal study of indoor nitrogen dioxide levels and respiratory symptoms in inner-city children with asthma. 116(10):1428-32.
	Space heater use 14.4 (0.8, 28.8) Stove/Oven for heating 12.4 (2.6, 22.2) Risk of asthma symptoms per 20-ppb increase in NO_2. IRR (95% CI) Daytime wheezing, coughing, or chest tightness 1.04 (0.97, 1.12) Slowing activity due to asthma, wheeze, chest tightness, or cough 1.08 (0.94, 1.15) Limited speech due to wheeze 1.17 (1.08, 1.27) Wheeze, cough, or chest tightness while running 1.09 (1.01, 1.17) Coughing without a cold 1.15 (1.07–1.23) Nocturnal awakenings due to cough, wheeze, shortness of breath, or chest tightness 1.12 (1.04, 1.19)
Follow up	6 months
Study methods	Methods: An interviewer-administered questionnaire was completed by parents of study participants to determine the characteristics of the homes and potential sources of nitrogen dioxide. Indoor nitrogen dioxide was measured over a 72 hour period by placing a passive sampler on an elevated surface in the bedroom of each child. Daily ambient nitrogen dioxide levels during the study period were obtained from the US Environmental Protection Agency Air Quality System database. Analysis was performed considering mean ambient nitrogen dioxide as a covariate to ensure that the effects of indoor nitrogen dioxide were independent of ambient levels. Statistical analysis: Multivariate linear regression
Newcastle-Ottawa Scale	Selection Representativeness of the exposed cohort • truly representative of the average household in the community Selection of the non-exposed cohort • drawn from the same community as the exposed cohort Ascertainment of exposure • Interviewer administered questionnaire Demonstration that outcome of interest was not present at start of study • No Comparability Comparability of cohorts on the basis of the design or analysis • Analysis was performed adjusting for season Outcome Assessment of outcome • Independent assessment Was follow-up long enough for outcomes to occur • Yes Adequacy of follow up of cohorts • complete follow up - all subjects accounted for **Overall risk of bias: low**
Source of funding	Not reported
Comments	No additional comments

D.1.8 Jedrychowski 2014

Bibliographic reference	**Jedrychowski WA, Perera FP, Majewska R, et al (2014) Separate and joint effects of tranplacental and postnatal inhalatory exposure to polycyclic aromatic hydrocarbons: prospective birth cohort study on wheezing events. Paediatric pulmonology 49(2), 162-72**	
Study design	Prospective cohort study	
Objective	To compare the impacts of prenatal and postnatal airborne PAH compounds on wheezing events in 4-year old children	
Setting/Study location	Poland	
Number of participants	257 children Number of dwelling: not reported	
Selected population	No	
Participant characteristics	Individual characteristics:	
	Age-Maternal age mean (SD)	27.81 (3.57)
	Gender:	
	Male	126 (49.0%)
	Girls (%)	131 (51.0%)
	Smoking	
	Prenatal ETS	69 (26.8%)
	Postnatal ETS	88 (34.2)
	Race	Not reported
Inclusion criteria	Women between 18 and 35 years of age Non-smokers Singleton pregnancies Without illicit drug use HIV negative Free from chronic diseases such as diabetes or hypertension Resident in Krakow for at least one year prior to pregnancy	
Exclusion criteria	Not reported	
Type of pollutant/exposure	Polycyclic aromatic hydrocarbons (PAHs): pyrene and Σ8PAH non-volatile	
Pollutant/exposure assessment	The monitoring of pregnant women for personal exposure to airborne PAH and fine particles was carried out over a 48-hour period (working days) during the second trimester of pregnancy. The women were instructed by a trained staff member how to use a personal monitor and asked to wear the monitoring device during the daytime hours for two consecutive days and to place it near the bed at night	
Outcome	Wheeze	
Results	Adjusted odds ratios (aORs) and 95% confidence intervals (CIs) for association between PAH exposure and recurrent wheezing reported in children	
		Recurrent wheezing
		aOR (95% CI)
	Prenatal PAH exposure	1.40 (0.97, 2.03)
	Postnatal PAH exposure	1.61 (1.16, 2.24)
	Source of PAH	
	Gas cooker (heating season)	B=0.096 (SE 0.055)
	Gas cooker (non-heating season)	B=0.059 (SE 0.045)
Follow up	4 years	

Bibliographic reference	**Jedrychowski WA, Perera FP, Majewska R, et al (2014) Separate and joint effects of tranplacental and postnatal inhalatory exposure to polycyclic aromatic hydrocarbons: prospective birth cohort study on wheezing events. Paediatric pulmonology 49(2), 162-72**
Risk of bias (Newcastle-Ottawa Scale)	Selection Representativeness of the exposed cohort • truly representative of the average child in the community Selection of the non-exposed cohort • drawn from the same community as the exposed cohort Ascertainment of exposure • Objective sampling Demonstration that outcome of interest was not present at start of study • Yes Comparability Comparability of cohorts on the basis of the design or analysis • study controls for exposure to environmental tobacco smoke • study controls for any additional factor gender of child, season of birth, parity, maternal education, maternal atopy and prenatal or postnatal exposure to PAH Outcome Assessment of outcome • self-report Was follow-up long enough for outcomes to occur • Yes Adequacy of follow up of cohorts • subjects lost to follow up unlikely to introduce bias -, description provided of those lost) **Overall risk of bias: Moderate** (concerns over self-report of outcome)
Source of funding	**Government:** NIEHS **Charity:** Lundin Foundation and the Gladys T. and Roland Harriman Foundation
Comments	

D.1.9 Park 2001

Bibliographic reference	**Park JH, Spiegelman DL, Gold R et al. (2001) Predictors of Airborne Endotoxin in the Home. Environ Health Perspectv 109 (8); PMC1240416**
Study design	Prospective cohort study
Objective	To evaluate what home characteristics are associated with airborne endotoxin levels.
Setting/Study location	Boston, USA
Number of dwellings and participants	Number of dwellings: 111 Number of participants: not reported
Building and Participant characteristics	Building characteristics: Location: urban Dwelling type: 70% apartments Building age: not reported Type of ownership/tenancy: not reported Participant characteristics: Not reported

Bibliographic reference	**Park JH, Spiegelman DL, Gold R et al. (2001) Predictors of Airborne Endotoxin in the Home. Environ Health Perspectv 109 (8); PMC1240416**
Inclusion criteria	Dwellings were selected from those of participants in a birth cohort study that assessed children with parents who had a history of allergies or asthma. This cohort was derived from a daily list of women who had just delivered at a specific hospital and lived in the greater Boston area. Only mothers 18 years or older who did not plan to move within 12 months were included.
Exclusion criteria	New-born babies who were immature (<36 weeks), had major congenital abnormalities, or were receiving neonatal intensive care were excluded.
Building factor/exposure	Dehumidifier use in home, concrete floor in the living room, water damage in home
Building factor/exposure assessment	Building factors were ascertained by asking participants to complete an interviewer-administered questionnaire.
Outcome	Endotoxin levels in the living room
Results	Building characteristic — Percentage change in endotoxin levels relative to “no” category (95% CI) Dehumidifier use — -31 (-49, -6) Water damage in home — 22 (-3, 54) Concrete floor in living room — 62 (-6, 180)
Follow up	Up to 12 months
Study methods	Methods: Each household was visited twice: the first visit was between 2 and 3 months of the child being born, then the second visit was 6 to 8 months after the first visit. At each visit, a detailed questionnaire about the building’s characteristics was administered then dust samples were taken by hoovering 4 specified areas: floor surrounding baby’s crib, bedding in the crib, cushions and arms of the living room sofa, and surfaces in the kitchen as well as around the fridge. Aliquots of the dust samples were then tested for allergens, fungi and endotoxins. Samples were excluded if there were signs contamination that occurred during calibration: when the soap solution in the calibrator was contaminated with bacteria. Statistical analysis: airborne endotoxin levels are best described using the log-normal distribution. Thus, geometric means were calculated and used in analyses. Multivariate regression (not specified but likely to be linear) was performed to assess associations. The model was determined using stepwise backward elimination.
Newcastle-Ottawa Scale	Selection Representativeness of the exposed cohort • selected group – households of children with parents who had a history of allergies Selection of the non-exposed cohort • drawn from the same community as the exposed cohort Ascertainment of exposure • interviewer administered questionnaire Demonstration that outcome of interest was not present at start of study • No Comparability Comparability of cohorts on the basis of the design or analysis • Unclear what factors were controlled for Outcome Assessment of outcome • independent assessment

Bibliographic reference	Park JH, Spiegelman DL, Gold R et al. (2001) Predictors of Airborne Endotoxin in the Home. Environ Health Perspectv 109 (8); PMC1240416
	Was follow-up long enough for outcomes to occur • Yes Adequacy of follow up of cohorts • no statement **Overall risk of bias: High** (concerns over lack of detail on variables adjusted for and adequacy of follow-up)
Source of funding	The study was supported by grants from the National Institute of Environmental Health Sciences (NIEHS)
Comments	None

D.1.10 Raaschou-Nielsen 2011

Bibliographic reference	Raaschou-Nielsen O, Sørensen M, Hertel O et al. (2011) Predictors of indoor fine particulate matter in infants' bedrooms in Denmark. Environ Res. 2011 Jan;111(1):87-93. doi: 10.1016/j.envres.2010.10.007
Study design	Prospective cohort study
Objective	To measure air particulate matter levels in the bedrooms of infants in a Danish birth cohort and to identify and quantify associations between sources and concentrations
Setting/Study location	Copenhagen, Denmark
Number of dwellings and participants	Number of dwellings: 389 Number of participants: 389 infants of mothers with asthma
Building and Participant characteristics	Building characteristics: Location: mixed participants mostly lived within 15 km from the city centre, but some lived up to 90 km away Dwelling type: not reported Building age: not reported Type of ownership/tenancy: not reported Participant characteristics: Not reported
Inclusion criteria	Dwellings were selected from those of participants in a birth cohort study that assessed children with mothers who had a history of asthma.
Exclusion criteria	Not reported
Building factor/exposure	Use of fireplace or wood-burning stove, interior rebuilding or renovation, proximity to traffic, area
Building factor/exposure assessment	Building factors were ascertained by asking participants to complete a self-reported questionnaire as well as by investigator assessments.
Outcome	Fine particulate matter levels (no definition provided)
Results	(see table below)

Building characteristic	Effect estimate (95% CI)
Use of fireplace or wood-burning stove vs no use	1.00 (0.87, 1.14)
Interior rebuilding or renovation	0.94 (0.85, 1.04)
Type of traffic (vs. little traffic):	1.19 (1.07, 1.32)
Some local traffic	1.22 (1.03, 1.43)
Heavy traffic	1.77 (1.35, 2.31)
Very heavy traffic	
Area (vs. rural):	
Provincial town	0.96 (0.87, 1.05)

Bibliographic reference	**Raaschou-Nielsen O, Sørensen M, Hertel O et al. (2011) Predictors of indoor fine particulate matter in infants' bedrooms in Denmark. Environ Res. 2011 Jan;111(1):87-93. doi: 10.1016/j.envres.2010.10.007**
	5-10 km from Copenhagen city centre 1.02 (0.91, 1.15) ≤5 km from Copenhagen city centre 1.12 (1.00, 1.25) NB: Authors did not state what type of effect estimate they were reporting; however, they did state that that estimates should be interpreted as follows: An estimate of 1.77 for very heavy traffic means that particulate matter levels were 77% higher in households near very heavy traffic compared to those in near little traffic.
Follow up	Median of 22 months
Study methods	Methods: Fine particulate matter was measured by trained personnel placing instruments away from windows and doors, preferably at about 1.5 metres above the floor. Measurements were repeated up to 4 times, with the first and last measurements taken at a median of 9 and 22 months, respectively. The median time period between measurements was 6 months. The parents of each infant were asked to complete a questionnaire about their activities in the house and use of household facilities. Study staff noted certain characteristics about the property, such as proximity to traffic. Statistical analysis: multivariate linear regression
Newcastle-Ottawa Scale	Selection Representativeness of the exposed cohort • selected group – households of children with mothers who had asthma Selection of the non-exposed cohort • drawn from the same community as the exposed cohort Ascertainment of exposure • self-reported and investigator assessed Demonstration that outcome of interest was not present at start of study • No Comparability Comparability of cohorts on the basis of the design or analysis • unclear what factors were controlled for Outcome Assessment of outcome • independent assessment Was follow-up long enough for outcomes to occur • Yes Adequacy of follow up of cohorts • no statement **Overall risk of bias: High** (concerns over lack of detail on variables adjusted for and adequacy of follow-up)
Source of funding	This study was funded by the Danish Ministry of the Interior and the Health Research Centre for Environmental Medicine
Comments	None

D.1.11 Reponen 2011

Bibliographic reference	**Reponen T, Vesper S, Levin L, et al (2011) High environmental relative moldiness index during infancy as a predictor of asthma at 7 years of age. Annals of allergy, asthma & immunology : office al publication of the American College of Allergy, Asthma, and & Immunology 107(2), 120-6**	
Study design	Prospective cohort study	
Objective	To assess residential exposure to mould at ages 1 and 7 and association with asthma at 7 years of age	
Setting/Study location	United States	
Number of participants	288 dwellings 176 children	
Selected population	No	
Participant characteristics	Building characteristics: Location: Urban Dwelling type: Not reported Building age: Before 1955 1955 - 1985 After 1985 Type of ownership/tenancy: Individual characteristics: Age: Gender Smoker in home: Race African-American Other	288 Not reported 115 104 69 Not reported 7 years of age 102 (58%) Not reported 66 222
Inclusion criteria	At least 1 parent was atopic	
Exclusion criteria	None reported	
Type of pollutant/exposure	Mould	
Pollutant/exposure assessment	Environmental Relative Moldiness Index (ERMI) (threshold for high=5) Home inspections were carried out by trained 2-person teams and year 1 and year 7. They investigated for presence of mould damage (visual and olfactory) and collected house dust samples for mould exposure assessment. Dust samples were collected by vacuum in the room where the child spent most of their time.	
Outcome	Asthma	
Results	ERMI at 1 year > 5 Central air-conditioning Dust mite sensitization at 7 years	aOR (95% CI) for asthma 2.4 (1.04, 5.73) 0.3 (0.14, 0.83) 4.1 (1.55, 11.07)
	Central air-conditioning (yes v no) Carpet (yes vs. no) Building age: o Before 1955 o 1955 - 1985 o After 1985	Predicted change in ERMI units (95% CI) -2.5 (-4.7, -0.4) -2.1 (-4.4, 0.1) 2.9 (0.4, 5.4) 0.6 (-1.8, 2.9) Reference 2.2 (-0.1, 4.6)

Bibliographic reference	**Reponen T, Vesper S, Levin L, et al (2011) High environmental relative moldiness index during infancy as a predictor of asthma at 7 years of age. Annals of allergy, asthma & immunology : office al publication of the American College of Allergy, Asthma, and & Immunology 107(2), 120-6**
	Dust mite allergen (≥ vs.<Level of detection)
Follow up	7 years
Newcastle-Ottawa Scale	Selection Representativeness of the exposed cohort • truly representative of the average child at high risk of asthma Selection of the non-exposed cohort • drawn from the same community as the exposed cohort Ascertainment of exposure • written self-report Demonstration that outcome of interest was not present at start of study • Yes Comparability Comparability of cohorts on the basis of the design or analysis • study controls for parental asthma • study controls for race, smoking at home, income Outcome Assessment of outcome • independent blind assessment • self-report Was follow-up long enough for outcomes to occur • Yes Adequacy of follow up of cohorts • complete follow up - all subjects accounted for **Overall assessment=Low**
Source of funding	Government: US Department of Housing and Urban Development; National Institute of Environmental Health Sciences; Environmental Protection Agency Asthma Initiative
Comments	Study reports unadjusted OR for building characteristics and high ERMI only Data on building characteristics taken from 2nd publication
Additional reference	Reponen T, Levin L, Zheng S, et al (2013) Family and home characteristics correlate with mold in homes. Environmental research 124, 67-70

D.1.12 Roda 2011

Bibliographic reference	**Roda C, Kousignian I, Guihenneuc-Jouyaux, et al. (2011) Formaldehyde Exposure and Lower Respiratory Infections in Infants: Findings from the PARIS Cohort Study. Environ Health Perspect. 119 (11): 1653–1658.**
Study design	Prospective cohort study
Objective	To determine the impact of formaldehyde exposure on lower respiratory tract infection incidence during the first year of life of infants from a birth cohort.
Setting/Study location	France
Number of dwellings and participants	Number of dwellings: 196 Number of participants: Not reported

Bibliographic reference	**Roda C, Kousignian I, Guihenneuc-Jouyaux, et al. (2011) Formaldehyde Exposure and Lower Respiratory Infections in Infants: Findings from the PARIS Cohort Study. Environ Health Perspect. 119 (11): 1653–1658.**
Building and Participant characteristics	Building characteristics: Location: urban and suburban Dwelling type: apartments, 92.9%; house, 7.1% Building age: constructed before 1975, 72.5%; 1976 to 1990, 11.2%; After 1990, 16.3% Type of ownership/tenancy: not reported Participant characteristics: Sex: not reported Age: not reported Smokers in the household: 23.5% Asthma or allergies in the family: 19.9%
Inclusion criteria	Dwellings of healthy new-borns, who were participating in a birth cohort study were included. Infants were selected from 5 maternity hospitals in Paris. All infants were singleton full-term new-borns with a birth weight > 2.5 kg and an uncomplicated birth and neonatal period. Parents had to reside in the Paris area or its close suburbs, and mothers had to speak French.
Exclusion criteria	Not reported
Building factor/exposure	Age (construction date), housing area, number of occupants, type of wall coating, type of flooring, mechanical ventilation, and double glazing.
Building factor/exposure assessment	Building factors were ascertained by conducting a telephone interview.
Outcome	High formaldehyde levels (defined as the upper formaldehyde level tertile)
Results	

Building characteristic	Odds ratio (95% CI)
Age (Construction date)	
1976 to 1990 vs. before 1975	1.26 (0.41, 3.92)
After 1990 vs. before 1975	3.61 (1.09, 11.98)
Housing area	
>70 m^2 vs. <70 m^2	2.07 (0.94, 4.58)
Number of occupants	
>3 vs. ≤3	2.11 (0.96, 4.64)
Wall coating material	
Paint of fibre cloth for ≥1 year vs. no	5.34 (1.84, 15.46)
Paint of fibre cloth for <1 year vs. no	5.14 (1.76, 15.03)
Flooring material	
Wood pressed products or varnished parquet flooring ≥1 year vs. no	1.98 (0.87, 4.51)
Wood pressed products or varnished parquet flooring <1 year vs. no	3.70 (1.06, 12.86)
Mechanical ventilation	
Present vs. absent	1.74 (0.72, 4.21)
Double glazing	
Present vs. absent	2.76 (1.22, 6.28)
Use of windows	
Open for more than 1 hour	0.89 (0.81, 0.99)

Health outcomes

Bibliographic reference	**Roda C, Kousignian I, Guihenneuc-Jouyaux, et al. (2011) Formaldehyde Exposure and Lower Respiratory Infections in Infants: Findings from the PARIS Cohort Study. Environ Health Perspect. 119 (11): 1653–1658.**
	Per IQR increase in formaldehyde Lower respiratory infections 1.32 (1.11, 1.55) Lower respiratory infections with wheeze 1.41 (1.14, 1.74)
Follow up	1 year
Study methods	Methods: Parents regularly reported health outcomes in mailed self-reported questionnaires derived from previously validated questionnaires such as the Asthma Multicentre infants Cohort Study and French version of the International study of allergies and asthma in childhood. One month after birth, a standardised phone interview was conducted with parents by trained interviewers to determine home characteristics; including, construction date, number of occupants, home surface area, heating and cooking appliances, presence of mechanical ventilation, double glazing, wall and floor coverings, and family living conditions. An environmental questionnaire was then sent every 3 months to ascertain any changes to living environments. Aldehyde air sampling measurements were performed 4 times during the first year of birth. Formaldehyde levels were collected using a passive sampler placed in the bedroom of the infant for 7 days. Statistical analysis: multivariate logistic regression (adjusting for season of declaration)
Newcastle-Ottawa Scale	Selection Representativeness of the exposed cohort • selected group – healthy new-borns, delivered at 5 maternity hospitals in Paris Selection of the non-exposed cohort • drawn from the same community as the exposed cohort Ascertainment of exposure • self-reported Demonstration that outcome of interest was not present at start of study • No Comparability Comparability of cohorts on the basis of the design or analysis • study adjusts for season of declaration Outcome Assessment of outcome • independent assessment Was follow-up long enough for outcomes to occur • Yes Adequacy of follow up of cohorts • complete follow up - all subjects accounted for. Furthermore, multiple imputation was performed to account for any missing data. **Overall risk of bias: Low**
Source of funding	Not reported
Comments	None

D.1.13 Spengler 1996

Bibliographic reference	**Spengler JD, Schwab M, McDermott A, et al. (1996) Nitrogen dioxide and respiratory illness in children. Part IV: Effects of housing and meteorologic factors on indoor nitrogen dioxide concentrations. Res Rep Health Eff Inst. 1996 Dec;(58):1-29; discussion 31-6.**
Study design	Prospective cohort study
Objective	To characterise the influence of housing characteristics and me meteorological factors on nitrogen dioxide concentrations in a sample of houses in Albuquerque
Setting/Study location	Albuquerque, USA
Number of dwellings and participants	Number of dwellings: 766 homes Number of participants: not reported
Building and Participant characteristics	Building characteristics: Location: not reported Dwelling type: not reported Building size: not reported Building age built after 1970, 58.9% Type of ownership/tenancy: not reported Participant characteristics: Not reported
Inclusion criteria	Not reported
Exclusion criteria	Not reported
Building factor/exposure	Range type and pilot lights, size of house, kitchen to bed distance, heating system, age of home, fireplace, electric oven, attached garage, microwave oven
Building factor/exposure assessment	Building factors were ascertained by participant interview and direct observation.
Outcome	Nitrogen dioxide levels (parts per billion)
Results	Building characteristic / β coefficient: Gas cooking range / Electric cooking range Pilot lights: 6.45 [a] / N/A Inverse size of house: 6.16 [a] / 1.87 Kitchen to bed distance: -0.06 / 0.04 Heating system: 6.13 [a] / 3.35 [b] Age of home (built before 1970 vs after): -7.56 [a] / -2.09 [b] Fireplace: -2.28 [b] / -1.57 Electric oven: -2.84 / 0 Attached garage: 0.49 / 0.8 Microwave oven: 1.23 / -0.41 [a] p-value<0.01 [b] p-value<0.05
Follow up	18 months
Study methods	Methods: The sample of households was selected by stratification by type of cooking range (25% electric and 75% gas). In homes with gas ranges, consecutive 2-week samples were obtained in the bedrooms of participants from the time of their enrolment until they reached 18 months of age. During alternative

Bibliographic reference	Spengler JD, Schwab M, McDermott A, et al. (1996) Nitrogen dioxide and respiratory illness in children. Part IV: Effects of housing and meteorologic factors on indoor nitrogen dioxide concentrations. Res Rep Health Eff Inst. 1996 Dec;(58):1-29; discussion 31-6.
	months in the winter 2-week samples were taken in the living room and kitchens. In the homes with electric ranges, samples were taken from the child's bedroom every other 2-week cycle throughout follow-up. No samples were collected in other rooms. Technicians assessed housing characteristics by interview and direct observation. Information was collected on construction characteristics, appliances, and size of the residence. Parents were asked about use of the stove for space heating, and changes in cooking and space heating appliances. Statistical analysis: multivariate linear regression
Newcastle-Ottawa Scale	Selection Representativeness of the exposed cohort • no description of the derivation of the cohort Selection of the non-exposed cohort • no description of the derivation of the non-exposed cohort Ascertainment of exposure • self-reported and investigator assessed Demonstration that outcome of interest was not present at start of study • No Comparability Comparability of cohorts on the basis of the design or analysis • unclear what factors were controlled for Outcome Assessment of outcome • independent assessment Was follow-up long enough for outcomes to occur • Yes Adequacy of follow up of cohorts • no statement **Overall risk of bias: High** (concerns over lack of detail on variables adjusted for and adequacy of follow-up)
Source of funding	The study was funded by the Health Effects Institute (USA)
Comments	No comments

D.1.14 van Strien 2002

Bibliographic reference	van Strien , R T, Koopman L P, Kerkhof M, et al (2002) Mite and pet allergen levels in homes of children born to allergic and nonallergic parents: The PIAMA study. Environmental Health Perspectives 110(11), A693-A698	
Study design	Prospective cohort study	
Objective	To investigate which housing characteristics, influence Der p 1 and Der f 1 concentrations in mattress dust	
Setting/Study location	The Netherlands	
Number of participants	1753 dwellings	
Selected population	No	
Participant characteristics		

Bibliographic reference	**van Strien , R T, Koopman L P, Kerkhof M, et al (2002) Mite and pet allergen levels in homes of children born to allergic and nonallergic parents: The PIAMA study. Environmental Health Perspectives 110(11), A693-A698**	
Inclusion criteria	Pregnant women during the first trimester of pregnancy Self-reported allergies and/or asthma,	
Exclusion criteria	Not reported	
Type of pollutant/exposure	House dust mite allergen	
Pollutant/exposure assessment	Trained fieldworkers took dust samples from the parents' mattress and the child's mattress after the blanket (but not the bottom sheet) was removed, so dust was sampled from the entire upper surface of the sheets, on which the subjects actually slept.	
Outcome	House dust mite allergen levels	
Results	Adjusted odds ratios (aORs) and 95% confidence intervals (CIs)	
	total mite allergen (Der p 1 + Der f 1) on the child's mattress,	
	Allergen avoidance measures taken No vs. yes	1.0 (0.9, 1.2)
	Carpeted bedroom floor Yes vs. no	1.1 (0.9, 1.2)
	Living in apartment Yes vs. no	1.2 (0.9, 1.6)
	Double-glazed windows Yes vs. no	0.8 (0.7, 1.0)
	Age of mattress 1–2 years vs. new	1.1 (0.9, 1.3)
	Age of mattress > 2 years vs. new	1.8 (1.4, 2.2)
	Mechanical ventilation No vs. yes	0.9 (0.7, 1.1)
	Construction period of house 1920–1975 vs. after 1975	1.1 (0.9, 1.4)
	Construction period of house Before 1920 vs. after 1975	1.2 (0.9, 1.7)
	Damp stains (anywhere) Yes vs. no	1.1 (1.0, 1.3)
	total mite allergen (Der p 1 + Der f 1) on the parents' mattress,	
	Allergen avoidance measures taken No vs. yes	1.1 (0.9, 1.3)
	Carpeted bedroom floor Yes vs. no)	0.9 (0.8, 1.1)
	Living in apartment Yes vs. no	1.1 (0.8, 1.5)
	Double-glazed windows Yes vs. no	0.9 (0.7, 1.0)
	Age of mattress 1–2 years vs. new	1.9 (1.5, 2.4
	> 2 years vs. new	1.7 (1.3, 2.2)
	Mechanical ventilation No vs. yes	1.0 (0.8, 1.3)
	Construction period of house 1920–1975 vs. after 1975	1.5 (1.2, 1.9)
	Before 1920 vs. after 1975	1.3 (0.9, 2.0)
	Damp stains (anywhere) Yes vs. no	1.2 (0.9, 1.4)
	Can d 1 on child's mattress	
	Allergen avoidance measures taken No vs. yes	1.0 (0.9, 1.1)
	Carpeted bedroom floor Yes vs. no)	1.0 (0.8, 1.1)
	Living in apartment Yes vs. no	1.0 (0.8, 1.2)
	Double-glazed windows Yes vs. no	0.9 (0.8, 1.0)
	Age of mattress 1–2 years vs. new	1.1 (0.9, 1.2)
	> 2 years vs. new	1.0 (0.9, 1.2)
	Mechanical ventilation No vs. yes	0.8 (0.7, 1.0)
	Construction period of house 1920–1975 vs. after 1975	1.1 (0.9, 1.3
	Before 1920 vs. after 1975	0.9 (0.7, 1.2)

Bibliographic reference	van Strien , R T, Koopman L P, Kerkhof M, et al (2002) Mite and pet allergen levels in homes of children born to allergic and nonallergic parents: The PIAMA study. Environmental Health Perspectives 110(11), A693-A698	
	Damp stains (anywhere) Yes vs. no	1.0 (0.9, 1.2)
	Fel d 1 on child's mattress	
	Allergen avoidance measures taken No vs. yes	1.0 (0.8, 1.3)
	Carpeted bedroom floor Yes vs. no	0.9 (0.7, 1.1)
	Living in apartment Yes vs. no	1.1 (0.8, 1.6)
	Double-glazed windows Yes vs. no	0.9 (0.7, 1.1)
	Age of mattress 1–2 years vs. new	1.3 (1.0, 1.7)
	> 2 years vs. new	1.4 (1.0, 1.9)
	Mechanical ventilation No vs. yes	0.9 (0.7, 1.1)
	Construction period of house 1920–1975 vs. after 1975	1.1 (0.8, 1.5))
	Before 1920 vs. after 1975	0.9 (0.5, 1.4)
	Damp stains (anywhere) Yes vs. no	1.1 (0.9, 1.4)
	Can d 1 on parent's mattress	
	Allergen avoidance measures taken No vs. yes	0.9 (0.8, 1.1)
	Carpeted bedroom floor Yes vs. no)	0.8 (0.7, 0.9)
	Living in apartment Yes vs. no	1.1 (0.9, 1.3)
	Double-glazed windows Yes vs. no	0.9 (0.8, 1.0)
	Age of mattress 1–2 years vs. new	1.0 (0.9, 1.1)
	> 2 years vs. new	0.9 (0.8, 1.1)
	Mechanical ventilation No vs. yes	1.0 (0.9, 1.1)
	Construction period of house 1920–1975 vs. after 1975	1.1 (0.9, 1.3)
	Before 1920 vs. after 1975	1.0 (0.7, 1.2)
	Damp stains (anywhere) Yes vs. no	0.9 (0.8, 1.0)
	Fel d 1 on parent's mattress	
	Allergen avoidance measures taken No vs. yes	0.9 (0.7, 1.1)
	Carpeted bedroom floor Yes vs. no)	0.8 (0.7, 0.9
	Living in apartment Yes vs. no	1.3 (1.0, 1.7)
	Double-glazed windows Yes vs. no	0.9 (0.8, 1.1)
	Age of mattress 1–2 years vs. new	0.9 (0.8, 1.1)
	> 2 years vs. new	0.9 (0.7, 1.1)
	Mechanical ventilation No vs. yes	1.0 (0.8, 1.2)
	Construction period of house 1920–1975 vs. after 1975	1.2 (1.0, 1.5)
	Before 1920 vs. after 1975	1.1 (0.8, 1.6)
	Damp stains (anywhere) Yes vs. no	1.0 (0.9, 1.2)
Follow up	Not reported	
Risk of bias (Newcastle-Ottawa Scale)	Representativeness of the exposed cohort • truly representative of the average dwelling in the community Selection of the non-exposed cohort • drawn from the same community as the exposed cohort Ascertainment of exposure • structured interview Demonstration that outcome of interest was not present at start of study Yes Comparability	

Bibliographic reference	van Strien , R T, Koopman L P, Kerkhof M, et al (2002) Mite and pet allergen levels in homes of children born to allergic and nonallergic parents: The PIAMA study. Environmental Health Perspectives 110(11), A693-A698
	Comparability of cohorts on the basis of the design or analysis • study controls for allergen avoidance measures taken • study controls for additional factors- all other factor in model Outcome Assessment of outcome • Objective measure Was follow-up long enough for outcomes to occur • Yes Adequacy of follow up of cohorts • complete follow up - all subjects accounted for **Overall risk of bias: Low**
Source of funding	Not reported
Comments	

D.1.15 Wickens 2001

Bibliographic reference	Wickens K, Mason K, Fitzharris P, et al (2001) The importance of housing characteristics in determining Der p 1 levels in carpets in New Zealand homes. Clinical and Experimental Allergy 31(6), 827-835	
Study design	Prospective cohort	
Objective	To determine Der p 1 levels over time and relationship with housing characteristics	
Setting/Study location	New Zealand	
Number of participants	355 dwellings	
Selected population	No	
Participant characteristics	Building characteristics	Not reported
Inclusion criteria	Dwellings with dust samples from carpets only at baseline	
Exclusion criteria	Houses with a composite sample form carpets and rugs	
Type of pollutant / exposure	Allergens (Der p 1)	
Pollutant / exposure assessment	Trained technicians collected samples using a vacuum and samples assessed using ELISA methods	
Outcome	Ratio of geometric mean µg/m^2	
Results		Der p 1 levels in whole room sample ratio of geometric mean
	Insulation/room vs other	0.52 (0.27, 1.03)
	Age of house pre-1978 versus post 1978	1.70 (0.80, 3.61)
	Tufted carpet versus woven	2.34 (0.55, 9.03)
	Depth of underlay <8 mm versus 8 to 13mm	2.90 (1.12, 7.46)
	Vacuum motor size – up to 1000 watts versus 1001 watts or greater	1.79 (0.94, 3.42)

Bibliographic reference	**Wickens K, Mason K, Fitzharris P, et al (2001) The importance of housing characteristics in determining Der p 1 levels in carpets in New Zealand homes. Clinical and Experimental Allergy 31(6), 827-835**
Follow up	4 years
Risk of bias (Newcastle-Ottawa Scale)	Selection Representativeness of the exposed cohort • truly representative of the average dwelling in the community Selection of the non-exposed cohort • drawn from the same community as the exposed cohort Ascertainment of exposure • structured interview Demonstration that outcome of interest was not present at start of study • Yes Comparability Comparability of cohorts on the basis of the design or analysis • study controls for carpet type • study controls for additional factors- age of house, insulation/room, vacuum cleaner motor size, depth of underlay Outcome Assessment of outcome • Objective measure Was follow-up long enough for outcomes to occur • Yes Adequacy of follow up of cohorts • complete follow up - all subjects accounted for **Overall risk of bias: Low**
Source of funding	**Government:** Health Research Council of New Zealand **Academic:** University of Otago
Comments	

Appendix E: Forest plots

No forest plots were created for this review

Appendix F: GRADE tables

F.1.1 Population factors

F.1.1.1 Household occupant density

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Formaldehyde									
Per person increase in household									
Dassonville 2009	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	196	β=0.06 (p=0.18)	MODERATE
Number of occupants >3 vs. ≤3									
Roda 2013	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[e]	None	196	aOR=2.11 (0.96, 4.64)	MODERATE
Hexanal									
Per person increase in household									
Dassonville 2009	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	196	β=0.04 (p=0.56)	MODERATE
Acetyl-aldehyde									
Per person increase in household									
Dassonville 2009	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	196	β=0.03 (p=0.5)	MODERATE
HDM allergens									
≥ 6 occupants									
Couper 1998	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[f]	None	72	GM ratio 3,42 (p=0.013)	HIGH

(a) No concerns over risk of bias
(b) Not applicable as only one study included
(c) No concerns over directness

(d) Serious concerns as findings are not statistically significant (p > 0.05)
(e) Serious concerns as findings are not statistically significant (95%CIs cross line of no effect)
(f) No concerns as findings are statistically significant (p < 0.05)

F.1.2 Lifestyle / behavioural factors

F.1.2.1 Method of cooking

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Formaldehyde									
Dassonville 2009	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	196	β=0.005 (p=0.9)	MODERATE
NO_2									
Gas stove									
Hansel 2008	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[e]	None	150	β=15.7 (6.9, 24.6)	HIGH
Pilot light on gas stove									
Spengler 1996	Prospective cohort	Very serious[f]	NA[b]	Not serious[c]	Not serious[g]	None	766	β=6.45 (p<0.01)	LOW
Natural gas vs electric									
Esplugues 2010	Retrospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[e]	None	362	β=0.51 (0.26, 0.77)	HIGH
Butane gas vs electric									
Esplugues 2010	Retrospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[e]	None	362	β=0.59 (0.33, 0.86	HIGH
Propane gas vs electric									
Esplugues 2010	Retrospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[h]	None	362	β=0.67 (-0.23, 1.57	MODERATE
PAHs									
Gas cooker in heating season									
Jedrychowski 2014	Cohort	Serious[a]	NA[b]	Not serious[c]	Serious[d]	None	257	β=0.096 (p=0.084)	LOW

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Gas cooker in non-heating season									
Jedrychowski 2014	Cohort	Serious[a]	NA[b]	Not serious[c]	Serious[d]	None	257	B=0.059 (p=0.194)	LOW

(a) No concerns over risk of bias
(b) Not applicable as only one study included
(c) No concerns over directness
(d) Serious concerns as findings are not statistically significant (p > 0.05)
(e) No concerns as findings are statistically significant (95%Cis do not cross line of no effect)
(f) Very serious concerns due to lack of detail on variables adjusted for and adequacy of follow-up
(g) No concerns as findings are statistically significant (p<0.05)
(h) Serious concerns as findings are not statistically significant (95%CIs cross line of no effect)

F.1.2.2 Vacuuming frequency

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
HDM allergens									
Carpet and vacuum<1/week									
Couper 1998	Prospective cohort	Not serious[g]	NA[b]	Not serious[c]	Serious[d]	None	72	GM ratio=4,75 (p not reported)	MODERATE
Carpet and vacuum >1/week									
Couper 1998	Prospective cohort	Not serious[g]	NA[b]	Not serious[c]	Serious[d]	None	72	GM ratio=10.81 (p not reported	MODERATE

(a) No concerns over risk of bias
(b) Not applicable as only one study included
(c) No concerns over directness
(d) Serious concerns as no variance for point estimate reported

F.1.2.3 Vacuum motor size

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Allergens (Der p 1)									

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
up to 1000 watts versus 1000 watts or greater									
Wickens 2001	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	355	GM ratio =1.79 (0.94, 3.42)	MODERATE

(a) No concerns over risk of bias
(b) Not applicable as only one study included
(c) No concerns over directness
(d) Serious concerns as findings are not statistically significant (95% CIs cross line of no effect

F.1.2.4 Clothes drying

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
HDM allergens									
Dry washing on outside line									
Couper 1998	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	72	GM ratio 0.26 (p=0.050)	MODERATE

(a) No concerns over risk of bias
(b) Not applicable as only one study included
(c) No concerns over directness
(d) Serious concerns as findings are not statistically significant (p=0.05)

F.1.2.5 Allergen avoidance measure taken

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Allergens (Der p 1 + Der f 1) on child's mattress									
Allergen avoidance measures taken (No vs Yes)									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	1753	1.0 (0.9, 1.2)	MODERATE

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Allergens (Der p 1 + Der f 1) on parent's mattress									
Allergen avoidance measures taken (No vs Yes)									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	1753	1.1 (0.9, 1.3)	MODERATE
Allergens (Can d 1) on child's mattress									
Allergen avoidance measures taken (No vs Yes)									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	1753	1.0 (0.9, 1.1)	MODERATE
Allergens (Can d 1) on parent's bed									
Allergen avoidance measures taken (No vs Yes)									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	1753	0.9 (0.8, 1.1)	MODERATE
Allergens (Fel d 1) on child's mattress									
Allergen avoidance measures taken (No vs Yes)									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	1753	1.0 (0.8, 1.3)	MODERATE
Allergens (Fel d 1) on parent's mattress									
Allergen avoidance measures taken (No vs Yes)									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	1753	0.9 (0.7, 1.1)	MODERATE

(a) No concerns over risk of bias
(b) Not applicable as only one study included
(c) No concerns over directness
(d) Serious concerns as findings are not statistically significant (95%CIs cross the line of no effect)

F.1.2.6 Bedding (wool)

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Der p 1 allergens									

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Garrett 1998	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[d]	None	80	β=0.145 (p=0.033)	HIGH

(a) No concerns over risk of bias
(b) Not applicable as only one study included
(c) No concerns over directness
(d) No concerns as findings are statistically significant ($p<0.05$)

F.2.1.1 Mattress type – Inner spring

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Der p 1 allergens									
Garrett 1998	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	80	β=0.250 (p=0,085)	MODERATE

(a) No concerns over risk of bias
(b) Not applicable as only one study included
(c) No concerns over directness
(d) Serious concerns as findings are not statistically significant (p > 0.05)

F.2.1.2 Mattress – age

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Allergens (Der p 1 + Der f 1) on child's mattress									
1 to 2 years old vs new									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	1753	1.1 (0.9, 1.2)	MODERATE
More than 2 years old vs new									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	1753	1.0 (0.9, 1.2)	MODERATE
Allergens (Der p 1 + Der f 1) on parent's mattress									
1 to 2 years old vs new									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[e]	None	1753	1.3 (1.0, 1.7)	HIGH
More than 2 years old vs new									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[e]	None	1753	1.4 (1.0, 1.9)	HIGH
Allergens (Can d 1) on child's mattress									
1 to 2 years old vs new									

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	1753	1.0 (0.9, 1.1)	MODERATE
More than 2 years old vs new									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	1753	0.9 (0.8, 1.1)	MODERATE
Allergens (Can d 1) on Parent's mattress									
1 to 2 years old vs new									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	1753	1.0 (0.9, 1.1)	MODERATE
More than 2 years old vs new									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	1753	0.9 (0.8, 1.1)	MODERATE
Allergens (Fel d 1) on child's mattress									
1 to 2 years old vs new									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[e]	None	1753	1.3 (1.0, 1.7)	HIGH
More than 2 years old vs new									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[e]	None	1753	1.4 (1.0, 1.9)	HIGH
Allergens (Fel d 1) on parent's bed									
1 to 2 years old vs new									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[e]	None	1753	0.9 (0.8, 1.1)	MODERATE
More than 2 years old vs new									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	1753	0.9 (0.7, 1.1)	MODERATE

(a) No concerns over risk of bias
(b) Not applicable as only one study included
(c) No concerns over directness
(d) Serious concerns as findings are not statistically significant (95%CIs cross the line of no effect)
(e) No concerns as findings are statistically significant (95%CIs do not cross the line of no effect)

F.2.2 Building characteristics

F.2.2.1 Dwelling type

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Formaldehyde									
House compared to apartment									
Dassonville 2009	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	196	β=0.18 (p=0.12)	MODERATE
Hexanal									
House compared to apartment									
Dassonville 2009	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	No serious[e]	None	196	β=0.35 (p=0.03)	HIGH
Allergens (Der p 1 + Der f 1) on child's mattress									
Living in an apartment vs not									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[f]	None	1753	1.2 (0.9, 1.6)	MODERATE
Allergens (Der p 1 + Der f 1) on parent's mattress									
Living in an apartment vs not									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[f]	None	1753	1.1 (0.8, 1.5)	MODERATE
Allergens (Can d 1) on child's mattress									
Living in an apartment vs not									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[f]	None	1753	1.0 (0.8, 1.2)	MODERATE
Allergens (Can d 1) on parent's mattress									
Living in an apartment vs not									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[f]	None	1753	1.1 (0.9, 1.3)	MODERATE
Allergens (Fel d 1) on child's mattress									
Living in an apartment vs not									

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[f]	None	1753	1.1 (0.8, 1.6)	MODERATE
Allergens (Fel d 1) on parent's mattress									
Living in an apartment vs not									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[g]	None	1753	1.3 (1.0, 1.7)	HIGH

(a) No concerns over risk of bias
(b) Not applicable as only one study included
(c) No concerns over directness
(d) Serious concerns as findings are not statistically significant (p > 0.05)
(e) No concerns as findings are statistically significant (p<0.05)
(f) Serious concerns as findings are not statistically significant (95%Ci cross line of no effect)
(g) No concerns as findings are statistically significant (95%Ci do not cross line of no effect)

F.2.2.2 Building age

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Formaldehyde									
Building from 1976 to 1990 vs. before 1975 for high formaldehyde levels (defined as the upper formaldehyde level tertile									
Roda 2013	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	196	1.26 (0.41, 3.92)	MODERATE
Buildings from 1990 and newer vs. before 1975 for high formaldehyde levels (defined as the upper formaldehyde level tertile)									
Roda 2013	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[e]	None	196	3.61 (1.09, 11.98)	HIGH
NO_2									
Spengler 1996	Prospective cohort	Very serious[f]	NA[b]	Not serious[c]	Not serious[g]	None	766	β=-7.56 (P<0.01)	LOW
Mould (reported as predicted change in ERMI)									
Building age before 1955 vs after 1985									
Reponen 2011	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	176	2.9 (0.4, 5.4)	MODERATE

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Building age from 1955 to 1985 vs after 1985									
Reponen 2011	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	176	0.6 (-1.8, 2.9)	MODERATE
Allergens (Der p 1)									
Pre 1978 vs post 1978									
Wickens 2001	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	355	GM ratio =1.70 (0.80, 3.61)	MODERATE
Allergens (Der p 1 + Der f 1) on child's mattress									
Construction period of house 1920–1975 vs. after 1975									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	1753	1.1 (0.9, 1.4)	MODERATE
Construction period of house Before 1920 vs. after 1975									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	1753	1.2 (0.9, 1.7)	MODERATE
Allergens (Der p 1 + Der f 1) on parent's mattress									
Construction period of house 1920–1975 vs. after 1975									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[e]	None	1753	1.5 (1.2, 1.9)	HIGH
Construction period of house Before 1920 vs. after 1975									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	1753	1.3 (0.9, 2.0)	MODERATE
Allergens (Can d 1) on child's mattress									
Construction period of house 1920–1975 vs. after 1975									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	1753	1.1 (0.9, 1.3)	MODERATE
Construction period of house Before 1920 vs. after 1975									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	1753	0.9 (0.7, 1.2)	MODERATE
Allergens (Can d 1) on Parent's bed									

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Construction period of house 1920–1975 vs. after 1975									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	1753	1.1 (0.9, 1.3)	MODERATE
Construction period of house Before 1920 vs. after 1975									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	1753	1.0 (0.7, 1.2)	MODERATE
Allergens (Fel d 1) on child's mattress									
Construction period of house 1920–1975 vs. after 1975									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	1753	1.1 (0.8, 1.6)	MODERATE
Construction period of house Before 1920 vs. after 1975									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	1753	0.9 (0.5, 1.4)	MODERATE
Allergens (Fel d 1) on parent's bed									
Construction period of house 1920–1975 vs. after 1975									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[e]	None	1753	1.2 (1.0, 1.5)	HIGH
Construction period of house Before 1920 vs. after 1975									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	1753	1.1 (0.8, 1.6)	MODERATE
Phthalates DEHP > 0.770mg/g									
Built before 1960 vs after 1983									
Bornehag 2005 b	Nested case control	Not serious[a]	NA[b]	Not serious[c]	Not serious[e]	None	346	2.30 (1.17, 4.52)	MODERATE
Built between 1960 and 1983 vs after 1983									
Bornehag 2005 b	Nested case control	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	346	1.09 (0.55, 2.18)	LOW

(a) No concerns over risk of bias
(b) Not applicable as only one study included
(c) No concerns over directness

(d) Serious concerns as findings are not statistically significant (95%Ci cross line of no effect)
(e) No concerns as findings are statistically significant (95%Cis do not cross line of no effect)
(f) Very serious concerns over lack of detail on variables adjusted for and adequacy of follow-up
(g) No concerns as findings are statistically significant (p<0.05)

F.2.2.3 Housing size

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Formaldehyde									
Housing area ->70 m^2 vs. <70 m^2									
Roda 2013	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	196	2.07 (0.94, 4.58)	MODERATE
Per m^2 increase in areas of room									
Dassonville 2009	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[e]	None	196	β=-0.01 (p=0.01)	HIGH
Hexanal									
Per m^2 increase in areas of room									
Dassonville 2009	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[f]	None	196	β=-0.004 (p=0.48)	MODERATE
Acetyl-aldehyde									
Per m^2 increase in areas of room									
Dassonville 2009	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[f]	None	196	β=-0.0006 (p=0.1)	MODERATE
NO_2									
Inverse size of the house									
Spengler 1996	Prospective cohort	Very serious[g]	NA[b]	Not serious[c]	Not serious[e]	None	766	β=6.16 (p<0.01)	LOW
Kitchen to bed distance									
Spengler 1996	Prospective cohort	Very serious[g]	NA[b]	Not serious[c]	Serious[h]	None	766	β=-0.06 (no 95% CI)	VERY LOW

(a) No concerns over risk of bias
(b) Not applicable as only one study included
(c) No concerns over directness

(d) Serious concerns finding are not statistically significant (95%CI cross line of no effect)
(e) No concerns as findings are statistically significant (p<0.05)
(f) Serious concerns as finding are not statistically significant (p > 0.05)
(g) Very serious concerns over risk of bias due to lack of detail on variables adjusted for and adequacy of follow-up
(h) Serious concerns as no variance around point estimate reported

F.2.2.4 Location

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Particulate matter									
Provincial town									
Raaschou-Nielsen 2010	Prospective cohort	Serious[a]	NA[b]	Not serious[c]	Serious[d]	None	389	0.96 (0.87, 1.05)	LOW
Between 5 and 10 km from city centre									
Raaschou-Nielsen 2010	Prospective cohort	Serious[a]	NA[b]	Not serious[c]	Not serious[e]	None	389	1.21 (1.10, 1.34)	MODERATE
Less than 5 km from city centre									
Raaschou-Nielsen 2010	Prospective cohort	Serious[a]	NA[b]	Not serious[c]	Not serious[e]	None	389	1.36 (1.23, 1.49)	MODERATE

(a) Serious concerns over self-report of outcomes
(b) Not applicable as only one study included
(c) No concerns over directness
(d) Serious concerns as findings are not statistically significant (95%CIs cross line of no effect)
(e) No serious concerns as findings are statistically significant (95%CIs do not cross line of no effect)

F.2.2.5 Location – Proximity to traffic

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Particulate matter									
Some local traffic									
Raaschou-Nielsen 2010	Prospective cohort	Serious[a]	NA[b]	Not serious[c]	Not serious[d]	None	389	1.19 (1.07, 1.32)	MODERATE
Heavy traffic									

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Raaschou-Nielsen 2010	Prospective cohort	Serious[a]	NA[b]	Not serious[c]	Not serious[d]	None	389	1.22 (1.03, 1.43)	MODERATE
Very heavy traffic									
Raaschou-Nielsen 2010	Prospective cohort	Serious[a]	NA[b]	Not serious[c]	Not serious[d]	None	389	1.77 (1.35, 2.31)	MODERATE

(a) Serious concerns over self-report of outcomes
(b) Not applicable as only one study included
(c) No concerns over directness
(d) No serious concerns as findings are statistically significant (95%CIs do not cross line of no effect)

F.2.2.6 Heating – Gas

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Formaldehyde									
Dassonville 2009	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	196	β=-0.003 (p=0.9)	MODERATE
NO_2									
Garcia-Algar 2003	Prospective cohort	Serious[e]	NA[b]	Not serious[c]	Not serious[f]	None	340	GM ratio 1.49 (1.14, 1.94)	MODERATE
Garcia-Algar 2003	Prospective cohort	Serious[e]	NA[b]	Not serious[c]	Serious[g]	None	340	GM ratio 1.16 (0.87, 1.57)	MODERATE
Gas heater									
Hansel 2008	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[g]	None	150	β=4.4 (-2.8, 11.6)	MODERATE
Space heater use									
Hansel 2008	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[f]	None	150	β=14.4 (0.8, 28.8)	HIGH
Stove/Oven for heating									
Hansel 2008	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[f]	None	150	β=12.4 (2.6, 22.2)	HIGH
Heating System									

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Spengler 1996	Prospective cohort	Very serious[h]	NA[b]	Not serious[c]	Not serious[i]	None	766	β=6.13 (p<0.01)	LOW
Reported as no gas central heating vs electric convector heating									
Garcia-Algar 2003	Prospective cohort	Serious[a]	NA[b]	Not serious[c]	Not serious[f]	None	340	1.29 (1.01, 1.66)	MODERATE
Reported as gas central heating vs electric convector heating									
Garcia-Algar 2003	Prospective cohort	Serious[a]	NA[b]	Not serious[c]	Not serious[g]	None	340	1.16 (0.87, 1.57)	MODERATE

(a) No concerns over risk of bias
(b) Not applicable as only one study included
(c) No concerns over directness
(d) Serious concerns as findings are not statistically significant (p > 0.05)
(e) Serious concerns over lack of detail on variables adjusted for
(f) No concerns as findings are statistically significant (95%Cis do not cross the line of no effect)
(g) Serious concerns as findings are not statistically significant (95%Cis cross the line of no effect)
(h) Very serious concerns over lack of detail on variables adjusted for and adequacy of follow-up
(i) No concerns as findings are statistically significant (p<0.05)

F.2.2.7 Heating - Fire place / wood burning fire

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Formaldehyde									
Dassonville 2009	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	196	β=0.26 (p=0.17)	MODERATE
Acetyl-aldehyde									
Dassonville 2009	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	196	β=0.04 (p=0.9)	MODERATE
Particulate matter									
Raaschou-Nielsen 2010	Prospective cohort	Very serious[e]	NA[b]	Not serious[c]	Serious[f]	None	389	1.00 (0.87, 1.14)	VERY LOW
NO_2									

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Spengler 1996	Prospective cohort	Very serious[e]	NA[b]	Not serious[c]	Not serious[g]	None	766	β=-2.28 ($p<0.05$)	LOW

(a) No concerns over risk of bias
(b) Not applicable as only one study included
(c) No concerns over directness
(d) Serious as findings are not statistically significant (p > 0.05)
(e) Very serious concerns over risk of bias due to lack of detail on variables adjusted for and adequacy of follow-up
(f) Serious as findings are not statistically significant (95%Cis cross line of no effect)
(g) No concerns as findings are statistically significant (p<0.05)

F.2.2.8 Recent refurbishment or DIY

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Particulate matter									
Current interior rebuilding or renovation									
Raaschou-Nielsen 2010	Prospective cohort	Serious[a]	NA[b]	Not serious[c]	Serious[d]	None	389	0.94 (0.85, 1.04)	LOW

(a) Serious concerns over self-report of outcomes
(b) Not applicable as only one study included
(c) No concerns over directness
(d) Serious concerns as the findings are not statistically significant (95%Cis cross the line of no effect)

F.2.2.9 Integral garage

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
NO_2									
Spengler 1996	Prospective cohort	Very serious[a]	NA[b]	Not serious[c]	Serious[d]	None	766	β=0.49 ($p > 0.05$)	VERY LOW

(a) Very serious concerns over lack of detail on variables adjusted for and adequacy of follow-up
(b) Not applicable as only one study included
(c) No concerns over directness
(d) Serious concerns as findings are not statistically significant (p > 0.05)

F.2.2.10 Wall coverings

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Formaldehyde									
Paint or fibre cloth for ≥1 year vs. no									
Roda 2013	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[d]	None	196	5.34 (1.84, 15.46)	HIGH
Paint or fibre cloth for <1 year vs. no									
Roda 2013	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[d]	None	196	5.14 (1.76, 15.03)	HIGH
Formaldehyde									
Wall paper for less than 1 year									
Dassonville 2009	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[e]	None	196	β=-0.004 (p=0.9)	MODERATE

(a) No concerns over risk of bias
(b) Not applicable as only one study included
(c) No concerns over directness
(d) No concerns as findings are statistically significant (95%CI intervals do not cross the line of no effect)
(e) Serious concerns as findings are not statistically significant ($p > 0.05$)

F.2.2.11 Water heating

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
NO_2									
Natural gas vs electric									
Esplugues 2010	Retrospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	362	β=0.15 (-0.17, 0.48)	MODERATE
Butane gas vs electric									
Esplugues 2010	Retrospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[e]	None	362	β=0.46 (0.16, 0.76)	HIGH
Propane gas vs electric									
Esplugues 2010	Retrospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	362	β=-0.09 (-0.74, 0.56)	MODERATE

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Oil / diesel vs electric									
Esplugues 2010	Retrospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	362	β=0.16 (-0.30, 0.61)	MODERATE

(a) No concerns over risk of bias
(b) Not applicable as only one study included
(c) No concerns over directness
(d) Serious concerns as findings are not statistically significant (95%CIs cross line of no effect)
(e) No concerns as findings are statistically significant (95%Cis do not cross line of no effect)

F.2.2.12 Brick cladding

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Der p 1 allergens									
Garrett 1998	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	80	β=0.155 (p=0.051)	MODERATE

(a) No concerns over risk of bias
(b) Not applicable as only one study included
(c) No concerns over directness
(d) Serious concerns as findings are not statistically significant ($p > 0.05$)

F.2.2.13 Concrete floor in basement

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Allergens									
Park 2001	Prospective cohort	Very serious[a]	NA[b]	Not serious[c]	Serious[d]	None	111	% change=62 (-6, 180)	VERY LOW

(a) Serious concerns over lack of detail on variables adjusted for and adequacy of follow-up
(b) Not applicable as only one study included
(c) No concerns over directness
(d) Serious concerns as findings are not statistically significant (95%Cis cross the line of no effect)

F.2.2.14 Flooring - Carpeting

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Formaldehyde									
Dassonville 2009	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	196	β=- 0.04 (p=0.5)	MODERATE
Acetyl-aldehyde									
Dassonville 2009	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[e]	None	196	β=0.4 (p=0.01)	HIGH
Allergens (Der p 1)									
Tufted carpet vs woven									
Wickens 2001	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[f]	None	355	GM ratio =2.34 (0.55, 9.03)	MODERATE
Allergens (Der p 1 + Der f 1) on child's mattress									
Carpeted bedroom floor vs not									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[f]	None	1753	1.1 (0.9, 1.2)	MODERATE
Allergens (Der p 1 + Der f 1) on parent's mattress									
Carpeted bedroom floor vs not									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[f]	None	1753	0.9 (0.8, 1.1)	MODERATE
Allergens (Can d 1) on child's mattress									
Carpeted bedroom floor vs not									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[f]	None	1753	1.0 (0.8, 1.1)	MODERATE
Allergens (Can d 1) on parent's mattress									
Carpeted bedroom floor vs not									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[f]	None	1753	0.9 (0.7, 1.1)	MODERATE
Allergens (Fel d 1) on child's mattress									
Carpeted bedroom floor vs not									

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[f]	None	1753	0.9 (0.7, 1.1)	MODERATE
Allergens (Fel d 1) on parent's mattress									
Carpeted bedroom floor									
Van Strien 2002	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[g]	None	1753	0.8 (0.7, 0.9)	HIGH

(a) No concerns over risk of bias
(b) Not applicable as only one study included
(c) No concerns over directness
(d) Serious concerns as findings are not statistically significant ($p \geq 0.05$)
(e) No concerns as findings are statistically significant ($p<0.05$)
(f) Serious concerns as findings are not statistically significant (95%CIs cross line of no effect)
(g) No concerns as findings are statistically significant (95%Cis do not cross the line of no effect)

F.2.2.15 Flooring - Depth of carpet underlay

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Allergens (Der p 1)									
Less than 8 mm versus 8 to 13mm									
Wickens 2001	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[d]	None	355	GM ratio =2.90 (1.12, 7.46)	HIGH

(a) No concerns over risk of bias
(b) Not applicable as only one study included
(c) No concerns over directness
(d) No concerns as findings are statistically significant (95% CIs do not cross line of no effect)

F.2.2.16 Flooring - Wood pressed products or varnished parquet flooring

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Formaldehyde									
For 1 year or more vs. no									

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Dassonville 2009	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[d]	None	196	β=0.14 (P=0.008)	HIGH
Roda 2013	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[e]	None	196	1.98 (0.87, 4.51)	MODERATE
For less than 1 year vs. no									
Roda 2011	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[f]	None	196	3.70 (1.06, 12.86)	HIGH
Hexanal									
Dassonville 2009	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[d]	None	196	β=0.36 (P=0.007)	HIGH

(a) No concerns over risk of bias
(b) Not applicable as only one study included
(c) No concerns over directness
(d) No concerns as findings are statistically significant (p<0.05)
(e) Serious concerns as findings are not statistically significant (95% Ci cross line of no effect)
(f) No concerns as findings are statistically significant (95%Ci do not cross line of no effect)

F.2.2.17 Flooring – PVC

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Phthalates									
BBzP > 0.150 mg/g									
Bornehag 2005 b	Nested case control	Not serious[e]	NA[b]	Not serious[c]	Not serious[d]	None	346	3.85 (2.37, 6.24)	MODERATE
DEHP > 0.770mg/g									
Bornehag 2005 b	Nested case control	Not serious[e]	NA[b]	Not serious[c]	Not serious[d]	None	346	1.85 (1.15, 2.98)	MODERATE

(a) No concerns over risk of bias
(b) Not applicable as only one study included
(c) No concerns over directness
(d) No concerns as findings are statistically significant (95% Cis do not cross line of no effect)

F.2.2.18 Insulation

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Allergens (Der p 1)									
Insulation / room vs other									
Wickens 2001	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[d]	None	355	GM ratio 0.52 (0.27, 1.03)	MODERATE

(a) No concerns over risk of bias
(b) Not applicable as only one study included
(c) No concerns over directness
(d) Serious concerns as findings are not statistically significant (95% CIs cross lie of no effect)

F.2.3 Ventilation-related factors

F.2.3.1 Double glazing

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Formaldehyde									
Roda 2013	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[d]	None	196	2.76 (1.22, 6.28)	HIGH
Allergens (Der p 1 + Der f 1) on child's mattress									
Double glazing vs none									
Van Strien 2002	Prospective cohort	Not serious[e]	NA[b]	Not serious[c]	Serious[e]	None	1753	0.8 (0.7, 1.0)	MODERATE
Allergens (Der p 1 + Der f 1) on parent's mattress									
Double glazing vs none									
Van Strien 2002	Prospective cohort	Not serious[e]	NA[b]	Not serious[c]	Serious[e]	None	1753	0.9 (0.7, 1.0)	MODERATE

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Allergens Can d 1) on child's mattress									
Double glazing vs none									
Van Strien 2002	Prospective cohort	Not serious[e]	NA[b]	Not serious[c]	Serious[e]	None	1753	0.9 (0.8, 1.0)	MODERATE
Allergens Can d 1) on parent's mattress									
Double glazing vs none									
Van Strien 2002	Prospective cohort	Not serious[e]	NA[b]	Not serious[c]	Serious[e]	None	1753	0.9 (0.8, 1.0)	MODERATE
Allergens (Fel d 1) on child's mattress									
Double glazing vs none									
Van Strien 2002	Prospective cohort	Not serious[e]	NA[b]	Not serious[c]	Serious[e]	None	1753	0.9 (0.7, 1.1)	MODERATE
Allergens (Fel d 1) on parent's mattress									
Double glazing vs none									
Van Strien 2002	Prospective cohort	Not serious[e]	NA[b]	Not serious[c]	Serious[e]	None	1753	0.9 (0.8, 1.1)	MODERATE

(a) No concerns over risk of bias
(b) Not applicable as only one study included
(c) No concerns over directness
(d) No concerns as findings are statistically significant (95%Cis do not cross the line of no effect)
(e) Serious concerns as findings are statistically significant (95%CIs cross the line of no effect)

F.2.3.2 Central air conditioning

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Mould									
Central air conditioning vs No central air conditioning									
Reponen 2011	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[d]	None	176	-2.5 (-4.7, -0.4)	HIGH

(a) No concerns over risk of bias
(b) Not applicable as only one study included
(c) No concerns over directness
(d) No serious concerns as findings are statistically significant (95%CIs do not cross line of no effect)

F.2.3.3 Mechanical ventilation

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Formaldehyde									
Mechanical ventilation									
Dassonville 2009	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[d]	None	196	β=0.22 (p=0.002)	HIGH
Roda 2013	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Serious[e]	None	196	1.74 (0.72, 4.21)	MODERATE
Acetyl-aldehyde									
Mechanical ventilation									
Dassonville 2009	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[d]	None	196	β=-0.13 (p=0.04)	HIGH
Allergens (Der p 1 + Der f 1) on child's mattress									
No mechanical ventilation vs mechanical ventilation									
Van Strien 2002	Prospective cohort	Not serious[e]	NA[b]	Not serious[c]	Serious[e]	None	1753	0.9 (0.7, 1.1)	MODERATE
Allergens (Der p 1 + Der f 1) on parent's mattress									
No mechanical ventilation vs mechanical ventilation									
Van Strien 2002	Prospective cohort	Not serious[e]	NA[b]	Not serious[c]	Serious[e]	None	1753	1.0 (0.8, 1.3)	MODERATE
Allergens (Can d 1) on child's bed									
No mechanical ventilation vs mechanical ventilation									
Van Strien 2002	Prospective cohort	Not serious[e]	NA[b]	Not serious[c]	Serious[e]	None	1753	0.8 (0.7, 1.0)	MODERATE
Allergens (Can d 1) on parent's bed									
No mechanical ventilation vs mechanical ventilation									

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Van Strien 2002	Prospective cohort	Not serious[e]	NA[b]	Not serious[c]	Serious[e]	None	1753	1.0 (0.9, 1.1)	MODERATE
Allergens (Fel d 1) on child's bed									
No mechanical ventilation vs mechanical ventilation									
Van Strien 2002	Prospective cohort	Not serious[e]	NA[b]	Not serious[c]	Serious[e]	None	1753	0.9 (0.7, 1.1)	MODERATE
Allergens (Fel d 1) on parent's bed									
No mechanical ventilation vs mechanical ventilation									
Van Strien 2002	Prospective cohort	Not serious[e]	NA[b]	Not serious[c]	Serious[e]	None	1753	1.0 (0.8, 1.2)	MODERATE

(a) No concerns over risk of bias
(b) Not applicable as only one study included
(c) No concerns over directness
(d) No concerns as findings are statistically significant (p<0.05)
(e) Serious concerns as findings are not statistically significant (95%Cis cross the line of no effect)
(f) Serious concerns as findings are not statistically significant (p > 0.05)

F.2.3.4 Opening windows

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Formaldehyde									
Window open more than 1 hour per day									
Roda 2013	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[d]	None	196	0.89 (0.81, 0.99)	HIGH

(a) No concerns over risk of bias
(b) Not applicable as only one study included
(c) No concerns over directness
(d) No concerns as findings are statistically significant (85%CIs do not cross the line of no effect)

F.2.3.5 Extractor fan use

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
NO_2									
Sometimes use of extractor fan vs always									
Garcia-Algar 2003	Prospective cohort	Serious[a]	NA[b]	Not serious[c]	Not serious[d]	None	340	1.17 (1.03, 1.33)	MODERATE
No use of extractor fan vs always									
Garcia-Algar 2003	Prospective cohort	Serious[a]	NA[b]	Not serious[c]	Not serious[d]	None	340	1.14 (1.01, 1.29)	MODERATE

(a) Serious concerns over lack of detail on variable adjusted for
(b) Not applicable as only one study included
(c) No concerns over directness
(d) No concerns as findings are statistically significant (95%CIs do not cross line of no effect)

F.2.3.6 Moisture

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
NO_2									
Visible dampness									
Garcia-Algar 2003	Prospective cohort	Serious[a]	NA[b]	Not serious[c]	Not serious[d]	None	340	GM ratio = 1.16 (1.01, 1.37)	MODERATE
Allergens									
Water damage in home									
Park 2001	Prospective cohort	Very serious[e]	NA[b]	Not serious[c]	Serious[f]	None	111	% change=22 (-3, 54)	VERY LOW
House Dust Mite allergens									
Mould in bathroom									
Couper 1998	Prospective cohort	Not serious[g]	NA[b]	Not serious[c]	Not serious[h]	None	72	GM ratio=2.11 (p=0.048)	HIGH

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Der p 1 allergens									
Visible mould growth									
Garrett 1998	Prospective cohort	Not serious[g]	NA[b]	Not serious[c]	Serious[i]	None	80	β=0.148 (p=0.052)	MODERATE
Allergens (Der p 1 + Der f 1) on child's mattress									
Damp stains anywhere (yes vs no)									
Van Strien 2002	Prospective cohort	Not serious[g]	NA[b]	Not serious[c]	Not serious[d]	None	1753	1.1 (1.0, 1.3)	HIGH
Allergens (Der p 1 + Der f 1) on parent's mattress									
Damp stains anywhere (yes vs no)									
Van Strien 2002	Prospective cohort	Not serious[g]	NA[b]	Not serious[c]	Serious[f]	None	1753	1.2 (0.9, 1.4)	MODERATE
Allergens (Can d 1) on child's mattress									
Damp stains anywhere (yes vs no)									
Van Strien 2002	Prospective cohort	Not serious[g]	NA[b]	Not serious[c]	Serious[f]	None	1753	1.0 (0.9, 1.2)	MODERATE
Allergens (Can d 1) on parent's mattress									
Damp stains anywhere (yes vs no)									
Van Strien 2002	Prospective cohort	Not serious[g]	NA[b]	Not serious[c]	Serious[f]	None	1753	0.9 (0.8, 1.0)	MODERATE
Allergens (Fel d 1) on child's mattress									
Damp stains anywhere (yes vs no)									
Van Strien 2002	Prospective cohort	Not serious[g]	NA[b]	Not serious[c]	Serious[f]	None	1753	1.1 (0.9, 1.4)	MODERATE
Allergens (Fel d 1) on parent's mattress									
Damp stains anywhere (yes vs no)									
Van Strien 2002	Prospective cohort	Not serious[g]	NA[b]	Not serious[c]	Serious[f]	None	1753	1.0 (0.9, 1.2)	MODERATE

(a) Serious concerns over lack of detail on variable adjusted for

(b) Not applicable as only one study included
(c) No concerns over directness
(d) No concerns as findings are statistically significant (95%Cis do not cross the line of no effect)
(e) Very serious concerns over lack of detail on variables adjusted for and adequacy of follow-up
(f) Serious concerns as findings are not statistically significant (95%Cis cross the line of no effect)
(g) No concerns over risk of bias
(h) No concerns as findings are statistically significant (p<0.05)
(i) Serious concerns as findings are not statistically significant (p > 0.05)

F.2.3.7 Humidity

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Formaldehyde									
Per 10% increase in humidity									
Dassonville 2009	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[d]	None	196	β=0.15 (p<0.001)	HIGH
Hexanal									
Per 10% increase in humidity									
Dassonville 2009	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[d]	None	196	β=0.01 (p=0.006)	HIGH
Acetyl-aldehyde									
Per 10% increase in humidity									
Dassonville 2009	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[d]	None	196	β=0.008 (p=0.004)	HIGH
House dust mite allergen loading									
Der p 1 allergen									
Relative humidity (%)									
Garrett 1998	Prospective cohort	Not serious[a]	NA[b]	Not serious[c]	Not serious[d]	None	80	β=0.020 (p=0.006)	HIGH

(a) No concerns over risk of bias
(b) Not applicable as only one study included
(c) No concerns over directness
(d) No concerns as findings are statistically significant (p<0.05)

F.2.3.8 Water leakage

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Phthalates BBzP > 0.150 mg/g									
Water leakage in previous 3 years									
Bornehag 2005 b	Nested case control	Not serious[a]	NA[b]	Not serious[c]	Not serious[d]	None	346	1.84 (1.05, 3.22)	MODERATE

(a) Very serious concerns over lack of detail on variables adjusted for and adequacy of follow-up
(b) Not applicable as only one study included
(c) No concerns over directness
(d) No concerns as the findings are statistically significant (95%CIs do not cross the line of no effect)

F.2.3.9 Dehumidifier use

No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Number (homes)	Adjusted relative effect (95% CI)	Quality
Acetyl-aldehyde									
Park 2001	Prospective cohort	Very serious[a]	NA[b]	Not serious[c]	Not serious[d]	None	111	% change=-31 (-49, -6)	LOW

(a) Very serious concerns over lack of detail on variables adjusted for and adequacy of follow-up
(b) Not applicable as only one study included
(c) No concerns over directness
(d) No concerns as findings are statistically significant (95%Cis do not cross line of no effect)

Appendix G: Economic evidence study selection

Please see cost-effectiveness review

Appendix H: Economic evidence tables

Please see cost-effectiveness review

Appendix I: Health economic evidence profiles

Please see cost-effectiveness review

Appendix J: Health economic analysis

Please see health economic modelling report

Appendix K: Excluded studies

K.1 Public health excluded studies

STUDY	REASON FOR EXCLUSION
Abbing-Karahagopian V, van der Gugten--, AC, van der Ent et al (2012) Effect of endotoxin and allergens on neonatal lung function and infancy respiratory symptoms and eczema. Pediatric Allergy and Immunology 23(5), 448-455	Study is concerned with bacterial endotoxins
Alderton LE, Spector LG, Blair CK et al (2006) Child and maternal household chemical exposure and the risk of acute leukemia in children with Down's syndrome: a report from the Children's Oncology Group. American journal of epidemiology 164(3), 212-21	Case control study and have included cohort studies of chemical exposure
Aldous M B, Holberg C J, Wright A L, et al (1996) Evaporative cooling and other home factors and lower respiratory tract illness during the first year of life. Group Health Medical Associates. American journal of epidemiology 143(5), 423-30	Study is concerned with evaporative cooling.
Amigou Al, Sermage-FC, Orsi L, et al (2011) Road traffic and childhood leukemia: the ESCALE study (SFCE). Environmental health perspectives 119(4), 566-72	Case control study and have included cohort studies of proximity to traffic
Andersen Z J, Ravnskjer L, Andersen K K, et al (2017) Long-term exposure to fine particulate matter and breast cancer incidence in the Danish nurse cohort study. Cancer Epidemiology Biomarkers and Prevention 26(3), 428-430	Study does not provide data on proximity to traffic
Annesi-Maesano I, Norback D, Zielinski J, et al (2013) Geriatric study in Europe on health effects of air quality in nursing homes (GERIE study) profile: objectives, study protocol and descriptive data. Multidisciplinary Respiratory Medicine. 21;8(1):7	Protocol for a study
Araki A, Kanazawa A, Kawai T, et al (2012) The relationship between exposure to microbial volatile organic compound and allergy prevalence in single-family homes. Science of the Total Environment 423, 18-26	Country not similar to UK
Arif AA, and Shah SM (2007) Association between personal exposure to volatile organic compounds and asthma among US adult population. International archives of occupational and environmental health 80(8), 711-9	Cross-sectional study
Baccarelli Andrea, Martinelli Ida, Pegoraro Valeria, et al (2009) Living near major traffic roads and risk of deep vein thrombosis. Circulation 119(24), 3118-24	Case control study and have included cohort studies of proximity to traffic
Bailey H D, De Klerk , N H, Fritschi L, et al (2011) Refuelling of vehicles, the use of wood burners and the risk of acute lymphoblastic leukaemia in childhood. Paediatric and Perinatal Epidemiology 25(6), 528-539	Case control study and have included cohort studies of heating fuel
Bailey HD, Metayer C, Milne E, et al (2015) Home paint exposures and risk of childhood acute lymphoblastic leukemia:	Case-control study and have included

STUDY	REASON FOR EXCLUSION
findings from the Childhood Leukemia International Consortium. Cancer Causes and Control 26(9), 1257-1270	cohort studies of VOC
Bailey HD, Milne E, de Klerk , NH, et al (2011) Exposure to house painting and the use of floor treatments and the risk of childhood acute lymphoblastic leukemia. International journal of cancer 128(10), 2405-14	Case control study and have included cohort studies of VOC
Bakolis I, Heinrich J, Zock J P et al (2015) House dust-mite allergen exposure is associated with serum specific IgE but not with respiratory outcomes. Indoor air 25(3), 235-44	Cross-sectional study
Balmes J R, Cisternas M, Quinlan P J, et al (2014) Annual average ambient particulate matter exposure estimates, measured home particulate matter, and hair nicotine are associated with respiratory outcomes in adults with asthma. Environmental Research 129, 1-10	Cross-sectional study
Barry A C, Mannino D M, Hopenhayn C et al (2010) Exposure to indoor biomass fuel pollutants and asthma prevalence in Southeastern Kentucky: results from the Burden of Lung Disease (BOLD) study. The Journal of asthma : official journal of the Association for the Care of Asthma 47(7), 735-41	Cross-sectional study
Batlles Garrido, J, Torres-Borrego J, Bonillo Perales, A , et al . 2010. "Prevalence and factors linked to atopic eczema in 10- and 11-year-old schoolchildren. Isaac 2 in Almeria, Spain". Allergologia et immunopathologia 38(4):174-80.	Cross-sectional study
Baxter LK, Clougherty JE, Laden F et al (2007) Predictors of concentrations of nitrogen dioxide, fine particulate matter, and particle constituents inside of lower socioeconomic status urban homes.. Journal of exposure science & environmental epidemiology 17(5), 433-44	Cross-sectional study
Baxter LK, Clougherty JE, Paciorek CJ, et al (2007) Predicting residential indoor concentrations of nitrogen dioxide, fine particulate matter, and elemental carbon using questionnaire and geographic information system based data. Atmospheric Environment 41(31), 6561-6571	Cross-sectional study
Beamer PI, Lothrop N, Lu Z et al (2016) Spatial clusters of child lower respiratory illnesses associated with community-level risk factors. Pediatric pulmonology 51(6), 633-42	Study concerned with spatial analysis and not on poor indoor air quality
Beckett WS, Gent JF, Naeher LP, et al (2006) Peak expiratory flow rate variability is not affected by home combustion sources in a group of nonsmoking women. Archives of Environmental and Occupational Health. ;61(4):176-82	Cross sectional study
Behbod B, Sordillo JE, Hoffman EB et al (2015) Asthma and allergy development: contrasting influences of yeasts and other fungal exposures. Clinical and experimental allergy : journal of the British Society for Allergy and Clinical Immunology 45(1), 154-63	Study is concerned with fungal concentration and diversity
Behbod B, Sordillo JE, Hoffman EB, et al (2013) Wheeze in infancy: protection associated with yeasts in house dust contrasts with increased risk associated with yeasts in indoor air and other fungal taxa. Allergy 68(11), 1410-8	Study is concerned with fungal concentration and diversity

STUDY	REASON FOR EXCLUSION
Bennett CM, Dharmage SC, Matheson M et al (2010) Ambient wood smoke exposure and respiratory symptoms in Tasmania, Australia. The Science of the total environment 409(2), 294-9	Study is concerned with respiratory symptoms and outdoor wood smoke
Bentayeb M, Billionnet C, Baiz N et al (2013) Higher prevalence of breathlessness in elderly exposed to indoor aldehydes and VOCs in a representative sample of French dwellings. Respiratory medicine 107(10), 1598-607	Cross-sectional study
Bentayeb M, Norback D, Bednarek M et al (2015) Indoor air quality, ventilation and respiratory health in elderly residents living in nursing homes in Europe. The European respiratory journal 45(5), 1228-38	Cross-sectional study
Bjornsson E, Norback D, Janson C, et al. 1995. "Asthmatic symptoms and indoor levels of micro-organisms and house dust mites". Clinical and Experimental Allergy 25(5):423-431.	Case-control study and we have cohorts on allergens
Blount RJ, Pascopella L, Catanzaro DG, et al (2017) Traffic-Related Air Pollution and All-Cause Mortality during Tuberculosis Treatment in California. Environmental health perspectives 125(9), 097026	Study does not report data that can be used
Bornehag CG, Sundell J, Weschler CJ, et al (2004) The association between asthma and allergic symptoms in children and phthalates in house dust: a nested case-control study. Environmental health perspectives 112(14), 1393-7	Nested case-control and we have cohort evidence on this topic
Bothwell J E, McManus L, Crawford VL et al (2003) Home heating and respiratory symptoms among children in Belfast, Northern Ireland. Archives of environmental health 58(9), 549-53	Cross-sectional study
Brown T, Dassonville C, Derbez M et al (2015) Relationships between socioeconomic and lifestyle factors and indoor air quality in French dwellings. Environmental research 140, 385-96	Cross-sectional survey
Brunekreef B, Smit J, de Jongste J, et al (2002) The prevention and incidence of asthma and mite allergy (PIAMA) birth cohort study: design and first results. Pediatric allergy and immunology : official publication of the European Society of Pediatric Allergy and Immunology 13 Suppl 15, 55-60	Studies do not have any results that can be used
Brussee JE, Smit HA, van Strien , RT, et al (2005) Allergen exposure in infancy and the development of sensitization, wheeze, and asthma at 4 years. The Journal of allergy and clinical immunology 115(5), 946-52	Study report of on risk in terms in terms of categories but reports medians of each category not the range
Bundy K W, Gent J F, Beckett W et al (2009). Household airborne Penicillium associated with peak expiratory flow variability in asthmatic children. Annals of allergy, asthma & immunology: official publication of the American College of Allergy, Asthma, and & Immunology, 103(1), pp.26-30.	Cross-sectional study
Canova C, Jarvis D, Walker S et al (2013). Systematic review of the effects of domestic paints on asthma related symptoms in people with or without asthma. The Journal of asthma:	Systematic review. Checked references for possible includes

STUDY	REASON FOR EXCLUSION
official journal of the Association for the Care of Asthma, 50(10), pp.1020-30.	
Carlos-Wallace FM, Zhang L, Smith MT, et al (2016) Parental, In Utero, and Early-Life Exposure to Benzene and the Risk of Childhood Leukemia: A Meta-Analysis. American journal of epidemiology 183(1), 1-14	Systematic review
Casas L, Tischer C, Wouters I M et al (2013) Early life microbial exposure and fractional exhaled nitric oxide in school-age children: a prospective birth cohort study. Environmental health: a global access science source, 12, pp.103.	Study is concerned with bacterial endotoxins
Casas L, Torrent M, Zock J-P, et al (2013) Early life exposures to home dampness, pet ownership and farm animal contact and neuropsylhological development in 4 year old children: a prospective birth cohort study. International journal of hygiene and environmental health 216(6), 690-7	Study do not report on outcomes of interest
Chen CM, Sausenthaler S, Bischof W, et al (2010) Perinatal exposure to endotoxin and the development of eczema during the first 6 years of life. Clinical and experimental dermatology 35(3), 238-44	Study is concerned with bacterial endotoxins
Chew GL, Rogers C, Burge HA, et al (2003) Dustborne and airborne fungal propagules represent a different spectrum of fungi with differing relations to home characteristics. Allergy 58(1), 13-20	Cross-sectional analysis of cohort data
Cho SH, Reponen T, Bernstein DI, et al (2006) The effect of home characteristics on dust antigen concentrations and loads in homes. Science of the Total Environment 371(1-3), 31-43	Cross-sectional analysis of cohort data
Colt JS, Hartge P, Davis S, et al (2007) Hobbies with solvent exposure and risk of non-Hodgkin lymphoma. Cancer causes & control : CCC 18(4), 385-90	Case control study
Crawford J A, Rosenbaum P F, Anagnost S E et al (2015) Indicators of airborne fungal concentrations in urban homes: understanding the conditions that affect indoor fungal exposures. The Science of the total environment 517, 113-24	Study concerned with fungal diversity and fungal concentration
Cuijpers C E, Swaen G M, Wesseling G et al (1995) Adverse effects of the indoor environment on respiratory health in primary school children. Environmental research 68(1), 11-23	Cross-sectional study
Custovic A, Simpson B M, Simpson A, et al (2003) Current mite, cat, and dog allergen exposure, pet ownership, and sensitization to inhalant allergens in adults. The Journal of allergy and clinical immunology 111(2), 402-7	Cross-sectional study
Dales R, Miller D, Ruest K, et al (2006) Airborne endotoxin is associated with respiratory illness in the first 2 years of life. Environmental health perspectives 114(4), 610-4	Study is concerned with bacterial endotoxins
Dallongeville A, Le Cann P , Zmirou-Navier D et al (2015) Concentration and determinants of molds and allergens in indoor air and house dust of French dwellings. The Science of the total environment 536, 964-72	Study concerned with fungal diversity and fungal concentration. Not on risk factors.

STUDY	REASON FOR EXCLUSION
Daniel AB, Shah H, Kamath Asha, et al (2012) Environmental tobacco and wood smoke increase the risk of Legg-Calve-Perthes disease. Clinical orthopaedics and related research 470(9), 2369-75	Country not similar to UK
Dannemiller KC, Gent JF, Leaderer BP et al (2016) Influence of housing characteristics on bacterial and fungal communities in homes of asthmatic children. Indoor air 26(2), 179-92	Study interested in housing characteristics and microbial ecology
Dannemiller KC, Gent JF, Leaderer BP, and Peccia Jordan (2016) Indoor microbial communities: Influence on asthma severity in atopic and nonatopic children. The Journal of allergy and clinical immunology 138(1), 76-83.e1	Study is concerned with atopic status and asthma severity
Dannemiller KC, Mendell MJ, Macher JM et al (2014) Next-generation DNA sequencing reveals that low fungal diversity in house dust is associated with childhood asthma development. Indoor air 24(3), 236-47	Study concerned with fungal diversity and asthma development
Danysh HE, Zhang K, Mitchell LE, et al (2016) Maternal residential proximity to major roadways at delivery and childhood central nervous system tumors. Environmental research 146, 315-22	Case control study and have cohort study on proximity to traffic
de Bilderling G , Mathot M, Agustsson S (2008). Early skin sensitization to aeroallergens. Clinical and experimental allergy: journal of the British Society for Allergy and Clinical Immunology, 38(4), pp.643-8.	Study is concerned with early skin testing to aeroallergens and not on indoor pollutants
De Roos , AJ, Koehoorn M, Tamburic L, et al (2014) Proximity to traffic, ambient air pollution, and community noise in relation to incident rheumatoid arthritis. Environmental health perspectives 122(10), 1075-80	Case control study
Dean T, Venter C, Pereira B, et al (2007) Patterns of sensitization to food and aeroallergens in the first 3 years of life. The Journal of allergy and clinical immunology 120(5), 1166-71	Study has no adjustment for confounders
DellaValle CT, Deziel NC, Jones RR, et al (2016) Polycyclic aromatic hydrocarbons: determinants of residential carpet dust levels and risk of non-Hodgkin lymphoma. Cancer causes & control : CCC 27(1), 1-13	Case control study and have cohort study on
Deshmukh JS, Motghare DD, Zodpey SP et al (1998) Low birth weight and associated maternal factors in an urban area. Indian pediatrics 35(1), 33-36	Study is concerned with exposure to tobacco as a risk factor for low birth weight
Dharmage S, Bailey M, Raven J et al (1999) Prevalence and residential determinants of fungi within homes in Melbourne, Australia. Clinical and experimental allergy : journal of the British Society for Allergy and Clinical Immunology 29(11), 1481-9	Cross-sectional study
Dharmage S, Bailey M, Raven J, et al. 1999. "Residential characteristics influence Der p 1 levels in homes in Melbourne, Australia". Clinical and experimental allergy: journal of the	Cross-sectional study

STUDY	REASON FOR EXCLUSION
British Society for Allergy and Clinical Immunology 29(4):461-9.	
Diette B G, Hansel N N, Buckley T J et al (2007) Home indoor pollutant exposures among inner-city children with and without asthma. Environmental health perspectives, 115(11), pp.1665-9.	Cohort study without adjustment for confounding variables
Dong G H, Qian Z, Liu M M et al (2014) Ambient air pollution and the prevalence of obesity in Chinese children: The seven northeastern cities study. Obesity 22(3), 795-800	Country not similar to UK
Dorans KS, Wilker EH, (2017) Residential proximity to major roads, exposure to fine particulate matter and aortic calcium: the Framingham Heart Study, a cohort study. BMJ open 7(3), e013455	Study is concerned with markers for aortic calcification
Dorans KS, Wilker EH, Li W, et al (2016) Residential Proximity to Major Roads, Exposure to Fine Particulate Matter, and Coronary Artery Calcium. Arteriosclerosis, Thrombosis, and and Vascular Biology 36(8), 1679-85	Study is concerned with markers for aortic calcification
Douwes J, Doekes G, Heinrich J, et al (2004) Endotoxin and β(1→3)-Glucan in House Dust and the Relation with Home Characteristics: A Pilot Study in 25 German Houses. Indoor Air 8(4), 255-263	Cross-sectional study
Edwards S C, Jedrychowski W, Butscher M et al (2010) Prenatal exposure to airborne polycyclic aromatic hydrocarbons and children's intelligence at 5 years of age in a prospective cohort study in Poland. Environmental Health Perspectives 118(9), 1326-1331	Study is concerned with outdoor and indoor air pollution and data are not presented separately by source of pollutant
Eiffert S, Noibi Y, Vesper S, et al (2016) A Citizen-Science Study Documents Environmental Exposures and Asthma Prevalence in Two Communities. Journal of environmental and public health, 2016, pp.1962901.	Cross-sectional study
Eisner MD, and Blanc PD (2003) Gas stove use and respiratory health among adults with asthma in NHANES III. Occupational and Environmental Medicine 60(10), 759-764	Cross-sectional study
Emond A M, Howat P, Evans J A, and Hunt L (1997) The effects of housing on the health of preterm infants. Paediatric and perinatal epidemiology 11(2), 228-39	Case control study and have cohort study on preterm, gas ovens, gas stoves and overcrowding
Engvall K, Norrby C, and Norback D (2001) Asthma symptoms in relation to building dampness and odour in older multifamily houses in Stockholm. The international journal of tuberculosis and lung disease : the official journal of the International Union against Tuberculosis and Lung Disease 5(5), 468-77	Cross-sectional study
Engvall K, Norrby C, Bandel J, et al (2001) Development of a Multiple Regression Model to Identify Multi-Family Residential Buildings with a High Prevalence of Sick Building Syndrome (SBS). Indoor Air 10(2), 101-110	Cross-sectional study

STUDY	REASON FOR EXCLUSION
Engvall K, Norrby C, and Norback D (2003) Ocular, nasal, dermal and respiratory symptoms in relation to heating, ventilation, energy conservation, and reconstruction of older multi-family houses. Indoor air 13(3), 206-11	Cross-sectional study
Engvall K, Norrby C, and Norback Dan (2002) Ocular, airway, and dermal symptoms related to building dampness and odors in dwellings. Archives of environmental health 57(4), 304-10	Cross-sectional study
Erdmann CA, and Apte MG (2004) Mucous membrane and lower respiratory building related symptoms in relation to indoor carbon dioxide concentrations in the 100-building BASE dataset. Indoor air 14 Suppl 8, 127-34	Study concerned with indoor air quality in the workplace
Farooq U, Joshi M, Nookala V, et al (2010) Self-reported exposure to pesticides in residential settings and risk of breast cancer: a case-control study. Environmental health : a global access science source 9, 30	Case control study and have cohort study on pesticides
Filippini T, Heck JE, Malagoli C, et al (2015) A review and meta-analysis of outdoor air pollution and risk of childhood leukemia. Journal of environmental science and health. Part C, and Environmental carcinogenesis & ecotoxicology reviews 33(1), 36-66	Systematic review and not relevant to this guideline
Finn P W, Boudreau J O, He H, et al (2000) Children at risk for asthma: Home allergen levels, lymphocyte proliferation, and wheeze. Journal of Allergy and Clinical Immunology 105(5), 933-942	Study does not report complete data
Fleisch AF, Rifas-Shiman SL, Koutrakis P, et al (2015) Prenatal exposure to traffic pollution: associations with reduced fetal growth and rapid infant weight gain. Epidemiology (Cambridge, and Mass.) 26(1), 43-50	Study not concerned with proximity to traffic
Fleisch A F, Luttmann-Gibson H, Perng W, et al (2017) Prenatal and early life exposure to traffic pollution and cardiometabolic health in childhood. Pediatric obesity 12(1), 48-57	Study concerned with markers for cardio-metabolic health
Freedman DM, Stewart P, Kleinerman RA, et al (2001) Household solvent exposures and childhood acute lymphoblastic leukemia. American journal of public health 91(4), 564-7	Case control study and have cohort study on solvents
Gauderman WJ, Vora H, McConnell R, et al (2007) Effect of exposure to traffic on lung development from 10 to 18 years of age: a cohort study. Lancet (London, and England) 369(9561), 571-7	Odds/risk ratios not reported
Gauderman WJ, Avol E, Lurmann F, et al . 2005. "Childhood asthma and exposure to traffic and nitrogen dioxide". Epidemiology (Cambridge, and Mass.) 16(6):737-43.	Study does not present data in a way that can be re-used
Gehring U, Bischof W, Fahlbusch B, et al (2002) House dust endotoxin and allergic sensitization in children. American Journal of Respiratory and Critical Care Medicine 166(7), 939-944	Study is concerned with bacterial endotoxins
Gehring U, Bolte G, Borte M et al (2001) Exposure to endotoxin decreases the risk of atopic eczema in infancy: a	Study is concerned with bacterial endotoxins

STUDY	REASON FOR EXCLUSION
cohort study. The Journal of allergy and clinical immunology 108(5), 847-54	
Gehring U, Heinrich J, Hoek G et al (2007) Bacteria and mould components in house dust and children's allergic sensitisation. The European respiratory journal 29(6), 1144-53	Case control study and have cohort study on house dust.
Gent J F, Ren P, Belanger K et al (2002). Levels of household mould associated with respiratory symptoms in the first year of life in a cohort at risk for asthma. Environmental health perspectives, 110(12), pp.A781-6.	Study concerned with the microbiological component/diversity of mould
Ghosh R, Amirian E, Dostal M, Sram R J, et al (2011) Indoor coal use and early childhood growth. Archives of Pediatrics and Adolescent Medicine 165(6), 492-497	Study reports on decrease z scores not adjusted OR / RR
Gillespie J, Wickens K, Siebers R, et al (2006) Endotoxin exposure, wheezing, and rash in infancy in a New Zealand birth cohort. The Journal of allergy and clinical immunology 118(6), 1265-70	Study is concerned with bacterial endotoxins
Godish T (1990) Residential formaldehyde: Increased exposure levels aggravate adverse health effects. Journal of Environmental Health 53(3), 34-37	Study without adjustment for confounding variables
Greenop KR, Peters S, Fritschi L, et al (2014) Exposure to household painting and floor treatments, and parental occupational paint exposure and risk of childhood brain tumors: results from an Australian case-control study. Cancer causes & control : CCC 25(3), 283-91	Case control study and have cohort study on painting
Greenop KR, Hinwood AL, Fritschi L, et al (2015) Vehicle refuelling, use of domestic wood heaters and the risk of childhood brain tumours: Results from an Australian case-control study. Pediatric blood & cancer 62(2), 229-234	Case control study and have cohort on factors of interest
Gross I, Heinrich J, Fahlbusch B, et al (2000) Indoor determinants of Der p 1 and Der f 1 concentrations in house dust are different. Clinical and experimental allergy : journal of the British Society for Allergy and Clinical Immunology 30(3), 376-82	Cross-sectional analysis of cohort data
Gunnbjornsdottir M I, Franklin K A, Norback D, et al (2006) Prevalence and incidence of respiratory symptoms in relation to indoor dampness: the RHINE study. Thorax 61(3), 221-5	Cross sectional study
Gunnbjornsdottir M I, Norback D, Plaschke P, et al (2003) The relationship between indicators of building dampness and respiratory health in young Swedish adults. Respiratory medicine 97(4), 302-7	Cross sectional study
Guxens M, Aguilera I, Ballester F et al (2012) Prenatal exposure to residential air pollution and infant mental development: modulation by antioxidants and detoxification factors. Environmental health perspectives 120(1), 144-9	Study is concerned with outdoor air pollution
Hagerhed-Engman L, Bornehag CG, and Sundell J (2009) Building characteristics associated with moisture related problems in 8,918 Swedish dwellings.. International journal of environmental health research 19(4), 251-65	Cross sectional study

STUDY	REASON FOR EXCLUSION
Halterman J S, Lynch K A, Conn K M et al (2009) Environmental exposures and respiratory morbidity among very low birth weight infants at 1 year of life. Archives of disease in childhood 94(1), 28-32	Odds/risk ratios for pre-specified pollutants not reported
Harris MH, Gold DR, Rifas-Shiman SL, et al (2015) Prenatal and Childhood Traffic-Related Pollution Exposure and Childhood Cognition in the Project Viva Cohort (Massachusetts, USA). Environmental health perspectives 123(10), 1072-8	Study concerned with markers for cognition
Heinrich J, Topp R, Gehring U, et al (2005) Traffic at residential address, respiratory health, and atopy in adults: the National German Health Survey 1998. Environmental research 98(2), 240-9	Cross sectional study
Herbarth O, Fritz G J, Rehwagen M (2006) Association between indoor renovation activities and eczema in early childhood. International journal of hygiene and environmental health 209(3), 241-7	Cross sectional study
Hernberg S, Sripaiboonkij P, Quansah R, et al (2014). Indoor molds and lung function in healthy adults. Respiratory Medicine. 2014 108(5):677-84	Cross sectional study
Hinwood A L, Callan A C, Heyworth J (2014) Polychlorinated biphenyl (PCB) and dioxin concentrations in residential dust of pregnant women. Environmental science. Processes & impacts 16(12), 2758-63	Cross sectional study
Holm S M, Balmes J, Gillette D, et al (2018) Cooking behaviors are related to household particulate matter exposure in children with asthma in the urban East Bay Area of Northern California. PLoS ONE 13(6), e0197199	Study not present usable data
Horick N, Weller E, Milton D K et al (2006) Home endotoxin exposure and wheeze in infants: correction for bias due to exposure measurement error. Environmental health perspectives 114(1), 135-40	Study is concerned with bacterial endotoxins
Houot J, Marquant F, Goujon S, et al (2014) Residential Proximity to Heavy-Traffic Roads, Benzene Exposure, and Childhood Leukemia-The GEOCAP Study, 2002-2007. American Journal of Epidemiology 182(8), 685-693	Case control study and have cohort study on proximity to traffic
Huss K, Adkinson N F, Jr, Eggleston P A et al (2001). House dust mite and cockroach exposure are strong risk factors for positive allergy skin test responses in the Childhood Asthma Management Program. The Journal of allergy and clinical immunology, 107(1), pp.48-54.	Cross sectional study
Hwang B F, Liu I P, and Huang T P (2011) Molds, parental atopy and pediatric incident asthma. Indoor Air 21(6), 472-478	Country not similar to UK
Iossifova Y, Reponen T, Sucharew H et al (2008) Use of (1-3)-beta-d-glucan concentrations in dust as a surrogate method for estimating specific fungal exposures. Indoor air 18(3), 225-32	Study is concerned with bacterial endotoxins
Iossifova YY, Reponen T, Bernstein DI, et al (2007) House dust (1-3)-beta-D-glucan and wheezing in infants. Allergy 62(5), 504-13	Study is concerned with bacterial endotoxins

STUDY	REASON FOR EXCLUSION
Jaakkola M S, Quansah R, Hugg T T, (2013) Association of indoor dampness and molds with rhinitis risk: A systematic review and meta-analysis. Journal of Allergy and Clinical Immunology 132(5), 1099	Systematic review
Jaakkola MS, Nordman H, Piipari R, et al (2002) Indoor dampness and molds and development of adult-onset asthma: A population-based incident case-control study. Environmental Health Perspectives 110(5), 543-547	Case control study and have cohort study on damp
Jaakkola JJ, Oie L, Nafstad P, et al (1999) Interior surface materials in the home and the development of bronchial obstruction in young children in Oslo, Norway. American journal of public health 89(2), 188-92	Case control study
Jacob B, Ritz B, Gehring U, et al. (2002) Indoor exposure to molds and allergic sensitization. Environmental Health Perspectives. 110(7):647-53	Case control study and have cohort study on damp
Jarvis D, Chinn S, Luczynska C, et al (1997) The association of family size with atopy and atopic disease. Clinical and experimental allergy 27(3), 240-245	Cross sectional study
Jarvis D, Zock JP, Heinrich J, et al (2007) Cat and dust mite allergen levels, specific IgG and IgG4, and respiratory symptoms in adults. The Journal of allergy and clinical immunology 119(3), 697-704	Study concerned with exposure to pets and sensitization
Jedrychowski W A, Perera F P, Maugeri U et al (2012) Prohypertensive effect of gestational personal exposure to fine particulate matter. Prospective cohort study in non-smoking and non-obese pregnant women. Cardiovascular toxicology 12(3), 216-25	Study does not report adjusted ratios for risk
Jedrychowski W, Maugeri U, Mroz E, et al . 2012. "Fractional exhaled nitric oxide in healthy non-asthmatic 7-year olds and prenatal exposure to polycyclic aromatic hydrocarbons: nested regression analysis". Pediatric pulmonology 47(11):1131-9.	Study concerned with markers of illness
Jedrychowski W, Maugeri U, Jedrychowska-Bianchi I et al (2002) The effect of house dust mite sensitization on lung size and airway caliber in symptomatic and nonsymptomatic preadolescent children: a community-based study in Poland. Environmental health perspectives 110(6), 571-4	Cross sectional study
Jedrychowski WA, Perera FP, Spengler JD, et al (2013) Intrauterine exposure to fine particulate matter as a risk factor for increased susceptibility to acute broncho-pulmonary infections in early childhood. International journal of hygiene and environmental health 216(4), 395-401	Study reports on risk factors for increased susceptibility to respiratory infections
Jedrychowski W, Maugeri U, Jedrychowska-Bianchi I et al (2005) Effect of indoor air quality in the postnatal period on lung function in pre-adolescent children: a retrospective cohort study in Poland. Public health 119(6), 535-41	Study concerned with a combination of ETS and household heating with no separate data reported
Jedrychowski W, Maugeri U, Perera F, et al (2011) Cognitive function of 6-year old children exposed to mold-contaminated	Study is concerned with duration of exposure

STUDY	REASON FOR EXCLUSION
homes in early postnatal period. Prospective birth cohort study in Poland. Physiology & behavior 104(5), 989-95	
Jedrychowski WA, Maugeri , Spengler J, et al (2013) Dose-dependent relationship between prenatal exposure to fine particulates and exhaled carbon monoxide in non-asthmatic children. A population-based birth cohort study. International journal of occupational medicine and environmental health 26(1), 73-82	Study is concerned with (exhaled Carbon Monoxide) Eco markers
Jedrychowski W, Maugeri U, Zembala M, et al (2007). Risk of wheezing associated with house-dust mite allergens and indoor air quality among three-year-old children. Kraków inner city study. International Journal of Occupational Medicine and Environmental Health. 20(2):117-26	Cross sectional study
Jedrychowski W, Flak E, Mroz E, et al (2008) Modulating effects of maternal fish consumption on the occurrence of respiratory symptoms in early infancy attributed to prenatal exposure to fine particles. Annals of nutrition & metabolism 52(1), 8-16	Study reports on risk for the number of days with symptoms
Jedrychowski WA, Perera FP, Majewska R, et al (2015) Depressed height gain of children associated with intrauterine exposure to polycyclic aromatic hydrocarbons (PAH) and heavy metals: the cohort prospective study. Environmental research 136, 141-7	Study does not report data that can be used.
Johansen J D, Andersen T F, Thomsen L K, et al. 2000. "Rash related to use of scented products. A questionnaire study in the Danish population. Is the problem increasing?" Contact dermatitis 42(4):222-6.	Cross sectional study
Johansson E, Reponen T, Vesper S et al (2013) Microbial content of household dust associated with exhaled NO in asthmatic children. Environment international 59, 141-7	Study is concerned with bacterial endotoxins
Just A C, Whyatt R M, Miller R L et al (2012) Children's urinary phthalate metabolites and fractional exhaled nitric oxide in an urban cohort. American journal of respiratory and critical care medicine 186(9), 830-7	Cross sectional study
Karr C J, Rudra C B, Miller K A et.al (2009) Infant exposure to fine particulate matter and traffic and risk of hospitalization for RSV bronchiolitis in a region with lower ambient air pollution. Environmental research 109(3), 321-7	Case-control study
Karvonen A M, Hyvarinen A, Gehring U, et al (2012) Exposure to microbial agents in house dust and wheezing, atopic dermatitis and atopic sensitization in early childhood: a birth cohort study in rural areas. Clinical and experimental allergy : journal of the British Society for Allergy and Clinical Immunology 42(8), 1246-56	Study does not have a multi-variate analysis
Karvonen AM, Hyvarinen A, Roponen M et al . 2009. "Confirmed moisture damage at home, respiratory symptoms and atopy in early life: a birth-cohort study". Pediatrics 124(2):e329-38.	Conference abstract with insufficient detail to assess risk of bias

STUDY	REASON FOR EXCLUSION
Kato I, Koenig KL, Watanabe-Meserve H, et al (2005) Personal and occupational exposure to organic solvents and risk of non-Hodgkin's lymphoma (NHL) in women (United States). Cancer causes & control : CCC 16(10), 1215-24	Case control study and have cohort study on solvents
Kidon MI, Chiang WC, Liew WK, et al. (2005) Sensitization to dust mites in children with allergic rhinitis in Singapore: does it matter if you scratch while you sneeze?. Clinical and experimental allergy : journal of the British Society for Allergy and Clinical Immunology 35(4), 434-40	Country not similar to UK
Kilpelainen M, Koskenvuo M, Helenius H et al (2001) Wood stove heating, asthma and allergies. Respiratory medicine 95(11), 911-6	Cross sectional study
Kingsley SL, Eliot MN, Whitsel EA, et al (2016) Maternal residential proximity to major roadways, birth weight, and placental DNA methylation. Environment international 92-93, 43-9	Study reports results that cannot be disaggregated to distance to road.
Kirjavainen PV, Taubel M, Karvonen AM, et al (2016) Microbial secondary metabolites in homes in association with moisture damage and asthma. Indoor air 26(3), 448-456	Study does not report on outcomes of interest
Kwon J H, Kim E, Chang M et al (2015) Indoor total volatile organic compounds exposure at 6 months followed by atopic dermatitis at 3 years in children. Pediatric allergy and immunology : official publication of the European Society of Pediatric Allergy and Immunology 26(4), 352-8	Country not similar to UK
Langer S, Ramalho O, Le Ponner et al (2017) Perceived indoor air quality and its relationship to air pollutants in French dwellings. Indoor air 27(6), 1168-1176	Study concerned with perceived air quality
Langer S, and Beko G (2013) Indoor air quality in the Swedish housing stock and its dependence on building characteristics. Building & Environment 69, 44-54	Study does not report data that can be used.
Langer S, Ramalho O, Derbez M et al (2016) Indoor environmental quality in French dwellings and building characteristics. Atmospheric Environment 128, 82-91	Study does not report data that can be used.
Leaderer BP, Belanger K, Triche E, et al (2002) Dust mite, cockroach, cat, and dog allergen concentrations in homes of asthmatic children in the Northeastern United States: Impact of socioeconomic factors and population density. Environmental Health Perspectives 110(4), 419-425	Cross sectional study
Lee K, Yanagisawa Y, Spengler JD et al (1996) Classification of House Characteristics in a Boston Residential Nitrogen Dioxide Characterization Study. Indoor Air 6(3), 211-216	Study does not adjust for confounding variables
Levy J I, Welker-Hood L K, Clougherty J E et al (2004) Lung function, asthma symptoms, and quality of life for children in public housing in Boston: a case-series analysis. Environmental health : a global access science source 3(1), 13	Study not concerned with indoor air quality
Lin S, Jones R, Munsie J P, Nayak S G, Fitzgerald E F, and Hwang S A (2012) Childhood asthma and indoor allergen exposure and sensitization in Buffalo, New York. International journal of hygiene and environmental health 215(3), 297-305	Study does not present adjusted OR / RR

STUDY	REASON FOR EXCLUSION
Lindfors A, Wickman M, Hedlin G, et al (1995) Indoor environmental risk factors in young asthmatics: a case-control study. Archives of disease in childhood 73(5), 408-12	Study does not present adjusted OR / RR
Lipfert F W, Zhang J, and Wyzga R E (2000) Infant mortality and air pollution: a comprehensive analysis of U.S. data for 1990. Journal of the Air & Waste Management Association (1995) 50(8), 1350-66	Study is concerned with outdoor and indoor air pollution with no disaggregation of data
Litonjua AA, Carey VJ, Burge HA, et al (2001) Exposure to cockroach allergen in the home is associated with incident doctor-diagnosed asthma and recurrent wheezing. Journal of Allergy and Clinical Immunology 107(1), 41-47	Study addressing cockroach allergen.
Liu X, Tan L, Yu I T et al (2018) Household cleaning products and the risk of allergic dermatitis: a prospective cohort study with primary-school children. Journal of the European Academy of Dermatology and Venereology 32(4), 624-631	Country not similar to UK
Llanora G V, Ming L J, Wei L M, Van Bever , and H P S (2012) House dust mite sensitization in toddlers predict persistent wheeze in children between eight to fourteen years old. Asia Pacific Allergy 2(3), 181-186	Country not similar to UK
Lodge CJ, Lowe AJ, Gurrin LC, et al (2011) House dust mite sensitization in toddlers predicts current wheeze at age 12 years. The Journal of allergy and clinical immunology 128(4), 782-788.e9	Study is concerned with sensitization as a risk factor
Lowe L A, Woodcock A, Murray C S et al (2004) Lung function at age 3 years: effect of pet ownership and exposure to indoor allergens. Archives of paediatrics & adolescent medicine 158(10), 996-1001	Study without adjustment for confounding variables
Lu Y, Lin S, Lawrence W R et al (2018). Evidence from SINPHONIE project: Impact of home environmental exposures on respiratory health among school-age children in Romania. The Science of the total environment, 621, pp.75-84.	Cross sectional study
Ma Xiaomei, Buffler Patricia A, Gunier Robert B, Dahl Gary, Smith Martyn T, Reinier Kyndaron, and Reynolds Peggy (2002) Critical windows of exposure to household pesticides and risk of childhood leukemia. Environmental health perspectives 110(9), 955-60	Case control study
Martins P, Valente J, Papoila A L et al (2012) Combined effect of air pollution and house dust mite exposure over the airways. Revista Portuguesa de Imunoalergologia 20(1), 47-57	Study concerned with air pollution with no separate data for indoor pollutants
Matheson M C, Dharmage S C, Forbes A B, et al . 2003. Residential characteristics predict changes in Der p 1, Fel d 1 and ergosterol but not fungi over time". Clinical and experimental allergy journal of the British Society for Allergy and Clinical Immunology 33(9):1281-8.	Study does not present numeric data that can be used
Matsui EC, Eggleston PA, Buckley TJ, et al (2006) Household mouse allergen exposure and asthma morbidity in inner-city preschool children. Annals of allergy, asthma & immunology :	Study does not report outcome data for all groups

STUDY	REASON FOR EXCLUSION
official publication of the American College of Allergy, Asthma, and & Immunology 97(4), 514-20	
Matsui E C (2014) Environmental exposures and asthma morbidity in children living in urban neighbourhoods. Allergy 69(5), 553-8	Non –systematic overview
Matulonga B, Rava M, Siroux V, et al (2016) Women using bleach for home cleaning are at increased risk of non-allergic asthma. Respiratory medicine 117, 264-71	Cross sectional study
Mazenq J, Dubus J, Gaudart J et al (2017) City housing atmospheric pollutant impact on emergency visit for asthma: A classification and regression tree approach. Respiratory medicine 132, 1-8	Study concerned with outdoor air pollution
McGuinn Laura A, Voss Robert W, Laurent Cecile A, Greenspan Louise C, Kushi Lawrence H, and Windham Gayle C (2016) Residential proximity to traffic and female pubertal development. Environment international 94, 635-641	Odds/risk ratios not reported
Mendy A, Wilkerson J, Salo P M, Cohn R D, Zeldin D C, and Thorne P S (2018) Endotoxin predictors and associated respiratory outcomes differ with climate regions in the U.S. Environment International 112, 218-226	Cross sectional study
Metayer C, Colt JS, Buffler PA, et al (2013) Exposure to herbicides in house dust and risk of childhood acute lymphoblastic leukemia. Journal of exposure science & environmental epidemiology 23(4), 363-70	Case control study and have cohort study on pesticides
Merrett Tg, Burr Ml, Butland Bk, et al (1988) Infant feeding and allergy: 12-month prospective study of 500 babies born into allergic families. Review 53 refs. Annals of allergy 61(6 (Pt 2)), 13-20	Study does not report risk as ratios
Moran S E, Strachan D P, Johnston I D et al (1999). Effects of exposure to gas cooking in childhood and adulthood on respiratory symptoms, allergic sensitization and lung function in young British adults. Clinical and experimental allergy: journal of the British Society for Allergy and Clinical Immunology, 29(8), pp.1033-41.	Study does not report on adjusted data on odds ratio/risk ratio
Morris K, Morgenlander M, Coulehan J L, Gahagen S, and Arena V C (1990) Wood-burning stoves and lower respiratory tract infection in American Indian children. American journal of diseases of children (1960) 144(1), 105-8	Case control study and we have e cohort study on this topic
Moshammer H, Fletcher T, Heinrich J, et al (2010) Gas cooking is associated with small reductions in lung function in children. The European respiratory journal, 36(2), pp.249-54.	Cross sectional study
Munir A K. M, Bjorksten B, Einarsson R, et al (1995) Mite allergens in relation to home conditions and sensitization of asthmatic children from three climatic regions. Allergy: European Journal of Allergy and Clinical Immunology 50(1), 55-64	Cross sectional study
Nafstad P, Jaakkola J J. K, Skrondal A et al (2005) Day care centre characteristics and children's respiratory health. Indoor air 15(2), 69-75	Study concerned with outdoor air quality

STUDY	REASON FOR EXCLUSION
Nafstad P, Oie L, Mehl R, et al (1998) Residential dampness problems and symptoms and signs of bronchial obstruction in young Norwegian children. American journal of respiratory and critical care medicine 157(2), 410-4	Case control study and have cohort study on dampness
Narayan S, Liew Z, Paul K, et al(2013) Household organophosphorus pesticide use and Parkinson's disease. International journal of epidemiology 42(5), 1476-85	Case control study and have cohort study on pesticides
Nguyen T, Lurie M, Gomez M (2010) The National Asthma Survey--New York State: association of the home environment with current asthma status. Public health reports (Washington, and D.C. : 1974) 125(6), 877-87	Cross sectional study
Nicolaou N, Yiallouros P, Pipis S, et al (2006) Domestic allergen and endotoxin exposure and allergic sensitization in Cyprus. Pediatric allergy and immunology : official publication of the European Society of Pediatric Allergy and Immunology 17(1), 17-21	Case control study and have cohort data on allergen exposure
Norback D, Bjornsson E, Janson C, et al (1999) Current asthma and biochemical signs of inflammation in relation to building dampness in dwellings. The international journal of tuberculosis and lung disease : the official journal of the International Union against Tuberculosis and Lung Disease 3(5), 368-76	Case control study and have cohort study on damp
Norback D, Lampa E, and Engvall K (2014) Asthma, allergy and eczema among adults in multifamily houses in Stockholm (3-HE study)--associations with building characteristics, home environment and energy use for heating. PloS one 9(12), e112960	Cross sectional study
Norback D, Zock J P, Plana E, et al (2017) Building dampness and mold in European homes in relation to climate, building characteristics and socio-economic status: The European Community Respiratory Health Survey ECRHS II. Indoor air 27(5), 921-932	Cross sectional study
Norback D, Zock J-P, Plana E, et al (2011) Lung function decline in relation to mould and dampness in the home: the longitudinal European Community Respiratory Health Survey ECRHS II. Thorax 66(5), 396-401	Study concerned with lung function not symptoms
Oudin A, Segersson D, Adolfsson R, et al . 2018. "Association between air pollution from residential wood burning and dementia incidence in a longitudinal study in Northern Sweden". PLoS ONE 13(6):e0198283.	Study is concerned with indoor and outdoor pollution
Park D-U, Choi Y-Y, Ahn J-J, et al (2015) Relationship between Exposure to Household Humidifier Disinfectants and Risk of Lung Injury: A Family-Based Study. PloS one 10(5), e0124610	Country not similar to UK
Park JH, Gold DR, Spiegelman DL, et al (2001) House dust endotoxin and wheeze in the first year of life. American journal of respiratory and critical care medicine 163(2), 322-8	Study is considered with bacterial endotoxin
Paulin L M, Williams D L, Peng R et al (2017). 24-h Nitrogen dioxide concentration is associated with cooking behaviors and	Study does not reported results in a way that can be used

STUDY	REASON FOR EXCLUSION
an increase in rescue medication use in children with asthma. Environmental research, 159, pp.118-123.	
Pekkanen J, Hyvarinen A, Haverinen-Shaughnessy U, et al (2007) Moisture damage and childhood asthma: A population-based incident case-control study. European Respiratory Journal 29(3), 509-515	Case control study and have cohort study on damp
Perera Frederica P (2009) Prenatal airborne polycyclic aromatic hydrocarbon exposure and child IQ at age 5 years. Pediatrics 124(2),	Odds/risk ratios not reported
Perry TT, Wood RA, Matsui EC, et al (2006) Room-specific characteristics of suburban homes as predictors of indoor allergen concentrations. Annals of Allergy, and Asthma and Immunology 97(5), 628-635	Cross sectional study
Perzanowski MS, Chew GL, Divjan A, et al (2013) Early-life cockroach allergen and polycyclic aromatic hydrocarbon exposures predict cockroach sensitization among inner-city children. The Journal of allergy and clinical immunology 131(3), 886-93	Study reports on risk factors for sensitization
Perzanowski MS, Ronmark E, James HR, et al (2016) Relevance of specific IgE antibody titer to the prevalence, severity, and persistence of asthma among 19-year-olds in northern Sweden. The Journal of allergy and clinical immunology 138(6), 1582-1590	Study reports on risk factors for sensitization
Perzanowski MS, Miller RL, Thorne PS, et al (2006) Endotoxin in inner-city homes: associations with wheeze and eczema in early childhood. The Journal of allergy and clinical immunology 117(5), 1082-9	Study is considered with bacterial endotoxin
Peters J L, Levy J I, Rogers C A, et al (2007) Determinants of allergen concentrations in apartments of asthmatic children living in public housing. Journal of Urban Health 84(2), 185-197	Cross sectional study
Phipatanakul W, Celedon JC, Raby BA, et al (2004) Endotoxin exposure and eczema in the first year of life. Pediatrics 114(1), 13-8	Study is considered with bacterial endotoxin
Phipatanakul W, Gold DR, Muilenberg M, Sredl DL, Weiss ST, and Celedon JC (2005) Predictors of indoor exposure to mouse allergen in urban and suburban homes in Boston. Allergy 60(5), 697-701	Cross sectional study
Pogoda J M, and Preston-Martin S (1997) Household pesticides and risk of pediatric brain tumors. Environmental health perspectives 105(11), 1214-20	Case control study and have cohort study data n pesticides
Ponsonby AL, Dwyer T, Kemp A, et al (2003) The use of mutually exclusive categories for atopic sensitization: A contrasting effect for family size on house dust mite sensitization compared with ryegrass sensitization. Pediatric Allergy and Immunology 14(2), 81-90	Study reports on risk factors for sensitization
Poynter JN, Richardson M, Roesler M, et al (2017) Chemical exposures and risk of acute myeloid leukemia and myelodysplastic syndromes in a population-based study. International journal of cancer 140(1), 23-33	Study concerned with occupational exposure to chemicals

STUDY	REASON FOR EXCLUSION
Quansah R, Jaakkola MS, Hugg TT, et al (2012) Residential dampness and molds and the risk of developing asthma: a systematic review and meta-analysis. PloS one 7(11), e47526	Systematic review
Rabito F A, Carlson J, Holt E W, et al. 2011. "Cockroach exposure independent of sensitization status and association with hospitalizations for asthma in inner-city children". Annals of Allergy, and Asthma and Immunology 106(2):103-109.	Cross sectional study
Ramagopal M, Wang Z, Black K, et al (2014) Improved exposure characterization with robotic (PIPER) sampling and association with children's respiratory symptoms, asthma and eczema. Journal of exposure science & environmental epidemiology 24(4), 421-7	Cross sectional study
Rauh VA, Chew GR, and Garfinkel RS (2002) Deteriorated housing contributes to high cockroach allergen levels in inner-city households. Environ Health Perspect. 110 (Suppl 2): 323–327.	Cross sectional analysis of cohort data
Reding KW, Young MT, Szpiro AA, H et al (2015) Breast Cancer Risk in Relation to Ambient Air Pollution Exposure at Residences in the Sister Study Cohort. Cancer Epidemiology Biomarkers & Prevention 24(12), 1907-1909	Study is not concerned with indoor air
Ren P, Jankun TM, Belanger K, et al (2001) The relation between fungal propagules in indoor air and home characteristics. Allergy 56(5), 419-24	Cross sectional analysis of cohort data
Rios P, Bailey H D, Lacour B, et al (2017) Maternal use of household pesticides during pregnancy and risk of neuroblastoma in offspring. A pooled analysis of the ESTELLE and ESCALE French studies (SFCE). Cancer Causes and Control 28(10), 1125-1132	Pooled analysis of 2 case-control studies
Rokoff LB, Koutrakis P, Garshick E, et al (2017) Wood Stove Pollution in the Developed World: A Case to Raise Awareness Among Pediatricians. Current problems in pediatric and adolescent health care 47(6), 123-141	Systematic review
Rosenbaum PF, Crawford JA, Anagnost SE et al (2010) Indoor airborne fungi and wheeze in the first year of life among a cohort of infants at risk for asthma. Journal of exposure science & environmental epidemiology 20(6), 503-15	Study is concerned with bacterial endotoxin
Rosenfeld L, Chew GL, Rudd R, et al (2011) Are building-level characteristics associated with indoor allergens in the household? Journal of urban health : bulletin of the New York Academy of Medicine 88(1), 14-29	Cross sectional analysis of cohort data
Ruckart PZ, Bove FJ, Shanley E 3rd, et al (2015) Evaluation of contaminated drinking water and male breast cancer at Marine Corps Base Camp Lejeune, North Carolina: a case control study. Environmental health : a global access science source 14, 74	Study is not concerned with indoor air pollution
Sahlberg B, Gunnbjornsdottir M, Soon A et al (2013) Airborne moulds and bacteria, microbial volatile organic compounds (MVOC), plasticizers and formaldehyde in dwellings in three North European cities in relation to sick building syndrome (SBS). The Science of the total environment 444, 433-40	Cross sectional study

STUDY	REASON FOR EXCLUSION
Salo P M, Wilkerson J, Rose K M, et al (2018) Bedroom allergen exposures in US households. Journal of Allergy and Clinical Immunology 141(5), 1870	Cross sectional study
Sapkota A, Zaridze D, Szeszenia-Dabrowska N et al (2013) Indoor air pollution from solid fuels and risk of upper aerodigestive tract cancers in central and eastern Europe. Environmental research 120, 90-5	Case-control study and have cohort studies on heating fuel
Scelo G, Metayer C, Zhang L, et al (2009) Household exposure to paint and petroleum solvents, chromosomal translocations, and the risk of childhood leukemia. Environmental health perspectives 117(1), 133-9	Case control study and have cohort studies on paint
Schenker MB, Samet JM, and Speizer FE (1983) Risk factors for childhood respiratory disease. The effect of host factors and home environmental exposures. The American review of respiratory disease 128(6), 1038-43	Study does not report results that can be re-used
Schindler C, Keidel D, Gerbase MW, et al (2009) Improvements in PM10 exposure and reduced rates of respiratory symptoms in a cohort of Swiss adults (SAPALDIA). American journal of respiratory and critical care medicine 179(7), 579-87	Study does not report results that can be re-used
Seo S, Han Y, Kim J, Choung J T, et al (2014) Infrared camera-proven water-damaged homes are associated with the severity of atopic dermatitis in children. Annals of Allergy, and Asthma and Immunology 113(5), 549-555	Country not similar to UK
Sharpe R A, Bearman N, Thornton C R, et al (2015) Indoor fungal diversity and asthma: A meta-analysis and systematic review of risk factors. Journal of Allergy and Clinical Immunology 135(1), 110-122	Systematic review
Sharpe R A, Thornton C R, Tyrrell J, et al 2015. Variable risk of atopic disease due to indoor fungal exposure in NHANES 2005-2006. Clinical and Experimental Allergy 45(10):1566-1578.	Cross sectional study
Sharpe RA, Thornton CR, Nikolaou V, et al (2015) Higher energy efficient homes are associated with increased risk of doctor diagnosed asthma in a UK subpopulation. Environment international 75, 234-44	Cross sectional study
Sharpe RA, Thornton CR, Nikolaou V, et al (2015) Fuel poverty increases risk of mould contamination, regardless of adult risk perception & ventilation in social housing properties. Environment International 79, 115-129	Cross sectional study
Shenassa ED, Daskalakis C, Liebhaber A, et al (2007) Dampness and mold in the home and depression: An examination of mold-related illness and perceived control of one's home as possible depression pathways. American Journal of Public Health 97(10), 1893-1899	Cross sectional study
Shorter C, Crane J, Pierse N, et al (2017) Indoor visible mold and mold odor are associated with new-onset childhood wheeze in a dose-dependent manner. Indoor Air 28(1), 6-15	Case control study and have cohorts on this topic

STUDY	REASON FOR EXCLUSION
Singh U, Levin L, Grinshpun SA et al (2011) Influence of home characteristics on airborne and dust borne endotoxin and beta-D-glucan. Journal of environmental monitoring : JEM 13(11), 3246-53	Study is concerned in bacterial endotoxins
Slater ME, Linabery AM, Spector LG, et al (2011) Maternal exposure to household chemicals and risk of infant leukemia: a report from the Children's Oncology Group. Cancer causes & control : CCC 22(8), 1197-204	Case control study and have cohort studies on chemicals
Smedje G, Wang J, Norback D, et al (2017) SBS symptoms in relation to dampness and ventilation in inspected single-family houses in Sweden. International archives of occupational and environmental health 90(7), 703-711	Cross sectional study
Smith B J, Nitschke M, Pilotto L S, et al (2000) Health effects of daily indoor nitrogen dioxide exposure in people with asthma. European Respiratory Journal 16(5), 879-885	Study does not use regression analysis to identify sources of NO_2
Sordillo JE, Hoffman EB, Celedon JC, et al (2010) Multiple microbial exposures in the home may protect against asthma or allergy in childhood. Clinical and experimental allergy : journal of the British Society for Allergy and Clinical Immunology 40(6), 902-10	Study is concerned in bacterial endotoxins
Sordillo J E, Alwis UK, Hoffman E, et al. 2011. "Home characteristics as predictors of bacterial and fungal microbial biomarkers in house dust". Environmental health perspectives 119(2):189-95.	Study concerns with microbial biomarkers in house dust
Spilak MP, Madsen AM, Knudsen SM et al(2015) Impact of dwelling characteristics on concentrations of bacteria, fungi, endotoxin and total inflammatory potential in settled dust. Building & Environment 93, 64-71	Cross sectional study
Sporik R, Holgate ST, Platts-Mills TA, et al (1990) Exposure to house-dust mite allergen (Der p I) and the development of asthma in childhood. A prospective study. The New England journal of medicine 323(8), 502-7	Study does not report results that can be re-used
Squance M L, Reeves G, Attia J, et al (2015) Self-reported Lupus flare: Association with everyday home and personal product exposure. Toxicology Reports 2, 880-888	Case control study and have cohort studies on personal products
Stankovic A, Nikolic M, and Arandjelovic M (2011) Effects of indoor air pollution on respiratory symptoms of non-smoking women in Nis, Serbia. Multidisciplinary respiratory medicine 6(6), 351-5	Country not similar to UK
Strachan D P (1988) Damp housing and childhood asthma: validation of reporting of symptoms. BMJ (Clinical research ed.) 297(6658), 1223-6	Cross sectional study
Strachan D P, and Carey I M (1995) Home environment and severe asthma in adolescence: a population based case-control study. BMJ (Clinical research ed.) 311(7012), 1053-6	Case control study

STUDY	REASON FOR EXCLUSION
Strumylaite L, and Kregzdyte R (2006) Household gas cooking and respiratory health in preschool children. Family Medicine and Primary Care Review 8(1), 21-25	Cross sectional study
Taha AA. ER, Etewa SE, Abdel-Rahman SA, et al (2018) House dust mites among allergic patients at the Allergy and Immunology Unit, Zagazig University: an immunologic and serologic study. Journal of Parasitic Diseases 42(3), 405-415	Country not similar to UK
Takeda M, Saijo Y, Yuasa M et al (2009) Relationship between sick building syndrome and indoor environmental factors in newly built Japanese dwellings. International archives of occupational and environmental health 82(5), 583-93	Country not similar to UK
Tavernier G O. G, Fletcher G D, Francis H C et al (2005) Endotoxin exposure in asthmatic children and matched healthy controls: results of IPEADAM study. Indoor air 15 Suppl 10, 25-32	Cross sectional study
Tavernier G, Fletcher G, Gee I et al (2006) IPEADAM study: indoor endotoxin exposure, family status, and some housing characteristics in English children. The Journal of allergy and clinical immunology 117(3), 656-62	Cross-sectional study
Tetreault L F, Doucet M, Gamache P, et al (2016) Childhood exposure to ambient air pollutants and the onset of asthma: An administrative cohort study in Quebec. Environmental Health Perspectives 124(8), 1276-1282	Study is not concerned with indoor air pollution
Thorn J, Brisman J, and Toren K. 2001. "Adult-onset asthma is associated with self-reported mold or environmental tobacco smoke exposures in the home". Allergy: European Journal of Allergy and Clinical Immunology 56(4):287-292.	Case-control study and we have cohort studies on mould
Tischer C G, Gref A, Standl M, et al (2013) Glutathione-S-transferase P1, early exposure to mould in relation to respiratory and allergic health outcomes in children from six birth cohorts. A meta-analysis. Allergy 68(3), 339-46	Systematic review
Tischer C, Chen C M, and Heinrich J (2011) Association between domestic mould and mould components, and asthma and allergy in children: a systematic review. The European respiratory journal 38(4), 812-24	Systematic review
Tischer C, Casas L, Wouters IM, et al (2015) Early exposure to bio-contaminants and asthma up to 10 years of age: results of the HITEA study. The European respiratory journal 45(2), 328-37	Study is concerned in bacterial endotoxins
Tischer C G, Hohmann C, Thiering E, et al (2011) Meta-analysis of mould and dampness exposure on asthma and allergy in eight European birth cohorts: an ENRIECO initiative. Allergy 66(12), 1570-9	Systematic review
Tischer C, Weikl F, Probst AJ, et al (2016) Urban Dust Microbiome: Impact on Later Atopy and Wheezing. Environmental health perspectives 124(12), 1919-1923	Study concerned with fungal ddiversity
Trevillian LF, Ponsonby AL, Dwyer T, et al (2003) An association between plastic mattress covers and sheepskin underbedding use in infancy and house dust mite sensitization in childhood: a prospective study. Clinical and experimental	Study concerned with sensitization

STUDY	REASON FOR EXCLUSION
allergy : journal of the British Society for Allergy and Clinical Immunology 33(4), 483-9	
Trupin L, Balmes J R, Chen H et al (2010) An integrated model of environmental factors in adult asthma lung function and disease severity: a cross-sectional study. Environmental health : a global access science source 9, 24	Cross sectional study
Turunen M, Iso-Markku K, Pekkonen M, et al (2017) Statistical associations between housing quality and health among Finnish households with children - Results from two (repeated) national surveys. Science of the Total Environment 574, 1580-1587	Study does not report longitudinal data
Ulrik CS, Backer V, Hesse B, et al (1996) Risk factors for development of asthma in children and adolescents: findings from a longitudinal population study. Respiratory medicine 90(10), 623-30	Study does not report on prognostic factors
van Rossem L, Rifas-Shiman SL, Melly SJ, et al (2015) Prenatal air pollution exposure and newborn blood pressure. Environmental health perspectives 123(4), 353-9	Study is not concerned with indoor air pollution
Venn A J, Cooper M, Antoniak M et al (2003) Effects of volatile organic compounds, damp, and other environmental exposures in the home on wheezing illness in children. Thorax 58(11), 955-60	Case-control study and have cohort studies on VOC
Vesper SJ, McKinstry C, Haugland RA, et al (2007) Relative moldiness index as predictor of childhood respiratory illness. Journal of exposure science & environmental epidemiology 17(1), 88-94	Study does not report on risk as an outcome
Viegi G, Paoletti P, Carrozzi L, et al (1991) Effects of home environment on respiratory symptoms and lung function in a general population sample in north Italy. The European respiratory journal 4(5), 580-6	Cross sectional study
Vilcekova S, Apostoloski I Z, Meciarova L et al (2017) Investigation of Indoor Air Quality in Houses of Macedonia. International journal of environmental research and public health 14(1),	Country not similar to UK
Volk HE, Hertz-Picciotto I, Delwiche L, et al (2011) Residential proximity to freeways and autism in the CHARGE study. Environmental health perspectives 119(6), 873-7	Case control study and have cohort studies on proximity to traffic
Volk HE, Lurmann F, Penfold B, et al (2013) Traffic-related air pollution, particulate matter, and autism. JAMA psychiatry 70(1), 71-7	Study is not concerned with proximity to traffic
Volkmer R E, Ruffin R E, Wigg N R et al (1995) The prevalence of respiratory symptoms in South Australian preschool children. II. Factors associated with indoor air quality. Journal of paediatrics and child health 31(2), 116-20	Cross-sectional study
Wallace J, D'Silva L, Brannan J, et al . 2011. "Association between proximity to major roads and sputum cell counts". Canadian respiratory journal 18(1):13-8.	Study concerned with markers of illness

STUDY	REASON FOR EXCLUSION
Wang J, Cozen W, Thorne PS, et al (2013) Household endotoxin levels and the risk of non-Hodgkin lymphoma. Cancer causes & control : CCC 24(2), 357-64	Study is concerned in bacterial endotoxins
Wang J, Engvall K, Smedje G, et al (2014) Rhinitis, asthma and respiratory infections among adults in relation to the home environment in multi-family buildings in Sweden. PloS one 9(8), e105125	Cross sectional study
Wang J, Engvall K, Smedje G, et al (2017) Current wheeze, asthma, respiratory infections, and rhinitis among adults in relation to inspection data and indoor measurements in single-family houses in Sweden-The BETSI study. Indoor air 27(4), 725-736	Cross sectional study
Wang L, Hu W, Guan Q et al (2018). The association between cooking oil fume exposure during pregnancy and birth weight: A prospective mother-child cohort study. The Science of the total environment, 612, pp.822-830.	Country not similar to the UK
Ward MH, Colt JS, Deziel NC, et al (2014) Residential levels of polybrominated diphenyl ethers and risk of childhood acute lymphoblastic leukemia in California. Environmental health perspectives 122(10), 1110-6	Case control study and have cohort studies on VOC
Ward MH, Colt JS, Metayer C, et al (2009) Residential exposure to polychlorinated biphenyls and organochlorine pesticides and risk of childhood leukemia. Environmental health perspectives 117(6), 1007-13	Case control study and have cohort studies on VOC
Ware J H, Dockery D W, Spiro A, 3rd , Speizer F E, Ferris B G, and Jr (1984) Passive smoking, gas cooking, and respiratory health of children living in six cities. The American review of respiratory disease 129(3), 366-74	Study does not report results that can be re-used
Webb E, Blane D, de Vries , and Robert . 2013. "Housing and respiratory health at older ages". Journal of epidemiology and community health 67(3):280-5.	Study concerned with indicators of poor respiratory health
Wegienka G, Johnson CC, Havstad S, et al (2010) Indoor pet exposure and the outcomes of total IgE and sensitization at age 18 years. Journal of Allergy and Clinical Immunology 126(2), 274	Study did not adjust for confounders
White A J, Teitelbaum SL, Stellman S D, et al (2014) Indoor air pollution exposure from use of indoor stoves and fireplaces in association with breast cancer: a case-control study. Environmental Health: A Global Access Science Source 13(1), 135-158	Case control study and have cohort studies on heating
White AJ, Bradshaw PT, Herring AH, et al (2016) Exposure to multiple sources of polycyclic aromatic hydrocarbons and breast cancer incidence. Environment International 89, 185-192	Case control study and have cohort studies on PAH
Wickens K, Douwes J, Siebers R, et al (2003) Determinants of endotoxin levels in carpets in New Zealand homes. Indoor air 13(2), 128-35	Study is concerned with endotoxins

STUDY	REASON FOR EXCLUSION
Wilhelm M, and Ritz B (2003) Residential proximity to traffic and adverse birth outcomes in Los Angeles county, California, 1994-1996. Environmental health perspectives 111(2), 207-16	Case control study and we have cohort studies on proximity to traffic
Wilker Elissa H, Martinez-Ramirez Sergi, Kloog Itai et.al (2016) Fine Particulate Matter, Residential Proximity to Major Roads, and Markers of Small Vessel Disease in a Memory Study Population. Journal of Alzheimer's disease : JAD 53(4), 1315-23	Study concerned with markers of disease
Williamson IJ, Martin CJ, McGill G, et al (1997) Damp housing and asthma: a case-control study. Thorax 52(3), 229-34	Case control study and have cohort studies on damp
Wilson J, Dixon SL, Breysse P, et al (2010) Housing and allergens: a pooled analysis of nine US studies. Environmental research 110(2), 189-98	Systematic review
Wong G W. K, Brunekreef B, Ellwood P et al (2013) Cooking fuels and prevalence of asthma: a global analysis of phase three of the International Study of Asthma and Allergies in Childhood (ISAAC). The Lancet. Respiratory medicine 1(5), 386-94	Data not reported separately for countries similar to the UK
Xu X, and Wang L (1993) Association of indoor and outdoor particulate level with chronic respiratory illness. American Review of Respiratory Disease 148(6 I), 1516-1522	Country not similar to the UK
Yang A, Janssen NA, Brunekreef B, et al (2016) Children's respiratory health and oxidative potential of Pm^2.5: the PIAMA birth cohort study. Occupational and environmental medicine 73(3), 154-60	Study did not measure indoor air quality
Yang S I, Kim B J, Kim H B, et al (2015) Prenatal particulate matter/tobacco smoke increases infants' respiratory infections: COCOA study. Allergy, and Asthma and Immunology Research 7(6), 573-582	Country not similar to UK
Zacharasiewicz A, Zidek T, Haidinger G et al (1999) Indoor factors and their association to respiratory symptoms suggestive of asthma in Austrian children aged 6-9 years. Wiener klinische Wochenschrift 111(21), 882-6	Cross-sectional study
Zejda J E, and Kowalska M. (2003). Risk factors for asthma in school children--results of a seven-year follow-up. Central European journal of public health, 11(3), pp.149-54.	Study does not report on adjusted data on odds ratio/risk ratio
Zhang G, Spickett J, Lee A H, et al. 2006. Ever eczema and itchy rash in relation to domestic environments in primary school children. Indoor and Built Environment 15(6):535-541.	Cross sectional study
Zhao Zhiqing, Lin Faying, Wang Bennett, Cao Yihai, Hou Xu, and Wang Yangang (2016) Residential Proximity to Major Roadways and Risk of Type 2 Diabetes Mellitus: A Meta-Analysis. International journal of environmental research and public health 14(1),	Systematic review
Zock JP, Plana E, Anto JM, et al (2009) Domestic use of hypochlorite bleach, atopic sensitization, and respiratory	Pollutant not of interest

STUDY	REASON FOR EXCLUSION
symptoms in adults. Journal of Allergy and Clinical Immunology 124(4), 731	
Zota AR, Aschengrau A, Rudel RA, et al (2010) Self-reported chemicals exposure, beliefs about disease causation, and risk of breast cancer in the Cape Cod Breast Cancer and Environment Study: a case-control study. Environmental health : a global access science source 9, 40	Case control study
Zota A, Adamkiewicz G, Levy JI, et al (2005) Ventilation in public housing: implications for indoor nitrogen dioxide concentrations. Indoor air 15(6), 393-401	Cross sectional study

K.2 Economic studies

Please see cost-effectiveness review

Appendix L: Research recommendations

L.1.1 Building materials and impact on indoor air quality and health

Population	Adults and children without pre-existing health conditions
prognostic factors, exposure	prognostic factors health effects associated with exposure to pollutants from building materials o Respiratory health effects o Allergic health effects o Cardiac health effects o Pregnancy related health effects o Cancer health effects
Outcomes	Adjusted risk ratios and odd ratios reported for health risk associated with prognostic factor(s) and the presence pollutants from building materials.
Study design	Cohort study design with only multivariate analysis adjusting for variables that might confound results. For example, ingress of outdoor air, presence of damp and mould, presence of open fires or use of gas stoves
Timeframe	At least 1 year follow up

Rationale: While there is epidemiological evidence showing associations between exposure to sources of indoor air pollutants such as gas cookers and poor health outcomes such as wheeze or cough, there is no evidence specific to indoor pollutants from building materials and its impact on people's health. Evidence about harms that may be associated with the use of building materials in new and old buildings would improve understanding and inform occupants, designers and architects of these materials.