The impacts of household damp and mould on human health: a review of the literature

1. Introduction

1.1. How does household damp and mould affect health?

People spend a large portion of their day indoors, especially within their own homes. The quality of the air they breathe during this time is an important determinant of their health and wellbeing. As such, indoor air pollution is a major cause of morbidity and mortality across low, middle, and high-income countries (1).

Microbial indoor air pollutants that are relevant to health include bacteria, fungi, algae, and some protozoa (1). The presence of many of these in the indoor environment is primarily due to dampness and inadequate ventilation (1). Excess moisture within the household environment can lead to the growth of these microbes, which can subsequently emit spores, cells, allergens, mycotoxins and volatile organic compounds (VOCs) into the air (1–3). Dampness also increases the risk of house dust mite and can initiate chemical or biological degradation of materials, which can pollute indoor air (1,2,4).

The mechanisms by which non-infectious microbial exposures associated with indoor air dampness and mould affect health are largely unknown, but they are likely to be multiple (1). Suggested mechanisms include inflammatory, allergic, cytotoxic and immunosuppressive responses to the spores, metabolites and components of microbial species (1,3).

1.2. Prevalence of household damp and mould

The prevalence of household damp varies widely within and between countries, and is related to a variety of factors, including climate, building construction and age (1,5). A review of studies conducted in Europe, Canada and the United States concluded that in most datasets, at least 20% of buildings have one or more signs of damp, although this is based largely on self-reporting rather than objective measures (2). More recently, the European Community Respiratory Health Survey (ECRHS II), which includes homes in the UK found self-reported dampness in 20.5% of homes, and self-reported mould in 15.8% of homes over a 12 month period (5). The proportion judged to have mould or dampness after objective assessment was similar. However, figures from the English Housing Survey were much lower. In the 2 years to March 2019, an average of 3% of households in England reported having damp (rising damp, penetrating damp, serious condensation, or mould) in at least one room of their home (6).

Although these surveys did not provide prevalence data by area deprivation or socio-economic status, the World Health Organisation (WHO) suggests that the prevalence of household damp and mould is likely to be highest in poorly maintained housing, lived in by people on a low income (1). The reasons for this are multiple, but fuel poverty is likely to be a major factor, since damp and mould problems are more common in cold, poorly insulated homes (7). Data from the English Housing survey also suggests that there are differences in household damp prevalence by ethnicity, with Mixed White and Black Caribbean (13%), Bangladeshi (10%), Black African (9%) and Pakistani (8%) households more likely to report damp than White British households (3%) (6). Given the health impacts, these disparities in prevalence between different population groups mean that household damp and mould is a significant driver of heath inequalities.

1.3. Purpose of this paper

Knowledge about the health impacts of poor indoor air quality, and the factors that cause it are key to enabling action by relevant stakeholders. This paper provides a summary of the literature focusing on the health impacts of household mould and damp. The aim is to inform the system-wide response to the recent death of Awaab Ishak, who died as a result of a severe respiratory condition due to prolonged exposure to mould in his home environment. Through collective action, it is hoped that future deaths and ill health due to household damp and mould can be prevented.

2. Methods

A literature search, using the research question: "What are the impacts of household damp and mould on human health?" was conducted by the UKHSA Knowledge and Library Services during the last week of November 2022. Limits applied include English language, and academic articles published between 2002 to the current day. Searches were made of CINAHL, Emcare, Embase, Global Health, Google, Medline and NICE evidence. Further details of the search strategy are provided in Appendix 1.

3. Results

3.1. Literature review

After de-duplication and screening for relevance, 303 articles were identified as fitting the inclusion criteria. Due to the volume of articles, these were sorted into the following categories:

- 2018 onwards (last 5 years)
- Reviews
- Top 25 (closest fit to the research question)
- Damp specific (mention of "damp" and "home/house" in title or abstract)
- Mould specific (mention of "mould/mold" in title or abstract)
- General domestic environmental risks regarding air quality/fungus growth.

A summary of the papers is attached in Appendix 2.

In total, 23 reviews (including narrative literature reviews, systematic reviews, and meta-analyses) were identified. All of these were read in full, and 18 were considered relevant for inclusion in this paper. A further ten reviews were identified from the reference lists of these articles. In light of the number of available reviews, the focus of this paper is on the evidence they present.

The findings have been categorised according to health impacts and are summarised below.

3.2. Asthma

Numerous studies have looked at the association between indoor damp and mould and asthma or asthma symptoms in both adults and children. In 2004, the Institute of Medicine (IoM) published a review looking at the impact of damp indoor spaces on health (2). They concluded that there was sufficient evidence of an association between exposure to a damp indoor environment and/or mould and the presence of asthma symptoms in people with asthma. They also found limited or suggestive evidence of an association between exposure and asthma development. Five years later, both the WHO, and Mendell et al., included additional studies in two updated reviews, and went further to say that there was *almost* sufficient evidence of causality in the relationship between indoor damp/mould and

increased risk of asthma exacerbation (1,8). They also concluded there was now sufficient evidence of an association between indoor dampness and asthma development. However, neither review drew conclusions for adults and children separately.

Most recently, Caillaud et al. (9) conducted a systematic review looking specifically at the impact of indoor mould exposure on asthma (separately in adults and children), and identified seven meta-analyses, four systematic reviews, and 27 longitudinal or panel studies published between January 2006 and November 2017. This included several systematic reviews and meta-analyses identified in our search (8,10–16). They concluded for the first time that there was now sufficient evidence of a causal relationship between exposure to indoor moulds and the development and exacerbation of asthma in children. In adults, they concluded that there was sufficient evidence of an association between indoor mould exposure and asthma exacerbation and the development of asthma in relation to work in a mouldy and damp building. However, they found limited evidence of the effect of indoor mould exposure on asthma onset in adults in the general population due to insufficient data.

In terms of quantifying these associations, Quansah et al. (12) conducted a systematic review and meta-analysis including only cohort and incident case-control studies to look at the impact of residential dampness and mould on asthma development (both doctor diagnosed and asthma symptoms) in both adults and children (although only 2 of the 16 included studies involved adults). The authors found that exposure to household damp or mould was associated with a 50% increase in the risk of asthma onset (95% CI 1.25–1.80). Significant impacts were also found separately for dampness (EE 1.33; 95% CI 1.12–1.56), visible mould (EE 1.29; 95% CI 1.04–1.60), and mould odour (EE 1.73; 95% CI 1.19–2.50), but not for water damage (EE 1.12, 95% CI 0.98–1.27).

Two large cohort studies, not included in this review and meta-analysis, but described in another recent review (17), have looked at dampness or mould and risk of asthma onset specifically in adults. One 9-year follow-up of young adults, within a population-based cohort study (ECRHS) from 13 countries (n = 7104), found an increased onset of asthma in homes with reports of water damage (RR 1.46; 95% CI 1.09–1.94) and indoor moulds (RR 1.30; 95% CI 1.00–1.68) at baseline (18). A dose–response effect was also observed. The authors concluded the population attributable risk was 3–10% for reported, and 3–14% for observed dampness/mould. Another 9-year follow-up within the population-based cohort RHINE from five countries in Northern Europe (n = 11,441) found associations between dampness, mould and mould odour at home and onset of asthma symptoms/ doctor diagnosed asthma (19). For doctor diagnosed asthma, the overall risk estimate (OR) for any type of household dampness at baseline was 1.43 (95% CI 1.12–1.82) and for mould odour it was 2.23 (95% CI 1.48–3.37).

A meta-analysis of eight birth cohort studies has also been published, investigating the role of dampness and mould at home on the risk of asthma and allergy development specifically in children (11). It concluded that exposure to visible mould and/or dampness in the first two years of life is associated with an increased risk of developing asthma, specifically in very young children aged 0-2 years (OR 1.39; 95% CI 1.05–1.84) (the association was not significant in older children).

Most of the studies described above used qualitative methods to assess exposure to damp and mould (water damage, visible mould, mould odours). Regarding quantitative exposure to culturable fungi, the evidence is less well developed. In their 2015 review Kanchongkittiphon et al. (15) identified limited evidence to suggest associations between quantified indoor culturable Penicillium or total fungi and exacerbation of asthma, but called for future studies to clarify the relationship. Similarly, in a 2014 systematic review (17 observational studies) and meta-analysis (7 studies), Sharpe et al. (16) found that certain fungal species were

present at higher concentrations in homes of asthmatic patients, and that the presence of Cladosporium, Alternaria, Aspergillus, and Penicillium species increased the exacerbation of current asthma symptoms by 36-48% compared with those exposed to lower concentrations of these fungi. However, the review included only one small case-control study in the UK, and the included studies were judged to be of medium quality, with many not accounting for covariates.

Mendell et al. explored the relationship between measured building moisture and occupant health effects due to microbial growth in their 2018 review, (20). Two studies, conducted in the UK, both reported dose-related increases in asthma exacerbation with higher measured moisture, with 1 study reporting an adjusted odds ratio of 7.0 for night-time asthma symptoms with higher bedroom moisture.

3.3. Rhinitis

The WHO review included 6 studies (3 prospective and 3 cross-sectional) looking at allergic rhinitis and concluded there was some evidence to suggest increased risks for occupants of damp and mouldy buildings, but that this was inconsistent (1). Similar findings were reported by Mendell et al. in their review published in 2011 (8). Stronger positive conclusions were reported in a more recent (2013) systematic review and meta-analysis of 31 observational studies (largely cross-sectional) looking at the impact of indoor dampness and moulds in both adults and children (21). The authors concluded that dampness and mould at home are determinants of rhinitis and its subcategories. In the meta-analysis, the summary effect estimate for any type of exposure was 2.08 (95% CI 1.56–2.75). When considering specific exposures (water damage, dampness, visible mould or mould odour), the largest risk was observed for mould odour (EE 2.18; 95% CI, 1.76-2.71) (21).

Tischer et al. (10) conducted a systematic review and meta-analysis of observational studies (both cross-sectional and longitudinal) in 2011, focusing on children only. In accordance with the results detailed above, the authors found an association between visible domestic mould and allergic rhinitis (OR 1.39; 95% CI 1.28–1.51) and stated that “the results were consistent with the evaluation of causation according to Hill’s criteria”. However, they found some evidence of moderate publication bias.

The same authors conducted a meta-analysis in eight European birth cohorts (including two in the UK) later in the same year and found that exposure to self-reported visible mould and/or dampness during the first 2 years of life was associated with a significantly increased risk of symptoms of allergic rhinitis at school age (6–8 years: aOR 1.12; 95% CI 1.02–1.23)) and at any time point between 3 and 10 years (aOR, 1.18, 95% CI 1.09–1.28) (11). Potential confounders that were adjusted for included gender, parental atopy, parental educational level, maternal smoking, environmental tobacco smoke, breastfeeding, and early day care attendance.

Most recently, Caillaud et al. (9) conducted a review of the literature published between 2006 and 2017 on the associations between indoor mould exposure and rhinitis in children and adults with a focus on longitudinal epidemiological studies. They concluded that there was sufficient evidence of an association, with an odds-ratio generally greater than 1.35 across the included studies. However, the authors noted that some studies have suggested there is a possible decreased risk of allergic rhinitis in individuals exposed to mould-derived components and highlighted the need for further longitudinal studies to provide conclusive evidence.

3.4. Respiratory symptoms

In their 2004 review, the IoM found sufficient evidence of an association between exposure to a damp indoor environment and/or mould and upper respiratory (nasal and throat) symptoms, cough and wheeze (2). Subsequent reviews by the WHO and Mendell et al. identified numerous additional studies (although most were cross-sectional in nature and not of improved quality), and came to the same conclusions (1,8). The summary estimate (OR) in both adults and children calculated from the latter of these reviews, was 1.67 (95% CI 1.49–1.86) for cough, 1.50 (95% CI 1.38–1.64) for wheeze, and 1.70 (95% CI 1.44–2.00) for upper respiratory tract symptoms (22).

Most recently, Fakunle et al. conducted a systematic review and meta-analysis of studies up to February 2020, investigating whether exposure to microbial aerosols (defined as the presence of specific microbial communities (bacteria, fungi, viruses, and/or microbial by-products) or visible moulds) within the indoor environment are associated with respiratory symptoms among children under 5 years of age (23). Fifteen non-UK cohort studies were included in in the meta-analysis, eight of which were assessed to have a high risk of bias, and most of which focused on self-reported wheeze as an outcome. The pooled risk estimate showed a significant association between objectively measured microbial exposure and respiratory symptoms (RR: 1.24; 95% CI 1.09, 1.41). The association was strongest with exposure to a combination of Aspergillus, Penicillium, Cladosporium and Alternaria species (pooled RR: 1.73; 95% CI 1.30, 2.31).

3.5. Respiratory infections

The WHO review included eight observational studies (five cross-sectional and three prospective) looking at the risk of indoor damp and mould on upper and lower respiratory tract infections in otherwise healthy people (largely children), and concluded there was enough evidence to show increased risk (except in otitis media) (1). A later review and meta-analysis, including 19 studies, came to the same conclusion for both adults and children (8,14). The risk estimates (OR) in the latter were 1.38 (95% CI 1.21–1.57) for common cold, 1.44 (95% CI 1.32–1.58) for any respiratory infection, and 1.45 (95% CI 1.34 – 1.56) for bronchitis (14).

Most recently, Fakunle et al. (24) investigated whether exposure to microbiome (defined as visible moulds or specific microorganisms identified to genus level), within the indoor environment is associated with risk of lower respiratory tract infections (LRTI) among children under 5 years of age. The meta-analysis included 7 non-UK studies (2 cohort and 5 case-control studies), 4 of which were judged to have a low risk of bias, and 3 a high risk of bias. The authors found that exposure to a higher concentration of indoor microbiome was associated with an increased risk of LRTI (OR 1.20, 95% CI 1.11-1.33). The risk was stronger with exposure to total fungal concentration (OR 1.27, 95% CI 1.13-1.44) than visible moulds (OR 1.20, 95% CI 1.07-1.34). However, the nature of the included studies meant that causality could not be inferred. In their discussion, Fakunle et a. postulated that “continuous activation of immune responses from fungal exposures may contribute to inflammation-related diseases, and the resulting inflamed mucosal tissue may result in respiratory infections”. The WHO suggest that the immunosuppressive effects of damp building-associated microbes could be an alternative explanation for the observed increase in respiratory infections associated with damp buildings (1).

Opportunistic infection with Aspergillus and other fungi is a well-known complication in patients who are susceptible or immunosuppressed. However, the WHO review found no studies to link such infections to mould in the indoor environment, and suggested that the infecting agents are not those typically encountered in damp houses (1).

3.6. Other health effects

A variety of other health effects associated with household damp and mould are reported in the literature. In particular, the WHO review found clinical evidence that exposure to mould and other dampness-related microbial agents increases the risks of rare conditions, such as hypersensitivity pneumonitis, allergic alveolitis, and allergic fungal sinusitis (1)

A recently published book has highlighted the increasing number of cross-sectional studies from around the world that show an association between household dampness and/or mould and atopic dermatitis or eczema (17). Studies mostly focus on paediatric populations, but several also include adults. The same book reports on the association between damp indoor environments and 'sick building syndrome' (SBS) identified in a small number of studies (17). SBS refers to a set of varying non-specific building-related symptoms, including eye, nose, throat and dermal symptoms, headache, and fatigue. Avoidance of the problematic indoor environment is reported to resolve the symptoms (17,25). However, in a review focusing on the Australian literature, Coulburn et al. suggest there is evidence that reversible SBS can proceed to irreversible hypersensitivity to dampness and/or mouldy indoor conditions that can affect many body systems, and is linked to autoimmunity and conditions such as postural tachycardia syndrome (POTS) and chronic fatigue syndrome (25). The authors also found limited evidence of an association between household mould and gastrointestinal infections in children, atopy, depression and joint pain (25).

Another important issue is quality of life related to dampness or mould at home. Few studies appear to be available on this topic, although there is some limited evidence that workplace dampness or mould is associated with poorer quality of life and impaired work ability (17). Norback et al. identified two studies (one cohort study and one cross-sectional study, both conducted in Europe), suggesting that dampness and mould at home can impair sleep quality in both adults and children (17).

3.7. The health benefits of action to address household damp and mould

There is a paucity of studies looking at the health benefits of targeted action to address household mould and damp, although given the weight of evidence described above, it is reasonable to assume this will be of significant benefit. The WHO report states that "Although few intervention studies were available, their results show that remediation of dampness can reduce adverse health outcomes" (1). Similarly, a 2010 review looking at housing interventions to reduce exposure to indoor biological agents implicated in asthma exacerbations found that combined elimination of moisture intrusion and leaks and removal of mouldy items was likely to be effective at reducing asthma symptoms in people with asthma (26).

The largest study included in this review (164 homes) was a randomized controlled trial (RCT) of visible mould eradication (with removal, fungicide application, and ventilation fan installation) among adults and children with asthma in South Wales (27). The authors found that peak expiratory flow rate variability did not differ between the two groups, but the intervention group had significant improvements in asthma symptoms at 6 months and significant reductions in preventer and reliever use at 12 months.

A second RCT found that comprehensive removal of sources of dampness and mould and cleaning of visible mould in the houses of highly symptomatic US children with asthma significantly reduced exacerbations (28). Acute care visits at 6–12 months after intervention were 90% fewer in those remediated versus controls. While both studies were (necessarily) unblinded, and had small sample sizes, they show important positive impacts of action.

A more recent Cochrane review evaluated health improvements after interventions in damp buildings (29). A total of 12 studies were identified (8028 participants); two RCTs, one cluster RCT and nine controlled before-after studies. The interventions varied from thorough renovation to cleaning only. Repairing houses decreased asthma-related symptoms in adults (OR 0.64; 95% CI 0.55–0.75), respiratory infections (OR 0.57; 95% CI 0.49–0.66) and rhinitis (OR 0.57; 95% CI 0.49–0.66). The conclusion from the review was that there is moderate to low-quality evidence that repairing mould-damaged houses and offices decreases asthma-related symptoms and respiratory infections in adults as compared to no intervention. The authors suggest that better research, with more validated outcome measures, is needed.

3.8. Limitations of the current evidence base

With few exceptions, most of the published literature in this topic comes from observational studies of varying quality. The results of these may have been prone to significant bias and confounding and largely cannot be used to determine causality. In particular, many of the included studies relied on self-reported indicators of mould and damp, which may have introduced reporting bias. For example, residents with health problems may be more aware of indoor dampness/moulds, and vice-versa, making them more likely to over-report the situation. Alternatively, others may under-report if they are not aware of the problems or if the problems are perceived as mild. While some authors have noted discrepancies between measured and self-reported damp and mould (4), others have found them to be similar (5).

Although some of the included studies adjusted for potential confounding factors, such as socioeconomic status, deprivation, house dust mite infestation, family history, cold housing, and smoking, many did not, and residual confounding may have affected the results. Furthermore, uncertainty about the causal exposures must be considered when interpreting the findings. While microbiological organisms (such as fungi) are considered among the most plausible explanations for the health risks associated with indoor dampness, further research is needed to clarify the exact nature of the relationship (including causative species, 'safe' exposure thresholds, and the role of co-exposure to multiple organisms). Household damp is also related to other factors, such as dust mites and chemical emissions from damp materials, which may provide other causative mechanisms for disease.

4. Relevant guidelines for addressing household mould and damp

Although the appropriate response for dealing with household damp and mould is outside the scope of this review, the following advice is available in the included literature.

In 2009, the WHO report concluded that; "As the relationships between dampness, microbial exposure and health effects cannot be quantified precisely, no quantitative, health-based guideline values or thresholds can be recommended for acceptable levels of contamination by microorganisms. Instead, it is recommended that dampness and mould-related problems be prevented. When they occur, they should be remediated because they increase the risk of hazardous exposure to microbes and chemicals" (1). This difficulty in developing guidelines that specify 'unhealthy' levels of household damp and mould has been echoed in later literature (30). Although studies show that as observed household damp/mould increases, the associated health risks also increase (often in a dose-related fashion), the evidence-based public health advice is currently limited to recommendations to prevent or remediate any indoor damp or mould that can be seen or smelled (30).

The IOM provides the following advice: "Homes and other buildings should be designed, operated, and maintained to prevent water intrusion and excessive moisture accumulation

when possible. When water intrusion or moisture accumulation is discovered, the source should be identified and eliminated as soon as practicable to reduce the possibility of problematic microbial growth and building material degradation. The most effective way to manage microbial contaminants, such as mould, that are the result of damp indoor environments is to eliminate or limit the conditions that foster its establishment and growth. That also restricts the dampness-related degradation of building materials and furnishings" (2). More details of guidance on how to respond to damp and mould are contained within the report.

On the basis of their 2009 evidence review (1), the WHO formulated the following guidelines:

- Persistent dampness and microbial growth on interior surfaces and in building structures should be avoided or minimized, as they may lead to adverse health effects.
- Indicators of dampness and microbial growth include the presence of condensation on surfaces or in structures, visible mould, perceived mouldy odour and a history of water damage, leakage or penetration.
- Thorough inspection and, if necessary, appropriate measurements can be used to confirm indoor moisture and microbial growth.
- As the relations between dampness, microbial exposure and health effects cannot be quantified precisely, no quantitative health-based guideline values or thresholds can be recommended for acceptable levels of contamination with microorganisms. Instead, it is recommended that dampness and mould-related problems be prevented. When they occur, they should be remediated because they increase the risk of hazardous exposure to microbes and chemicals.
- Well-designed, well-constructed, well-maintained building envelopes are critical to the prevention and control of excess moisture and microbial growth, as they prevent thermal bridges and the entry of liquid or vapour-phase water.
- Management of moisture requires proper control of temperatures and ventilation to avoid excess humidity, condensation on surfaces and excess moisture in materials.
- Ventilation should be distributed effectively throughout spaces, and stagnant air zones should be avoided.
- Building owners are responsible for providing a healthy workplace or living environment free of excess moisture and mould, by ensuring proper building construction and maintenance. The occupants are responsible for managing the use of water, heating, ventilation, and appliances in a manner that does not lead to dampness and mould growth.
- Dampness and mould may be particularly prevalent in poorly maintained housing for low-income people. Remediation of the conditions that lead to adverse exposure should be given priority to prevent an additional contribution to poor health in populations who are already living with an increased burden of disease.

The following NICE guidance may be useful for local authorities and housing bodies wishing to improve indoor air quality in houses in their area: Overview | Indoor air quality at home | Guidance | NICE. The following resources may also be useful for tenants and homeowners experiencing damp and mould issues:

- WHO: information brochure
- Shelter: damp and mould in rented homes
- Citizen's advice: damp repairs
- NHS: health effects of cold and damp

- Oldham Council: Mould and damp in the home | Mould and damp in the home | Oldham Council

5. Conclusions

A large body of research from across many different countries and settings has now consistently associated subjectively and qualitatively assessed household damp and mould with increases in a variety of adverse health effects in both adults and children, including asthma development and exacerbation, allergic rhinitis, and respiratory infections. While causality has not yet been established for many of these outcomes (except for the exacerbation and development of asthma in children), given the reported prevalence of household damp and mould in the UK, an important proportion of common illnesses may be attributable to residential damp and mould and could therefore be preventable. The risk of living in a property affected by damp or mould varies by factors such as ethnicity and socio-economic status, meaning that addressing this problem will both improve population health and tackle health inequalities.

The mechanism behind the health effects of household damp is not fully understood but is likely to be mediated through the increased risk of microbial agents such as bacteria and fungi, which may subsequently emit spores, cells, allergens, mycotoxins and VOCs, causing health problems through inflammatory, allergic, cytotoxic and immunosuppressive responses.

There is insufficient information on which to base quantitative recommendations for either the appropriate level of dampness reduction or the “safe” level of exposure to dampness-related agents. As such, it is recommended that all household dampness and mould-related problems be prevented or remediated as soon as possible.

The importance and relevance of this topic is likely to grow in future years because of climate change (increasing the risk of flooding and storm damage to residential properties), and the cost-of-living crisis/ associated fuel poverty (leading to colder homes, increased condensation, and reduced ventilation).

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Appendix 1: Search strategy and results

Knowledge & Library Services: Search results

Searcher: Megan Cox (Megan.Cox@ukhsa.gov.uk)
Person requesting search: Alison Pye
Date of request: 28/11/2022 **Date results sent: 01/12/2022**
Level of search: (1) bibliography

Search question:

What are the impacts of household damp and mould on human health?

Terms used:
See below.

Limits applied:

Age group	Language	Publication type	Time limit
	English	Academic	2002-2022

Summary of resources searched and results:

Source	No. of results*
CINAHL	38
Emcare	55
Embase	13
Global Health	584 (using Citation Chaser, see appendix)
Google	16
Medline	9
NICE Evidence	1

TOTAL after deduplication and screening for relevance = 303

Disclaimer
Although every effort has been made to ensure this information is accurate, it is possible it may not be representative of the whole body of evidence available. Both articles and internet resources may contain errors or out of date information. None of the resources have been critically appraised. No responsibility can be accepted for any action taken on the basis of this information.

Appendix: Search strategy
Global Health

#	Query	Limiters/Expanders	Last Run Via	Results
S6	S1 AND S2 AND S3	Limiters - Publication Year: 20020101-20221231 Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - Global Health	96
S5	S1 AND S2 AND S3	Limiters - Publication Year: 20220101-20221231 Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search	2

			Database - Global Health	
S4	S1 AND S2 AND S3	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - Global Health	117
S3	health AND impact OR impacts OR implications	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - Global Health	391,095
S2	Respiratory symptoms OR asthma OR respiratory infections OR allergy OR eczema OR bronchitis OR wheeze OR hay fever	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - Global Health	105,255
S1	(mould OR mold OR damp) AND (Household OR residential OR indoor OR home OR domestic)	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - Global Health	2,025

Database:

Ovid Emcare <2021 to 2022 Week 46>

#	**Query**	**Results from 29 Nov 2022**
1	mould.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word]	323
2	damp.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word]	295
3	mold.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word]	1,150
4	Household.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word]	20,921
5	residential.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word]	9,465

6	indoor.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word]	3,681
7	home.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word]	64,445
8	domestic.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word]	11,245
9	Health impact*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word]	4,267
10	Respiratory symptoms.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word]	2,238
11	asthma.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word]	14,843
12	respiratory infections.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word]	2,468
13	allergy.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word]	7,751
14	eczema.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word]	1,337
15	bronchitis.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word]	1,197
16	wheeze.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word]	563
17	hay fever.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word]	150
18	1 or 2 or 3	1,716
19	4 or 5 or 6 or 7 or 8	102,652
20	9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17	31,053
21	18 and 19 and 20	76
22	limit 21 to (english and last 10 years)	55

Database:

Embase <1974 to 2022 November 28>

#	Query	Results from 29 Nov 2022
1	mould.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word, floating subheading word, candidate term word]	10,699
2	damp.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word, floating subheading word, candidate term word]	6,354
3	mold.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word, floating subheading word, candidate term word]	17,275

4	Household.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word, floating subheading word, candidate term word]	119,050
5	residential.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word, floating subheading word, candidate term word]	64,351
6	indoor.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word, floating subheading word, candidate term word]	50,353
7	home.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word, floating subheading word, candidate term word]	457,272
8	domestic.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word, floating subheading word, candidate term word]	126,595
9	Health impact*.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word, floating subheading word, candidate term word]	26,639
10	Respiratory symptoms.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word, floating subheading word, candidate term word]	29,877
11	asthma.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word, floating subheading word, candidate term word]	324,353
12	respiratory infections.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word, floating subheading word, candidate term word]	25,672
13	allergy.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word, floating subheading word, candidate term word]	218,312
14	eczema.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word, floating subheading word, candidate term word]	46,738
15	bronchitis.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word, floating subheading word, candidate term word]	51,261
16	wheeze.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word, floating subheading word, candidate term word]	8,917
17	hay fever.mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word, floating subheading word, candidate term word]	8,596
18	1 or 2 or 3	32,043
19	4 or 5 or 6 or 7 or 8	762,620
20	10 or 11 or 12 or 13 or 14 or 15 or 16 or 17	590,079
21	9 and 18 and 19 and 20	19

22	limit 21 to (english and last 10 years)	13

Database:
Ovid MEDLINE(R) ALL <1946 to November 28, 2022>

#	Query	Results from 29 Nov 2022
1	mould.mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	5,119
2	damp.mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	4,882
3	mold.mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	14,690
4	Household.mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	87,150
5	residential.mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	45,166
6	indoor.mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	40,491
7	home.mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	294,169
8	domestic.mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	111,069
9	Health impact*.mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	18,618
10	Respiratory symptoms.mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism	19,443

	supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	
11	asthma.mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	193,665
12	respiratory infections.mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	19,247
13	allergy.mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	92,097
14	eczema.mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	24,151
15	bronchitis.mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	34,292
16	wheeze.mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	5,493
17	hay fever.mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	3,919
18	1 or 2 or 3	24,401
19	4 or 5 or 6 or 7 or 8	545,557
20	10 or 11 or 12 or 13 or 14 or 15 or 16 or 17	345,665
21	9 and 18 and 19 and 20	11
22	limit 21 to (english and last 10 years)	5

#	Query	Limiters/Expanders	Last Run Via	Results
S6	S1 AND S2 AND S3 AND S4	Limiters - Published Date: 20020101-20221231 Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	38
S5	S1 AND S2 AND S3 AND S4	Expanders - Apply equivalent subjects	Interface - EBSCOhost Research Databases	40

		Search modes - Boolean/Phrase	Search Screen - Advanced Search Database - CINAHL Complete	
S4	Health AND impact OR impacts OR implications	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	648,522
S3	Respiratory symptoms OR asthma OR respiratory infections OR allergy OR eczema OR bronchitis OR wheeze OR hay fever	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	99,512
S2	Household OR residential OR indoor OR home OR domestic	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	301,604
S1	Mould OR mold OR damp*	Expanders - Apply equivalent subjects Search modes - Boolean/Phrase	Interface - EBSCOhost Research Databases Search Screen - Advanced Search Database - CINAHL Complete	9,341

Cochrane

21 Cochrane Reviews matching mould in Title Abstract Keyword OR mold in Title Abstract Keyword OR damp in Title Abstract Keyword AND effective in Title Abstract Keyword AND behavior change in Title Abstract Keyword - in Cochrane Reviews (Word variations have been searched)

Citation Chase (488)

Forward citations for the following articles:

Indoor dampness and mould health effects – ongoing questions on microbial exposures and allergic versus nonallergic mechanisms: JM Cox-Ganser

Residential Dampness and Molds and the Risk of Developing Asthma: A Systematic Review and Meta-Analysis. Quansah et al.

Indoor fungal diversity and asthma: A meta-analysis and systematic review of risk factors. Sharpe et al.

Association between domestic mould and mould components, and asthma and allergy in children: a systematic review. Tisher et al.

Appendix 2: Papers obtained from the initial literature search

Copy of
20221129MLCMould