Strategies for reducing exposure to indoor air pollution from household burning of solid fuels: effects on acute lower respiratory infections in children under the age of 15 years (Protocol)

Havens D, Jary HR, Patel LB, Chiume ME, Mortimer KJ

This is a reprint of a Cochrane protocol, prepared and maintained by The Cochrane Collaboration and published in The Cochrane Library 2015, Issue 9

http://www.thecochranelibrary.com

WILEY
# Table of Contents

| Section                                      | Page |
|----------------------------------------------|------|
| Header                                       | 1    |
| Abstract                                     | 1    |
| Background                                   | 1    |
| Objectives                                   | 3    |
| Methods                                      | 3    |
| Acknowledgements                             | 6    |
| References                                   | 7    |
| Appendices                                   | 8    |
| Contributions of Authors                     | 9    |
| Declarations of Interest                     | 9    |
| Sources of Support                           | 10   |

Strategies for reducing exposure to indoor air pollution from household burning of solid fuels: effects on acute lower respiratory infections in children under the age of 15 years (Protocol)  
Copyright © 2015 The Authors. The Cochrane Database of Systematic Reviews published by John Wiley & Sons, Ltd. on behalf of The Cochrane Collaboration.
Strategies for reducing exposure to indoor air pollution from household burning of solid fuels: effects on acute lower respiratory infections in children under the age of 15 years

Deborah Havens1, Hannah R Jary2, Latifa B Patel3, Msandeni E Chiume4, Kevin J Mortimer5

1Liverpool School of Tropical Medicine, Liverpool, UK. 2Respiratory Infection Group, Liverpool School of Tropical Medicine, Liverpool, UK. 3University of Manchester, Manchester, UK. 4Department of Paediatrics and Child Health, Ministry of Health, Blantyre, Malawi. 5Department of Clinical Sciences, Liverpool School of Tropical Medicine, Liverpool, UK

Contact address: Deborah Havens, Liverpool School of Tropical Medicine, Pembroke Place, Liverpool, Merseyside, L3 5QA, UK. havensde@hotmail.com, chilumba1234@gmail.com, deborah.havens@lstmed.ac.uk.

Editorial group: Cochrane Acute Respiratory Infections Group.
Publication status and date: New, published in Issue 9, 2015.

Citation: Havens D, Jary HR, Patel LB, Chiume ME, Mortimer KJ. Strategies for reducing exposure to indoor air pollution from household burning of solid fuels: effects on acute lower respiratory infections in children under the age of 15 years. Cochrane Database of Systematic Reviews 2015, Issue 9. Art. No.: CD011870. DOI: 10.1002/14651858.CD011870.

Copyright © 2015 The Authors. The Cochrane Database of Systematic Reviews published by John Wiley & Sons, Ltd. on behalf of The Cochrane Collaboration. This is an open access article under the terms of the Creative Commons Attribution Licence, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

This is the protocol for a review and there is no abstract. The objectives are as follows:

This study aims to assess the effects of intervention strategies that reduce exposure to household air pollution from burning solid fuels on episodes of acute lower respiratory infection (ALRI) in children under the age of 15 years.

BACKGROUND

Description of the condition

Respiratory infections may occur anywhere in the respiratory tract: the nose, throat, trachea, bronchi or lungs. They can be caused by viruses, bacteria or fungal agents. Acute lower respiratory infections (ALRIs) are infections that affect the airways below the epiglottis and encompass bronchitis, bronchiolitis and pneumonia, while upper respiratory infections include those diseases occurring above the epiglottis such as pharyngitis, laryngitis or rhinitis (Simoes 2006). Knowledge of the specific location of a respiratory infection can affect the suspected aetiological agents, prognosis and treatment.

ALRIs are the leading cause of death in children worldwide, with pneumonia alone killing an estimated 1.4 million children below the age of five annually (WHO 2014b). It has also been estimated that 99% of the deaths due to severe or very severe ALRIs occurred in low-income countries (Nair 2013). Risk factors for ALRIs include decreased immunity due to conditions such as malnutrition, pre-existing illnesses such as measles or HIV, and environmental factors that include overcrowding, parental smoking and household air pollution (WHO 2014b).

Household air pollution is most commonly due to burning solid fuels, including coal and biomass fuels such as wood, animal dung,
crop residue and charcoal. Half of the world’s population rely on burning these fuels for essential everyday activities such as cooking, heating and lighting (Desai 2004). Burning these fuels in an inefficient manner can lead to incomplete combustion and the release of various substances such as carbon monoxide, respirable particles of various sizes (particulate matter), nitrogen oxides, polycyclic aromatic hydrocarbons and other health-damaging pollutants (Naehrer 2007). Burning these fuels indoors can repetitively expose individuals to levels of pollutants at much higher levels than those that have been recommended with respect to health and ambient air quality (von Schirnding 2000).

Exposure to household air pollution from the burning of solid fuels for cooking is the cause of approximately 5% of the global disease burden overall (Smith 2014). Many of the world’s poorest people do not have access to cleaner fuels, such as gas or electricity, and often cook on open fires in poorly ventilated homes. This exposes those who are cooking on the fire, usually women, and their young children who may be carried on their back or playing nearby, to levels of indoor air pollution many times higher than internationally recommended safe levels and often for extended periods of time (estimated at three to seven hours per day for years) (Ezzati 2001; WHO 2005). This exposure to household air pollution from the burning of solid fuels is a recognised risk factor for ALRIs in children, with a recent meta-analysis calculating an overall pooled odds ratio (OR) of 1.78 (95% confidence interval (CI) 1.45 to 2.18) (Dherani 2008). There is also good evidence for correlations between the products of combustion, such as carbon monoxide and particulate matter, and the occurrence of ALRIs. For example, an exposure-response correlation between particulate matter and child ALRI was described in the World Health Organization (WHO) Indoor air quality guidelines, which show a relative risk of 3.12 (95% CI 2.30 to 4.28) at higher levels of particulate matter exposure (WHO 2014a). A 50% exposure reduction in carbon monoxide (as a surrogate for particulate matter) has also been shown to be associated with a significant decrease in severe pneumonia (but not physician-diagnosed pneumonia) in an intervention trial in Guatemala (Smith 2011).

Although the effects of household air pollution exposure are notable, the association between household air pollution and ALRI is clear and interventions have the potential to reduce the risk by 20% to 50% (WHO 2014a), the value of specific interventions in decreasing ALRIs in children is less clear. The reasons for this are likely multifactorial, but may relate to proper diagnosis of ALRI, inability to decrease exposure to necessary levels, insufficient sustainability and adoption of interventions, or difficulties with the implementation of interventions within various low-income settings.

From an epidemiological perspective, the term ‘ALRI’ focuses on bronchiolitis and pneumonia, which are potentially more severe diseases, with less emphasis on bronchitis. A diagnosis of acute bronchiolitis centres on cough and it tends to be mild and self-limited (Laopaiboon 2015). Bronchiolitis is often defined by the presence of a wheeze in conjunction with other respiratory symptoms, such as cough or rhinorrhea. Pneumonia is a more severe form of ALRI that leads to inflammation of one or both lungs with consolidation. Application of these diagnoses in a real world setting can be variable, depending on access to resources and location (Lanata 2004; Rudan 2004). Less developed sites may have to rely solely on the clinical signs and symptoms of lower respiratory tract disease, such as fast or difficult breathing, chest wall indrawing and abnormal auscultation, while more developed clinical settings can utilise additional criteria such as pathogen diagnostics and cultures or radiographic findings for a more definitive diagnosis. Although the ‘gold standard’ for a diagnosis of pneumonia remains a finding of a new infiltrate on a chest radiograph or a positive culture plus a consistent clinical scenario, due to the lack of access to these diagnostic modalities the WHO have developed a clinical case definition for pneumonia that is widely used. It is described in the Integrated Management of Childhood Illness (IMCI) criteria as cough or difficult breathing in addition to the respiratory signs or symptoms of fast breathing (as determined by age), lower chest wall indrawing, stridor or selected danger signs (such as cyanosis or an inability to drink) (WHO Handbook 2005). Application of the IMCI criteria has allowed greater uniformity in the terminology, diagnosis and treatment of ALRIs, but there remains a great deal of variability between research studies performed in differing settings that utilise ALRI outcomes. For the purposes of this review, ALRI includes pneumonia and bronchiolitis, as determined by locally trained medical personnel, as these are considered to be the primary contributors to the burden of disease associated with respiratory infections in children.

The goal of this review is to consider the current state of interventions dedicated to reducing household air pollution and the subsequent effects on ALRIs in children. These interventions can include decreasing the source of fuels, altering the environment of exposure, changing the behaviour of those being exposed or intervening at a regulatory level to affect overarching changes within communities. By evaluating activities at all levels, greater emphasis can be placed on the most effective mechanisms to reduce preventable deaths and disease in children, while recognising that cultural, societal and economic factors may influence the effect of any single type of intervention.

**Description of the intervention**

Strategies for reducing exposure to household air pollution are urgently needed and the Global Alliance for Clean Cookstoves has recently been established in recognition of this (www.cleancookstoves.org). Factors affecting exposure to household air pollution are varied, giving rise to many potential opportunities for interventions to reduce exposure. Such intervention strategies include:
• using improved cookstoves, which aim to burn fuel more efficiently and therefore produce fewer waste combustion products;
• using cleaner or drier fuels, which produce fewer waste combustion products when burnt;
• improving ventilation, to avoid air pollution inside the household;
• changing behaviour, to reduce the amount of time an individual spends in proximity to a fire or stove; and
• altering regulatory or financial policies, with intent to improve access to advanced cookstoves or fuels, and provide incentives for changes within communities or towards community development.

No single intervention is likely to be successful globally, due to differences in cooking practices, fuel availability and housing structures between communities. We will therefore consider a variety of different interventions in this review, but they are likely to have different impacts in different populations.

How the intervention might work

Although household air pollution is preventable, the challenge of reducing the exposure of children to it is substantial. Since it is a known risk factor for health outcomes, decreasing exposure, quantification of exposure and ensuing health outcomes have been initiated in a number of studies. The questions that remain are which interventions might be most useful and valuable for decreasing the indoor air pollution exposure frequently encountered in the 0 to 15 years age group and which interventions are sufficiently effective at subsequently decreasing the risk of ALRIs.

Why it is important to do this review

Practical, behavioural and cultural complexities surrounding exposure mean that studies evaluating the effects of a given intervention are challenging. Furthermore, current methods for measuring exposure, such as by monitoring airborne particulate matter, are not without limitations (Fullerton 2009).

As the urgent requirement for practically viable and cost-effective strategies for household air pollution becomes increasingly recognised, funding opportunities to identify and evaluate potential interventions are also increasing, but remain limited. It is imperative that available resources are directed towards the most effective solutions. Summarising the available literature will help to ensure that research gaps are identified and subsequently addressed, and that investment in new interventions is based on the best available evidence.

Although a previous Cochrane review has summarised the effects of household improvements on health (Thomson 2013), this review did not examine the effects of reducing exposure to indoor air pollution using the interventions described above. Since the publication of a meta-analysis in 2008 on the effects of indoor air pollution on pneumonia in children under five (Dherani 2008), further intervention studies have been published (Schilmann 2015), therefore an updated review of the literature is warranted.

OBJECTIVES

This study aims to assess the effects of intervention strategies that reduce exposure to household air pollution from burning solid fuels on episodes of acute lower respiratory infection (ALRI) in children under the age of 15 years.

METHODS

Criteria for considering studies for this review

Types of studies

We will include randomised controlled trials (RCTs), controlled before-and-after studies and interrupted time series studies. As noted in the guidance provided by the Cochrane Effective Practice and Organisation of Care (EPOC) Review Group (EPOC 2015), controlled before-and-after studies will be eligible only if there are a minimum of two interventions and two control sites. Interrupted time series studies will be eligible only if there is a clearly defined point in time when the intervention occurred and if there are a minimum of three data measurement points before and after the intervention.

Types of participants

The outcome of interest will be measured in children (up to and including 15 years of age) who live in those households. We will not exclude participants due to other demographic factors including race, ethnicity, gender, religion, poverty or location of household (e.g. rural or urban). We will include studies from all geographical regions, including high-income and low-income countries.

Types of interventions

Recognising that interventions in many arenas may affect a child’s exposure, we will include studies of any strategy that aims to reduce a child’s exposure to household air pollution from burning solid fuels. These interventions may be characterised as those that affect the sources of pollutants, those that improve the indoor environment, those that alter exposure through behavioural interventions and those of a financial or regulatory nature.
This will include interventions that aim to reduce the production of air pollution, such as:
- the use of improved cookstoves;
- the use of cleaner or drier fuel;
- behavioural interventions to reduce the amount that a stove/fire is used or to make stove/fire use more efficient.

We will also include interventions that aim to reduce the build-up of air pollution inside a household, such as:
- using stoves that have flues attached;
- changes to improve the ventilation of the house (such as chimneys, windows or ventilation holes);
- behavioural changes to avoid using a stove or fire inside the house.

We will include behavioural interventions aimed at reducing a child's exposure to indoor air pollution, such as keeping the child away from the fire whilst the food is cooked.

In addition, we will consider policy interventions that function at a national level, including supply and distribution of alternative fuels such as electricity or gas, or at a local level, including altering community access to fuels or cooking options. This may include financial incentives for alternative practices.

We also recognise that interventions may have more than one area of influence, such as the use of cookstoves that utilise cleaner fuels in combination with financial inducements for use.

**Comparisons**

Standard practices in that setting, for example, comparing an improved cookstove with using a traditional open fire. We will also include studies that compare different interventions, for example, studies that compare two different types of improved cookstove.

**Types of outcome measures**

**Primary outcomes**

- Frequency of ALRIs

This includes pneumonia and other bacterial and viral ALRIs, such as respiratory syncytial virus (RSV) infection/bronchiolitis. Physician-made diagnosis, diagnosis made by the report of key symptoms by the caregiver withingroup healthcare providers or staff trained under WHO guidelines, or diagnosis made by recall of key symptoms by the caregiver within the previous two weeks is required for the study to be included in the analysis. We will consider those with a radiographic or culture-confirmed diagnosis in a separate subgroup analysis.

- Level of exposure

Ideally, studies included in this review will have quantified reduction in exposure by either household or individual monitoring of air pollution, such as particulate matter or carbon monoxide measurement. We will also include other forms of monitoring such as measurement of biomarkers of smoke exposure, exhaled carbon monoxide, reported or measured stove use, measured fuel use, measurement of time spent in the proximity of a fire (for example, Global Positioning System monitoring) or time-activity diaries completed by the caregiver.

**Secondary outcomes**

- Acceptability of interventions to household members; we will review any qualitative data regarding the acceptability of an intervention to members of the household in the study although we will only seek quantitative data as part of the search process.
- Severity of ALRI in children, as determined by referral for access to increased intensity of medical care, hospital admission or referral, inpatient status, use of intravenous antibiotics or clinical presentation.
- All-cause childhood mortality.
- Burns, including severity of burns as determined by size, location or percentage of area affected.

The secondary outcomes listed are not required as part of the eligibility requirements for a study to be included in this review.

**Search methods for identification of studies**

**Electronic searches**

We will search the Cochrane Central Register of Controlled Trials (CENTRAL, latest issue), which contains the Cochrane Acute Respiratory Infections Group Specialised Register, MEDLINE (1946 to current date), EMBASE (1974 to current date), CINAHL (1981 to current date), LILACS (1982 to current date), Web of Science (1985 to current date), Scopus (no date limit) and Global Health (no date limit).

We will use the search strategy described in Appendix 1 to search CENTRAL and MEDLINE. We will combine the MEDLINE search with the Cochrane Highly Sensitive Search Strategy for randomised trials (Lefebvre 2011). We will adapt the search strategy to search the other databases. We will not use any limits for publication type, language or dates. We will limit studies to those providing primarily quantitative data.
Searching other resources
- www.who.int/trialsearch.
- www.clinicaltrials.gov.
- Grey literature searching using Internet search engines for PhD theses and government reports.
- Handsearching of reference lists from extracted papers and review articles.
- Contacting researchers in the field.

Data collection and analysis
We will manage the search results in EndNote.

Selection of studies
Two review authors (DH, HJ) will independently conduct all aspects of study selection. At each stage of the selection process, we will compare the two independently selected lists of studies and we will discuss any discrepancies. Where consensus is not reached, we will consult a third review author (LP).
In the first stage of the selection process we will review titles for eligibility. At this stage, we will adopt an inclusive approach. We will only reject studies if the title unequivocally indicates that the study does not examine relevant exposures or outcomes. In the second stage we will review the abstracts of the remaining studies, again taking an inclusive approach. We will then review the full-text articles of the remaining studies for eligibility. We will keep a record of which stage any excluded studies were rejected and for studies rejected after a full-text review, we will record a reason for rejection.

Data extraction and management
Two review authors (DH, HJ) will independently extract data using pre-defined data extraction forms (to be piloted on a small subset of studies first) and then cross-check for discrepancies. We will discuss any unresolved issues with a third author (LP). We will contact trial authors to obtain complete data sets in the case of missing data. We will extract the following data:
- Study overview (study design, location of study, single-centre or multi-centre, length of study/follow-up period, year of publication, randomisation methods).
- Characteristics of participants (sample selection, sample size, age range, gender, urban versus rural living, details of other sources of smoke/pollution exposure, details of co-morbidities).
- Number of ALRI events.
- ALRI details (definition, type of ALRI, severity, use of radiology or microbiological tests).
- Air pollution exposure (type of exposure, type of fuel, measurements made, level of exposure as determined by format of assessment).
- Intervention (type, duration, adherence, acceptability).
- Number of deaths.
- Number of burns.

Cluster-randomised trials
For cluster-randomised trials, we will record the unit of randomisation (e.g. household or village), the number of clusters and the average size of clusters. Where possible, we will record the methods used for analysing the trial, including any adjustments made for clustering. If reported, we will document estimates of the intra-cluster correlation (ICC) coefficient.

Controlled before-and-after studies
We will extract and note the study methodology and details of the analysis method, including adjustment for covariates.

Assessment of risk of bias in included studies
Two review authors (DH, HJ) will independently use The Cochrane Collaboration’s tool for assessing ‘Risk of bias’ (with any discrepancies discussed and referred to a third review author (LP) if not resolved) and we will produce a ‘Risk of bias’ table and a ‘Risk of bias’ summary figure (Higgins 2011). We will assess selection bias, performance bias, detection bias, attrition bias and reporting bias. We will contact trial authors to clarify any unclear information. We will summarise the risk of bias for each outcome for each study. We will assess the impact of risk of bias on effect estimates using forest plots. We will restrict meta-analyses to studies with a low risk of bias.

Measures of treatment effect
We will extract the number of people allocated to each intervention group and the number of cases with the event for dichotomous outcomes. We will extract the number of people allocated to each intervention group and we will extract outcome means and standard deviations (SD) for continuous outcomes. We will calculate odd ratios (ORs) for dichotomous data. We will calculate mean differences (MDs) for continuous data. We will present the measures with 95% confidence intervals (CIs).

Cluster-randomised trials
Where analysis has been adjusted for clustering, we will take the reported point estimate and CIs. If not adjusted, we will calculate the OR or mean difference (MD) as above. If the number of individuals in each group is not reported, we will extract percentages or measures of effect.
Controlled before-and-after studies
We will extract adjusted measures of effect where they have been reported.

Unit of analysis issues
We will pay attention to the unit of analysis for each study, whether it is an individual or cluster-RCT, and we will analyse each study accordingly. For studies that have used a cluster-RCT design (e.g. randomisation occurs at a village or household level), when the analyses have not adjusted for clustering, we will attempt to adjust the results by multiplying the standard errors of the estimates by the square root of the design effect, where the design effect is calculated as DEff=1+(m-1)*ICC. This requires information to be reported, i.e. the average cluster size (m) and the intra-cluster correlation coefficient (ICC).

Dealing with missing data
In the case of missing data, we will contact the trial authors to complete missing data sets. We will analyse studies by a complete case analysis.

Assessment of heterogeneity
If studies of different interventions are included in the review, we will analyse each different intervention and present them separately. We will also consider different study designs separately. We will evaluate statistical heterogeneity by visually inspecting the forest plots to detect overlapping CIs, applying the Chi² test (P value < 0.10 considered statistically significant), and also by using the I² statistic (where an I² statistic of greater than 50% represents substantial heterogeneity). We anticipate a fair amount of heterogeneity and we will apply a random-effects meta-analysis model.

Assessment of reporting biases
We will consider separately different study designs and studies of different interventions. If there are sufficient studies (approximately 10) we will construct a funnel plot to assess potential reporting bias, although an asymmetrical plot may also indicate other forms of selection bias, poor methodological quality or true heterogeneity.

Data synthesis
We will analyse data using Review Manager 5.3 (RevMan 2014). We will stratify analysis by intervention type and study design, with cluster-RCTs that adjust for clustering and individually RCTs combined.

If substantial heterogeneity is detected (I² statistic > 50%), we will not perform a meta-analysis and we will report a narrative synthesis. If there is evidence of moderate statistical heterogeneity (I² statistic 30% to 50%), we will use a random-effects model for meta-analysis. In the absence of statistical heterogeneity we will use a fixed-effect model.

We will analyse controlled before-and-after studies separately. If these studies are found to be reasonably homogeneous and resistant to biases, we will perform a meta-analysis of adjusted estimates as an inverse-variance weighted average.

GRADE and 'Summary of findings’ table
We will create a ‘Summary of findings’ table using the following outcomes:
- ALRI;
- level of exposure;
- acceptability of interventions to household members;
- severity of ALRIs in children;
- all-cause childhood mortality;
- burns.

We will use the five GRADE considerations (study limitations, consistency of effect, imprecision, indirectness and publication bias) to assess the quality of a body of evidence as it relates to the studies that contribute data to the meta-analyses for the pre-specified outcomes (GRADE 2004). We will use the methods and recommendations described in Section 8.5 and Chapter 12 of the Cochrane Handbook for Systematic Reviews of Interventions (Higgins 2011) using GRADEpro GDT software (GRADEpro GDT 2015). We will justify all decisions to downgrade or upgrade the quality of studies using footnotes, and we will make comments to aid readers’ understanding of the review where necessary.

Subgroup analysis and investigation of heterogeneity
If statistical heterogeneity is present, we will investigate potentially influential study characteristics by conducting subgroup analysis with respect to age (under five and older than five years), ALRI type, ALRI diagnosis, ALRI severity, type of air pollution exposure and intervention duration.

Sensitivity analysis
We will conduct sensitivity analyses to test the robustness of the chosen methods, including the choice of meta-analysis model.

Acknowledgements
We wish to thank the following people for commenting on our draft protocol: Julie Gildie, Riitta Sauni, Ranjeeta Simon, John Balmes, Robert Ware and Susan Smith.
Additional references

Desai 2004
Desai MA, Mehta S, Smith KR. Indoor smoke from solid fuels: assessing the environmental burden of disease at national and local levels. WHO Environmental Burden of Disease Series, No. 4. Geneva: World Health Organization, 2004.

Dherani 2008
Dherani M, Pope D, Mascalles M, Smith K, Weber M, Bruce N. Indoor air pollution from unprocessed solid fuel use and pneumonia risk in children aged under five years: a systematic review and meta-analysis. Bulletin of the World Health Organization 2008;86(5):390–8C.

EPOC 2015
Effective Practice and Organisation of Care (EPOC) resources for review authors. Available from http://epoc.cochrane.org/epoc-specific-resources-review-authors. Oslo: Norwegian Knowledge Centre for Health Services, 2015 (accessed 10 July 2015).

Ezzati 2001
Ezzati M, Kammen DM. Indoor air pollution from biomass combustion and acute respiratory infections in Kenya: an exposure-response study. Lancet 2001;358(9282):619–24.

Fullerton 2009
Fullerton DG, Semple S, Kalambo F, Suseno A, Malamba R, Henderson G, et al. Biomass fuel use and indoor air pollution in homes in Malawi. Occupational and Environmental Medicine 2009;66(11):777–83.

GRADE 2004
GRADE Working Group. Grading quality of evidence and strength of recommendations. BMJ 2004;328(7454):1490.

GRADEpro GDT 2015
GRADEpro GDT. GRADEpro Guideline Development Tool [www.guidelinedevelopment.org]. Hamilton: McMaster University (developed by Evidence Prime, Inc.), 2015.

Higgins 2011
Higgins JPT, Green S (editors). Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011. Available from www.cochrane-handbook.org.

Lanata 2004
Lanata CF, Rudan I, Boschi-Pinto C, Tomaskovic L, Cherian T, Weber M, et al. Methodological and quality issues in epidemiological studies of acute lower respiratory infections in children in developing countries. International Journal of Epidemiology 2004;33:1362–72.

Laopaiboon 2015
Laopaiboon M, Panpanich R, Swa Mya K. Azithromycin for acute lower respiratory tract infections. Cochrane Database of Systematic Reviews 2015, Issue 3. [DOI: 10.1002/14651858.CD001954.pub4]

Lefebvre 2011
Lefebvre C, Manheimer E, Glanville J. Chapter 6: Searching for studies. In: Higgins JPT, Green S (editors). Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011. Available from www.cochrane-handbook.org.

Nacht 2007
Nachtel R, Brauer M, Lipsett M, Zelikoff J, Simpson C, Koenig J, et al. Woodsmoke health effects: a review. Inhalation Toxicology 2007;19:67–106.

Nair 2013
Nair H, Simoes EAF, Rudan I, Gessner BD, Azizi-Baumgartner E, Zhang JF, et al. Global and regional burden of hospital admissions for severe acute lower respiratory infections in young children in 2010: a systematic analysis. Lancet 2013;381(9875):1380–90.

RevMan 2014
The Nordic Cochrane Centre, The Cochrane Collaboration. Review Manager (RevMan). 5.3. Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2014.

Rudan 2004
Rudan I, Tomaskovic L, Boschi-Pinto C, Campbell H, WHO Child Health Epidemiology Reference Group. Global estimate of the incidence of clinical pneumonia among children under five years of age. Bulletin of the World Health Organization 2004;82(12):895–903.

Schilmann 2015
Schilmann A, Rios-Rodriguez H, Ramirez-Sedeno K, Berrueta VM, Petz-Padilla R, Romieu I. Children’s respiratory health after an efficient biomass stove (Patsari) intervention. EcoHealth 2015;12(1):68–76. [DOI: 10.1007/s10393-014-0965-4]

Simoes 2006
Simoes EAF, Cherian T, Chow J, Shahid-Salles SA, Laxminarayan R, John TJ. Acute respiratory infections in children. In: Jamison DT, Breman JG, Measham AR, Alleyne G, Claeson M, Evans DB, Jha P, Mills A, Musgrove P editor(s). Disease Control Priorities in Developing Countries. 2nd Edition. Vol. Chapter 25, Washington DC: World Bank, 2006.

Smith 2011
Smith K, McCracken J, Weber M, Hubbard A, Jenny A, Thompson L. Effect of reduction in household air pollution on childhood pneumonia in Guatemala (RESPIRE): a randomised controlled trial. Lancet 2011;378(9804):1717–26.

Smith 2014
Smith KR, Bruce NG, Balakrishnan K, Adair-Rohani H, Balmes J, Chafe Z, et al. Millions dead: how do we know and what does it mean? Methods used in the comparative risk assessment of household air pollution. Annual Review of Public Health 2014;35:185–206.
Thomson 2013
Thomson H, Thomas S, Sellstrom E, Petticrew M. Housing improvements for health and associated socio-economic outcomes. *Cochrane Database of Systematic Reviews* 2013, Issue 3. [DOI: 10.1002/14651858.CD008657.pub2]

von Schirnding 2000
von Schirnding Y, Bruce N, Smith K, Ezzati M, Lvovsky K. Addressing the impact of household energy and indoor air pollution on the health of the poor: implications for policy action and intervention measures paper prepared for the Commission on Macroeconomics and Health. http://www.who.int/mediacentre/events/H%26SD_Plaq_no9.pdf. 2000 (accessed 10 July 2015).

WHO 2005
World Health Organization. WHO Air Quality Guidelines, Global Update. http://www.euro.who.int/__data/assets/pdf_file/0005/78638/E90038.pdf 2005 (accessed 7 October 2014).

WHO 2014a
World Health Organization. Indoor air quality guidelines: household fuel combustion. http://www.who.int/indoorair/publications/household-fuel-combustion/en/ 2014 (accessed 10 July 2015).

WHO 2014b
World Health Organization. WHO Fact Sheet No. 331 Pneumonia. www.who.int/mediacentre/factsheets/fs331/en/index.html 2014 (accessed 7 October 2014).

WHO Handbook 2005
World Health Organization, Department of Child and Adolescent Health and Development. *Handbook. IMCI Integrated Management of Childhood Illness*. WHO, 2005.

* Indicates the major publication for the study

**APPENDICES**

**Appendix 1. MEDLINE search strategy**

1 exp Respiratory Tract Infections/
2 (acute respiratory infection* or acute respiratory tract infection* or lower respiratory infection* or lower respiratory tract infection*).tw.
3 (ari or Irti or alri).tw.
4 exp Pneumonia/
5 (pneumon* or bronchopneumon* or pleuropneumon*).tw.
6 bronchitis/ or exp bronchiolitis/
7 (bronchiolit* or acute bronchit* or wheez*).tw.
8 Respiratory Syncytial Virus Infections/
9 respiratory syncytial viruses/ or respiratory syncytial virus, human/
10 (respiratory syncytial virus* or rsv).tw.
11 exp Haemophilus influenzae/
12 Streptococcus pneumoniae/
13 Staphylococcus aureus/
14 (streptococc* or staphylococc* or haemophilus influenzae).tw.
15 ((lung or pulmonary) adj2 (inflammm* or infect*)).tw.
16 (((fast or rapid) adj1 breath*) or chest wall indrawing or stridor).tw.
17 or/1-16
18 Air Pollution, Indoor/
19 ((household or indoor*) adj2 air adj2 (pollut* or quality)).tw.
20 ((indoor or household or domestic or home) adj3 (fire or fires or smok* or woodsmok*)).tw.
21 (time* adj5 (stove or cook*)).tw.
22 ((combust* or burn*) adj3 (stove* or wood or kerosene or biomass or coal or charcoal or dung or crop waste* or agricultur* residu*)).tw.
23 ((improv* or replac* or chang*) adj3 (stove* or cookstove* or kitchen ventilat* or combustion or house construction or solar)).tw.
24 (vent* adj5 (home* or living space* or household* or kitchen* or cook* or stove* or window* or hood* or grate*)).tw.
25 ((stove* or cook* or kitchen* or fuel*) adj3 (emission* or clean* or flue or chimney*)).tw.

Strategies for reducing exposure to indoor air pollution from household burning of solid fuels: effects on acute lower respiratory infections in children under the age of 15 years (Protocol)
Copyright © 2015 The Authors. *The Cochrane Database of Systematic Reviews* published by John Wiley & Sons, Ltd. on behalf of The Cochrane Collaboration.
CONTRIBUTIONS OF AUTHORS

Conceiving the review - HJ
Designing the review - HJ
Co-ordinating the review - DH
Data collection for the review - HJ, DH, LP, MC
Designing search strategies - HJ
Undertaking searches - DH, HJ
Screening search results - HJ, DH, LP, MC
Appraising quality of papers - DH, HJ
Extracting data from papers - DH, LP
Writing to authors of papers for additional information - DH
Obtaining and screening data on unpublished studies - DH
Data management for the review - DH
Entering data into RevMan - DH, HJ
Analysis of data - DH, HJ
Providing a methodological perspective - KM
Providing a clinical perspective - KM, DH, HJ, LP, MC
Providing a policy perspective - KM
Writing the protocol - HJ
Writing the review - DH, HJ, LP, MC, KM
Providing general advice on the review - KM
Securing funding - N/A
Performing previous work that was the foundation of the current review - HJ
DECLARATIONS OF INTEREST

DH is the trial manager for the Cooking and Pneumonia Study (CAPS). She is employed to conduct a trial of an advanced cookstove intervention to prevent pneumonia in children under the age of five in Malawi (www.capstudy.org) which has funding from the MRC, Wellcome Trust and DfID.

HJ - None known.
LP - None known.
MC - None known.

KM is a Co-Principal Investigator of the Cooking and Pneumonia study (CAPS). He has funding from the MRC, Wellcome Trust and DfID to conduct a trial of an advanced cookstove intervention to prevent pneumonia in children under the age of five in Malawi (www.capstudy.org).

SAMPLE OF SUPPORT

Internal sources

- Wellcome Trust, UK.

HJ is a Wellcome Trust Clinical PhD Fellow

External sources

- No sources of support supplied