

# BMJ Open Health risks of exposure to air pollution in areas where coal-fired power plants are located: protocol for a scoping review

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## ABSTRACT

**Introduction** Coal-fired power plants are major sources of air pollution which impact human health. Coal combustion byproducts released into the air include particulate matter, nitrogen oxides and sulphur dioxide. Exposure to fine particulate matter is associated with increased risk of mortality. This scoping review will examine and summarise the current literature on the health risks of exposure to air pollution in areas in which coal-fired power plants exist.

**Methods and analysis** This scoping review will be conducted according to the Joanna Briggs Institute methodological framework and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews guidelines. Five electronic databases (PubMed, ScienceDirect, Scopus, Web of Science and Google Scholar) will be searched for relevant articles. Studies will be included up until 31 January 2024. There will be no restriction on geographical area. The searches will be limited to studies published in English. Title, abstract, full-text screening and data extraction of relevant articles will be done by two independent reviewers. Discrepancies will be resolved by group discussion. The findings will be presented in tables with a narrative summary. This review will consider epidemiological studies and grey literature that report on the health risks of exposure to air pollution in areas where coal-fired power plants exist.

**Ethics and dissemination** All data will be collected from published and grey literature. Ethics approval is therefore not required. We will submit our findings for publication in a peer-reviewed journal.

## INTRODUCTION

Coal supplies approximately 36% of the world's electricity.<sup>1</sup> According to the International Energy Agency, the global coal-fired power generation was about 10 400 terawatt-hours (Twh) in 2022.<sup>1</sup> There are more than 2400 coal-fired power plants (CFPPs) in operation worldwide. The process of coal combustion for electricity generation releases sulphur dioxide (SO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>), particulate matter (PM) and fly ash into the atmosphere. Other emissions include arsenic, mercury, lead, selenium and other toxic elements. The release of the pollutants in the

## STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ A comprehensive and systematic search of the databases and grey literature will ensure that all available evidence on the topic is retrieved.
- ⇒ The scoping review will strictly follow the methodological framework of the Joanna Briggs Institute and adhere to Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews reporting guidelines.
- ⇒ Only studies published in the English language will be included.
- ⇒ No risk of bias assessment will be performed given the broad nature of the topic and the use of a scoping review methodology; therefore, some studies of poor quality may be included.

air has negative environmental and health impacts.

Previous research has shown residential proximity to CFPPs has adverse effects on human health. Yang *et al* observed that pregnant women living 32 km to 48 km away from a coal power plant are at greater risks of low birth weight in New Jersey, USA.<sup>2</sup> There is growing evidence of maternal exposure to particulate matter with a diameter smaller than 2.5 µm (PM<sub>2.5</sub>) and adverse birth outcomes.<sup>3–5</sup> Research suggests that air pollutants can significantly affect the neurocognitive development of children.<sup>6</sup> Short-term exposure to air pollution in asthmatic children resulted in respiratory symptoms and school absence.<sup>7</sup> Young children exposed to air pollution were at higher risk for hospital admission for respiratory diseases in Wuhan, China.<sup>8</sup> A report on data from 22 European cohort studies showed that long-term exposure to PM<sub>2.5</sub> was associated with natural-cause mortality.<sup>9</sup> PM<sub>2.5</sub> has the potential to enter the bloodstream and can travel to the brain. Exposure to air pollution from CFPPs was associated with increased hospitalisation, respiratory effects, heart diseases,



chronic obstructive pulmonary diseases, lung cancer and mortality.<sup>10–16</sup>

Residents living in proximity to CFPPs and neighbouring communities are at high risk of poor health outcomes and premature deaths attributable to emissions from CFPPs.<sup>17</sup> Previous work observed that premature deaths were concentrated in districts where national CFPPs are located.<sup>18</sup> A recent study on the effects of the closure of three CFPPs in Chicago reported a decline in school absenteeism and emergency visits in areas.<sup>19</sup> Other studies reported an association between long-term exposure to air pollution and lung function development in children living near CFPPs in Israel.<sup>20–21</sup> Air pollutants from coal combustion can travel long distances therefore communities living far from CFPPs can also be affected.<sup>22</sup>

As the world transitions to clean energy, regions with limited resource regions are left behind. During the United Nations Framework Convention on Climate Change Conference of the Parties (COP26) more than 40 nations committed to phase out coal by 2040. According to the Energy Institute Statistical Review of World Energy report, China, India, USA, Japan and South Africa are among the top five countries with the highest coal consumption in 2022.<sup>23</sup> Previous reviews focused on the impact of air pollutants from coal combustion on human health in high-income countries.<sup>24–25</sup> Few studies have investigated the health effects of air pollution in areas where CFPPs are located among children and adults particularly in low/middle-income countries.<sup>10–26–29</sup> These were epidemiological observational studies with either an ecologic or cross-sectional study design. Although CFPPs are not the only source of air pollution, however, contribute significantly to poor air quality. There are currently no reviews on the proximity of CFPPs to communities and health effects. This scoping review will examine and summarise the current literature on the health risks of exposure to air pollution from CFPPs.

## Objectives

The objectives of this scoping review are:

1. To assess the effects of exposure to air pollution in areas where CFPPs are located on health.
2. To identify studies that estimate the health burden associated with this exposure.

## METHODS AND ANALYSIS

This scoping review protocol was developed using the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols checklist (online supplemental table 1).<sup>30–31</sup> The proposed scoping review will be carried out following the Joanna Briggs Institute (JBI) methodological framework and will be reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews.<sup>32–33</sup> The study is planned to begin in March 2024 and end in June 2024. The protocol was registered on the Open Science Framework.<sup>34</sup>

## Stage 1: identifying the research questions

In line with the objectives, the following research questions are posed:

1. What is the current evidence on the health risks associated with exposure to air pollution in areas where CFPPs exist?
2. What is the relationship between health outcomes and proximity to CFPPs?
3. What is the estimated mortality or morbidity risks of exposure to air pollution in areas where CFPPs exist?

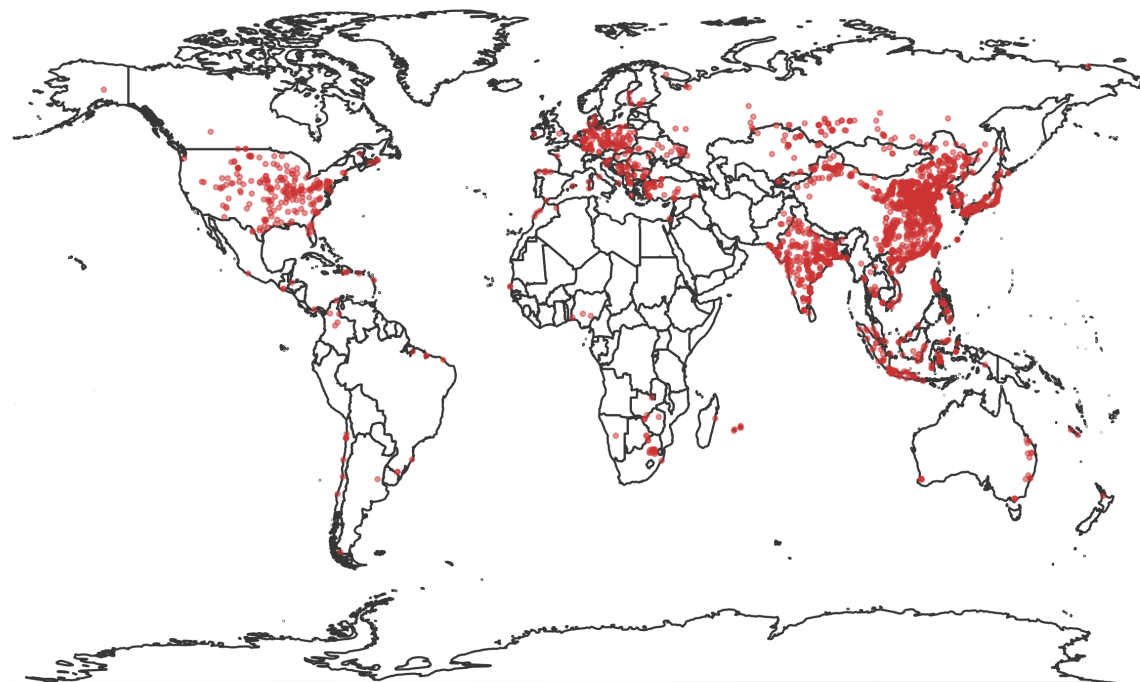
## Stage 2: identifying relevant studies

The databases to be searched include Google Scholar, PubMed, ScienceDirect, Scopus and Web of Science. Sources of grey literature will include environment organisation reports such as Centre for Environmental Rights and Environmental Defence Fund. Other forms of grey literature such as newspaper articles, magazines and blogs will be excluded. Studies will be restricted to the English language. We will include studies published until 31 January 2024. Books, conference proceedings and letters to editors will be excluded. Reviews articles will not be included but the list of references will be examined to identify relevant studies.

## Stage 3: study selection

The study selection will follow a two-part screening process: step 1: screening of title and abstract; and step 2: reviewing of full text. In both steps, two independent reviewers will screen the articles and disagreements will be discussed with a third reviewer. We will follow the PECOS framework (Population, Exposure, Context, Outcome, Study design) to identify eligible studies.<sup>35</sup> The inclusion criteria include:

1. Population: studies reporting on individuals or groups of all ages (ie, in utero, infants, children and adolescents, adults and the elderly) near CFPPs (as reported in the article, no km restriction).
2. Exposure: studies that include exposure to air pollution in areas where coal-fired power plants exist such as SO<sub>2</sub>, PM, NO<sub>x</sub>, mercury and other toxic elements.
3. Context: studies from all geographical areas will be considered. **Figure 1** shows the distribution of CFPPs in operation as of January 2024.<sup>36</sup> China and India are among the countries with the highest number of CFPPs.
4. Outcome: studies on health outcomes of communities located near to CFPPs such as respiratory illnesses and lung disease. Where possible, dose-response functions will be extracted. The health effects may be directly measured or estimated using models. All-cause or disease-specific mortality, hospital and emergency visits will be considered. Studies on health risk assessment will also be considered.
5. Study design: this review will include human epidemiological research articles published in peer-reviewed journals. Observational studies including cohort studies, case-control studies, time-series, ecological and



• Coal-fired power plants

**Figure 1** Global distribution of coal-fired power plants in operation as of January 2024.

cross-sectional studies will be considered for inclusion. Experimental studies on humans on the health effects of air pollution in areas where coal-fired power plants exist will be included. Reports that include health impacts from air pollution in areas where coal-fired power plants exist will also be included.

The exclusion criteria include:

1. Population: studies on animal models or in vitro will be excluded.
2. Exposure: studies not related to exposure to air pollution in areas where coal-fired power plants exist.
3. Context: there will be no restriction on geographical area.
4. Outcome: health outcomes not associated with exposure to air pollution in areas where CFPPs exist.
5. Study design: non-human studies (in vitro and in vivo) will be excluded. Studies on occupational exposure will also be excluded.

The search strategy will aim to find and identify published and unpublished literature. An initial search of PubMed will be undertaken to identify articles on the topic. The text words contained in the title and abstracts of relevant articles will be used to develop a full search strategy. The specific search terms include air pollutant\*, coal-fired power plant\* OR coal-fired power station\* and health (full search strategy for PubMed is shown in online supplemental table 2). Additional relevant documents will be identified by checking the reference lists of included documents. The full search strategy will be adapted for each database and information source.

#### Stage 4: charting, collating and reporting

All citations will be collated and uploaded into Rayyan software and duplicates will be removed. Rayyan is a free web application that facilitates abstract and full-text screening of studies. A pilot test of the screening process will be undertaken by two or more independent reviewers with a test sample of 50 abstracts. After completing the pilot test, two or more independent reviewers will screen the title and abstracts of all citation records against the inclusion criteria. Full-text articles will be retrieved of all included records and will be screened against the inclusion criteria by two or more independent reviewers. Reasons for exclusion of sources of evidence at full text that do not meet the inclusion criteria will be recorded and reported in the scoping review. Any discrepancies will be resolved through discussion, or with an additional reviewer. The results of the search and the study inclusion process will be reported in full in the final scoping review and presented in Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram (online supplemental figure 1).<sup>32 37</sup>

A data extraction tool will be developed by the reviewers where data from included articles will be populated (table 1). The draft data extraction tool will be modified and revised as necessary during the process of extracting data from each included evidence source. Modifications will be detailed in the scoping review.

A narrative report on the outcomes of the selected studies will be presented in the scoping review. This will include the country of origin, type of pollutant, distance

**Table 1** Data extraction tool

Category	Details
1. General information	a. Title of study b. Author(s) c. Year of publication d. Country (region and city) e. Study aim
2. Study design	Specify the type of study (eg, cross-sectional, cohort, case study)
3. Study population	a. Age b. Gender c. Ethnicity
4. Sample size	Report the sample size in numerical form
5. Duration of study	a. Start year b. End year
6. Distance of coal-fired power plant to the community reported?	Yes/No
7. If yes, indicate the distance	Report the distance in kilometres
8. Type of pollutants	Specify the pollutant reported in the study (eg, CO <sub>2</sub> , NO <sub>x</sub> , SO <sub>2</sub> , PM, fly ash)
9. Concentration of pollutant(s)	Report the concentration of pollutant with units of measurement (eg, average or mean/median)
10. Measure of health	Describe the measure of health reported (eg, hospital records, interviews, questionnaires, school absence)
11. Health outcomes	Describe health outcomes (eg, asthma, respiratory effects, neurological effects, hospital visits, mortality)
12. Confounders (if any)	Describe confounders reported in the study
13. Health risk assessment reported?	Yes/No
14. Statistical/modelling approach	Specify the statistical methods used in the study
15. Measures of effects	Specify the measure of effect (eg, dose-response or exposure-response, OR, risk ratio)
16. Key findings	Describe the significant findings from the study (eg, health impact of air pollution from CFPPs)
CFPP, coal-fired power plant.	

of coal-fired power plant to the community and health outcomes. The results will be described in relation to the review objectives and questions.

## Patient and public involvement

None.

## ETHICS AND DISSEMINATION

All data will be collected from published and grey literature. Ethics approval is therefore not required. We will submit our findings for publication in a peer-reviewed journal.

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