



Contents lists available at ScienceDirect

# Environmental Science and Policy

journal homepage: [www.elsevier.com/locate/envsci](http://www.elsevier.com/locate/envsci)

## Just energy transition from coal in South Africa: A scoping review

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### ARTICLE INFO

#### Keywords:

Just Energy Transition  
South Africa  
Mpumalanga  
Highveld Priority Area  
Social Justice  
Restorative Justice

### ABSTRACT

**Background:** South Africa's just energy transition (JET) aims to reduce coal dependency and shift toward a low-carbon, sustainable energy framework. However, achieving this goal requires addressing the socio-economic, health, and environmental burdens that coal dependency has placed on communities, particularly in regions like Mpumalanga. Integrating principles of social and restorative justice is essential to ensure an equitable transition.

**Objective:** This scoping review examines how South Africa's policymaking, regulatory frameworks, and public participation in the JET align with principles of social and restorative justice and global energy transition frameworks.

**Methods:** A systematic literature search was conducted across Scopus, Web of Science, and PubMed to identify relevant studies on energy transition and justice frameworks. Network analysis was employed to compare South Africa's JET strategies with global trends, focusing on indicators related to health, environmental, and socio-economic impacts.

**Results:** Findings reveal significant challenges in South Africa's JET, including regulatory limitations, stakeholder conflicts, and gaps in policy alignment with community needs. Although efforts to incorporate justice principles are emerging, disparities in policy implementation suggest the need for more tailored, inclusive approaches. Network analysis identified both overlaps and gaps between South Africa's JET policies and international frameworks, particularly in areas of public health and social equity.

**Conclusion:** To achieve a balanced and inclusive energy transition, the study recommends strengthening regulatory coherence, enhancing public engagement, and implementing concrete actions for social and restorative justice. Aligning domestic policies with international commitments while addressing local socio-economic conditions is critical for South Africa's JET to serve as a model for coal-dependent economies globally.

### 1. Introduction

The United Nations Sustainable Development Goals (SDGs) have health and well-being at their core in an attempt to ensure an equitable and sustainable life for all (United Nations, 2015). In attaining a sustainable livelihood for all, there must be access to essential services such as affordable and clean energy (SDG 7). More specifically, by 2030, there is a global goal to ensure universal access to affordable, reliable energy services (SDG 7.1) and sustainably increase sharing of renewable

energy in the international energy mix (SDG 7.2). When linking SDG 7 to assess the global renewable energy footprint, it is unsurprising that 13 % of the global population lacks access to modern energy. Approximately 3 billion people rely on coal and other fossil fuels for cooking and heating (International Energy Agency, 2019).

During coal combustion, complex mixtures of gaseous components are released into the atmosphere. Studies have shown that communities surrounding coal-fired power plants are exposed to various pollutants that may negatively impact their health (Hendryx et al., 2020;

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<https://doi.org/10.1016/j.envsci.2025.104044>

Received 29 October 2023; Received in revised form 25 October 2024; Accepted 18 March 2025

Available online 22 March 2025

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Komisarow and Pakhtigian, 2022). Communities and mine workers are negatively affected as coal dust is released during extraction, transport, and handling resulting in xenobiotic and potentially endocrine disruptive effects (Espitia-Pérez et al., 2018; Darbre, 2022). Global studies have shown that chronic exposure to air pollutants, including coal combustion, is associated with several diseases that may be fatal (Konduracka and Rostoff, 2022).

Globally, there are 6593 coal-burning units, with approximately 4000 coal-fired power plants, many with multiple burning units (Bloomberg Global Coal Countdown, 2022). There are currently 18 coal-fired power plants in South Africa, with 12 in the Mpumalanga province, 2 in the Limpopo province, and 4 in the Gauteng Province, which comprise the highveld priority area of South Africa (Shikwambana et al., 2020). In South Africa, a 2017 report detailed the health impacts of coal-fired power plants. The findings showed that air pollution has a broad spectrum of effects on health, including mortality and cardiovascular and respiratory illness (Holland, 2017). This report estimated that in South Africa, 2239 human deaths per year and more than 9500 cases of bronchitis among children 6–12 could be attributable to coal-related air pollution. This case formed the basis for the Deadly Air case, a legal challenge made in 2019 by two environmental justice organizations in South Africa. The organizations posited that the air quality in Mpumalanga Province, South Africa, has violated communities' constitutional right to a healthy environment (Centre for Environmental Rights, 2022a). On 18 March 2022, the judgment was delivered in favor of the environmental justice organizations. Amongst others, the order declared that the poor air quality in the Mpumalanga Province is in breach of the resident's section 24(a) constitutional right to safe environments for their health and well-being. Furthermore, the Minister of Environmental Affairs has a legal duty to prescribe regulations under section 20 of the National Environmental Management: Air Quality Act 39 of 2004 (Centre for Environmental Rights, 2022b).

There has been a global initiative to halt and close coal power plants. This initiative is in line with the global SDG and Intergovernmental Panel on Climate Change (IPCC) (2022) report that seeks to reduce carbon dioxide emissions from coal power plants to limit rising global temperatures and mitigate the impacts of climate change (IPCC, 2022). It is thus surprising that in the Mpumalanga province, a new power station is being built that will burn as much as 15 million tons of coal a year until it is eventually shut-down in 2073 (Burkhardt, 2022). This finding highlights the need to revisit the conversation regarding South Africa meeting its commitment to eliminating greenhouse gas emissions on a net basis by 2050 (Department of Forestry FatE, 2020).

There is a need to expedite the current debate on energy policy in South Africa and advance the Just Energy Transition (JET) just transition agenda. A JET seeks to secure the future and livelihoods of workers and their communities in transitioning to a low-carbon economy (International Trade Union Confederation, 2022). This scoping review synthesizes international and local research to examine South Africa's policymaking, regulatory frameworks, and public participation in JET. The study explores how these factors interact with social and restorative justice, identifying both challenges and opportunities for aligning South Africa's energy policies with global frameworks.

## 2. Methods

### 2.1. Eligibility criteria

All article titles and abstracts from the literature search were manually screened, spanning 1999–02 August 2022. We also reviewed the reference lists of the retrieved full-text articles. From these lists, relevant references aligned to the inclusion criteria not initially identified were retrieved and added. We included both qualitative and quantitative studies.

### 2.2. Search strategy

Peer-reviewed studies and reports published between 1 January 1999 and 02 August 2022 were reviewed. Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) were used (Tricco et al., 2018). The PRISMA-ScR (PRISMA extension for Scoping Reviews) was developed according to published guidance by the EQUATOR (Enhancing the QUALity and Transparency Of Health Research) Network to establish reporting guidelines. The 22-point PRISMA-ScR Checklist (appendix 1). A topic search using the 'advanced search option was performed within the ISI Web of Knowledge, Scopus, and PubMed electronic databases and applying the following phrases: "carbon dioxide" OR coal OR "coal combustion" OR "coal mine\*" OR "gas emission\*" AND energy OR "energy transition" OR justice OR "climate justice" OR "environ\* justice" AND "public health" OR cardiovascular OR cardiorespiratory OR cvd OR respiratory.

### 2.3. Data extraction

The first author extracted data using a standardized data collection form. The variables for data extraction included *inter alia*: the country or location of study; year of study; study design; study aims; study outcome measures; results, and conclusion of the study. The themes—Political and Economic Transition, Social Justice and Community Impact, and Health and Environmental Benefits—were selected to capture the multifaceted challenges and opportunities within South Africa's Just Energy Transition, focusing on policy dynamics, community equity, and public health as essential areas for sustainable and inclusive energy reform. The co-authors moderated the data extractions, resolved any differences, and provided additional publications not located by the first author.

### 2.4. Citation network analysis

Our study analyzed the strength of themes and sub-themes emerging from the scoping review. We used VosViewer software 1.6.5 (Eck and Waltman, 2009), a citation network visualization map, which depicts the publications related to each theme about the particular theme or sub-themes link strength network (i.e., inter-theme relation) within these clusters.

## 3. Results

Our search, conducted on 2 August 2022, initially identified 9187 papers, of which 26 papers were included in our final scoping review (Fig. 1). Overall, few observational or interventional studies were found in the peer-reviewed literature. Therefore, the articles included in the scoping review were critiqued and are presented in Table 1.

### 3.1. Citation network analysis

Based on the scoping review results, citation network analysis was conducted. The citation network analysis produced nodes and connections between the nodes. The nodes represent themes (larger size) and sub-themes (smaller size). The number of connections between nodes measures the closeness of themes and sub-themes. The thicker the line between the nodes, the closer the themes and sub-themes are to one another. The size of the nodes represents the number of publications, and the line between the themes and subthemes represents the cooperation between them. The colors represent the collaboration clusters. Two main clusters were identified based on themes from the scoping review, which are air pollution (red cluster) and climate change (green cluster) (Fig. 2). Three small clusters with sub-themes on particulate matter (PM) 2.5 (blue cluster), energy (yellow cluster), and emissions (purple cluster) formed mainly by the two main clusters.

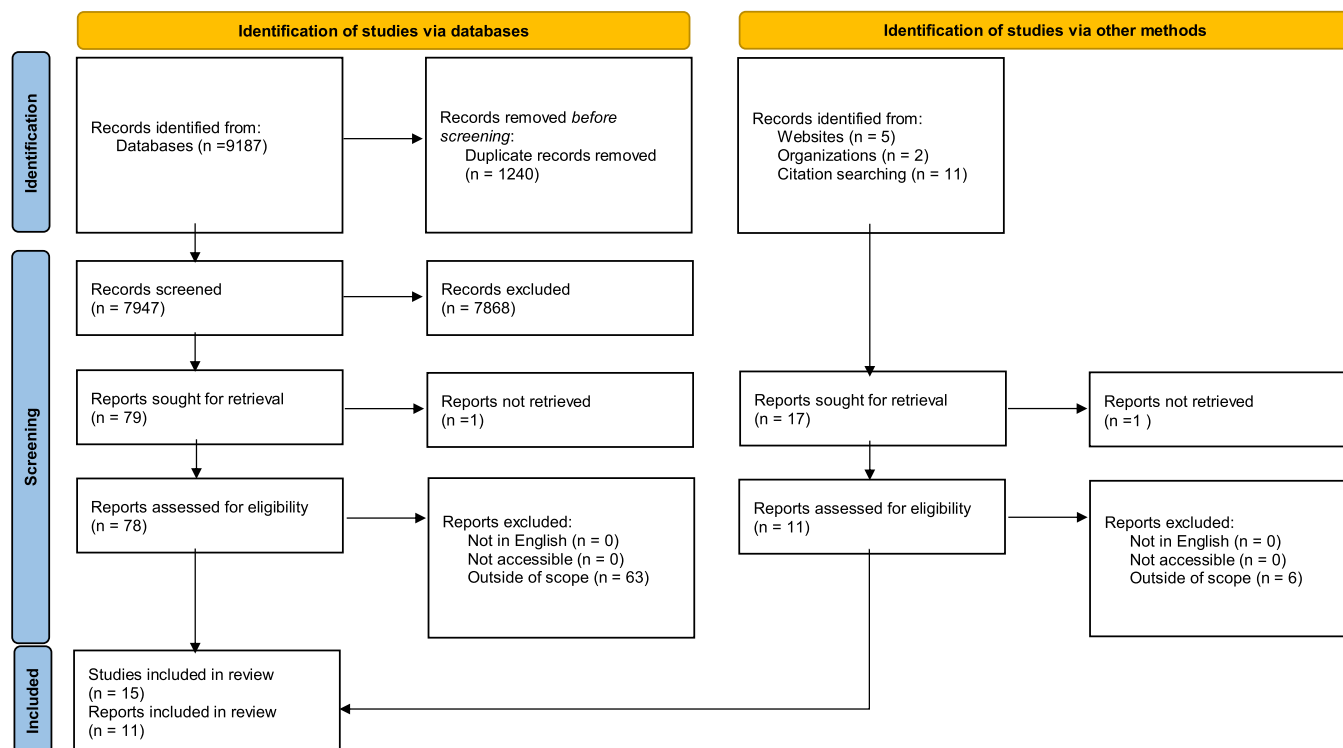


Fig. 1. PRISMA DIAGRAM (Page et al., 2021).

In relation to climate change (green cluster), the strongest links were observed with public health and, to a lesser extent, human health, environmental impacts, health effects, solar energy, and climate change mitigation. In relation to air pollution (red cluster), the strongest links were observed with coal and, to a lesser extent, environmental health, air quality, adaptation, energy policy, and mitigation.

The weak linkages to sub-themes such as health co-benefits, health impacts, renewable energy, environmental justice, and carbon footprint are of concern. Most of these sub-themes form part of the just energy transition framework and are key in operationalizing the transition from coal to alternative energy sources that promote health benefits (International Trade Union Confederation, 2022). Yet these themes need to appear in the literature around climate, public health, air pollution and coal. Moreover, if we are to operationalize a just energy transition, there should be a stronger focus on interlinkages between disciplines and a transdisciplinary strategy should be sought.

#### 4. Discussion

The regulation of coal is crucial in fulfilling our international obligations under the Paris Agreement (Hamilton et al., 2021), and there is a growing emphasis on achieving a fair transition. The primary difficulties for regions that rely on coal are the structural changes required for industry and labor (Kim et al., 2022). South Africa's energy policy evolution reflects the interplay of economic, social, and environmental priorities, influenced by a diverse array of stakeholders, including government bodies, private sectors, and civil society organizations. Each entity brings a distinct influence, shaping priorities around cost-effectiveness, energy access, and climate commitments. Mapping these influences in the policy-making process underscores how stakeholder priorities can either converge towards or diverge from a comprehensive JET framework. By linking domestic policy priorities with key **network analysis indicators**, this paper suggests how South Africa's political landscape can align with the principles of JET (Table 1).

In South Africa, the Presidential Climate Commission has provided a

just transition framework, positing that a just transition in South Africa aims for a quality life, climate resilience, and net-zero emissions by 2050. It promotes decent work, social inclusion, poverty eradication, and prioritizes the vulnerable in decision-making, emphasizing renewable energy and sustainable resources.

Despite warnings from the IPCC (IPCC, 2022) and SDG agenda goals (United Nations, 2015), many countries and corporations still need to transition away from coal. Without policies that ensure a fair transition, regions that rely on coal will face significant economic challenges. While renewable energy jobs can replace some of the jobs lost due to the retirement of fossil fuels (Mayer, 2022), the transition must be carefully planned to ensure that it benefits everyone, particularly those in lower-income households. For example, replacing coal plants with solar photovoltaic plants can create more jobs that benefit low-income households more than wind energy (Brown and O'Sullivan, 2020). In addition, the persistence of poverty in areas affected by endemic coal-related diseases is a major concern (Lloyd, 2014), as residents may be unable to afford clean energy solutions.

Nonetheless, the upward trend in investments in coal infrastructure in Asia and Sub-Saharan Africa is a cause for concern (Pistelli, 2020), given the increasing production costs and environmental concerns associated with coal and the decreasing costs of alternative energy sources. A carefully managed transition plan for South Africa could provide opportunities for economic diversification, but this would require significant government intervention. Policy decisions need to be tailored to individual countries. They must consider current energy technologies and long-term energy production and consumption targets (Ritchie et al., 2022) while balancing the objectives of a fast decarbonization process, cost-effectiveness, and a just transition. There is an urgent need to develop effective policies and take positive actions to accelerate the development of the rural economy to facilitate the transition away from coal.

These findings highlight the importance of environmental justice, which aims to ensure that environmental burdens and benefits are distributed fairly and equitably within society (Declet-Barreto and Rosenberg, 2022). Environmental justice recognizes that certain

**Table 1**

Key Theme of JET, study findings, and indicators for policy engagement in South Africa.

Key theme	Country	Reviewed Studies	Applicability to South Africa	Key indicators policy engagement
Political and Economic Transition	Germany, UK, Turkey, US, China, EU	<a href="#">Bang et al. (2022)</a> observe that after the Paris Agreement, just transition perspectives gained more attention, especially in Germany, where policymakers prioritized transition by including stakeholder representation. In the UK, however, cost-effectiveness was prioritized over just transition ( <a href="#">Bang et al., 2022</a> ; <a href="#">Blohm, 2021</a> ) emphasizes that policy decisions should be tailored to each country, considering current technologies and long-term energy targets. <a href="#">Kimmell and Cleetus, 2018</a> echo the necessity for effective regulation of coal, noting the diverse strategies employed across China, Germany, India, and the US.	These findings underline the need for South Africa to adopt tailored policies that consider local energy needs, socio-political factors, and economic implications while advancing the Just Transition agenda. They also emphasize the importance of engaging stakeholders to ensure a balanced transition.	Network analysis should track <b>policy development metrics</b> (e.g., decarbonization targets, stakeholder engagement, financial investment in renewables) to compare countries' transition strategies and assess outcomes. Identifying <b>policy overlaps and gaps</b> with South Africa's goals will enhance alignment with global efforts.
Social Justice and Community Impact	South Africa, US, India, Poland, Germany, Australia	<a href="#">Brown and Spiegel (2019)</a> highlight the cultural politics of coal in different regions and the need to consider lived experiences in planning just transition frameworks. In the US, <a href="#">Cha (2020)</a> finds that without significant government intervention, coal-dependent regions face economic challenges requiring well-managed and planned transition policies. <a href="#">Dwyer and Sambath (2019)</a> explore ethical issues in India, emphasizing the disproportionate distribution of pollution burdens and benefits. In South Africa, <a href="#">Barnes (2022)</a> underscores the need for clarity between Climate Justice and Restorative Justice, noting that both are often broadly categorized under the concept of just transition."	Highlighting the socio-cultural impact and need for justice, these studies support the need for South Africa's transition framework to be sensitive to community needs and social inequities. By differentiating between climate and restorative justice, the framework can address both environmental and historical injustices.	To engage these themes, network analysis can track <b>social equity indicators</b> (e.g., community health, livelihood security, energy accessibility) and <b>stakeholder representation metrics</b> to monitor if policies align with affected communities' needs. <b>Social impact trends</b> across similar transitions can be analyzed for relevance to South Africa's framework.
Health and Environmental Benefits	US, China, Australia, EU, South Africa, Turkey, UK	<a href="#">Driscoll et al. (2015)</a> advocate for carbon standards necessary for local and regional health co-benefits. <a href="#">Deetjen and Azevedo (2020)</a> highlight that a coal-to-gas shift balances health and climate impacts. In the EU, <a href="#">Sasmaz et al. (2021)</a> emphasize that renewable energy adoption reduces the need for fossil fuel imports and has positive health effects. In Australia, <a href="#">Chapman et al. (2018)</a> stress that non-cost impacts and benefits should be considered for an equitable transition. In South Africa, <a href="#">Winkler et al. (2021)</a> call for strategies addressing both mitigation and social justice.	These findings inform South Africa's approach by showcasing the dual benefits of reducing coal reliance for health and environmental outcomes. The insights suggest prioritizing health-focused policies that will also contribute to meeting climate goals.	Tracking <b>health and environmental indicators</b> (e.g., pollution reduction, public health metrics) in network analysis can highlight the local/global health benefits linked to renewable energy use. Identifying <b>co-benefit hotspots</b> across studies helps target policies that maximize environmental and health gains for South Africa.

communities, particularly those with low-income or minority populations, often bear a disproportionate share of the negative impacts of environmental pollution and degradation while benefiting less from activities that generate pollution. Addressing environmental justice requires considering impacted communities' social and economic contexts and acknowledging their right to participate in decision-making. The results indicate two distinct post-carbon themes in a just transition society. Social and restorative justice are central to JET, particularly in ensuring that transition policies address both immediate social needs and the long-standing environmental and health burdens borne by coal-dependent communities.

The concept of social justice in this context involves equitable access to clean energy, improved health outcomes, and the creation of economic opportunities for displaced coal workers. Social justice must be a key consideration to achieve a just transition. This involves targeting greenhouse gas emission reductions while minimizing negative societal impacts ([Winkler et al., 2021](#)). Such a transition is expected to result in net social gains, considering health and climate benefits ([Gao et al., 2018](#); [Watts et al., 2017](#)). Successful reduction of coal dependency in most countries has involved demand-side and supply-side transitions ([Zhao et al., 2021](#)), highlighting the importance of policy approaches in

South Africa that target both demand and supply to achieve a complete coal phase-out. The effectiveness of JET in South Africa hinges on meaningful public participation, particularly for communities historically impacted by coal mining and environmental degradation. Incorporating community voices in policy decisions aligns with the principles of social justice and equity, addressing socio-economic inequalities that have been perpetuated by the fossil fuel industry. Tracking **social equity indicators**—such as community health metrics, livelihood security, and renewable energy accessibility—will help assess whether JET policies adequately address local needs and promote inclusive development (Table 1).

**Restorative justice**, on the other hand, requires acknowledging and addressing specific harms inflicted on these communities by the coal industry ([Hazrati and Heffron, 2021](#)). The cultural politics of coal in different regions should be considered, and communities' lived experiences must be addressed and incorporated using a social innovation lens approach ([Rajasekhar, 2020](#)). South Africa needs a clear definition and approach to both social and restorative justice, which are conceptually distinct, despite being part of the unified calls for a just transition. In cases where toxic pollution and maldistribution persist, participatory and collaborative research can be conducted with meaningful local



building is necessary to understand the community’s needs in the just transition. The just transition allows *governments* and their leaders to address climate change, growing inequality, and social inclusion. Still, it is important to consider the historical implications and prospective tools and resources within government structures to realize this transition. A just transition *economic consideration* roadmap should articulate a new end vision for the financial ecosystem that aligns lending and investment actions with idealized government environmental and social policies that support a net-zero economy (Fankhauser et al., 2022). Finally, it is important to understand the industry’s role in the just transition and how fund allocation can address restorative justice at the micro, meso, and macro levels.

**Limitations:** This scoping review includes papers in English and may have excluded possible relevant literature from non-English-speaking countries with research and policies related to the just energy transition.

In conclusion, to support a comprehensive JET, we propose to align South Africa’s energy policy with principles of justice and inclusivity. First, enhancing regulatory coherence will require tailored policies that address local socio-economic conditions, informed by community input and aligned with international climate commitments. Second, sustaining public engagement will necessitate ongoing participatory mechanisms that allow communities to shape policies that impact their environment and livelihoods. Finally, implementing and monitoring social and restorative justice will be essential to ensure that policies contribute positively to communities historically affected by coal. This will align South Africa’s JET with broader global trends and best practices, providing a model that balances sustainable energy goals with equitable socio-economic development.

Further research be conducted to facilitate the development and implementation of an enabling framework for a sustainable future. Three key areas require attention:

1. A detailed guideline that outlines the existing barriers and issues must be developed to enhance the accessibility of the enabling framework. The guideline could also incorporate a measurable and comparable index to track progress.
2. Knowledge gaps that hinder the transition to carbon-neutral energy systems need to be identified and addressed.
3. The analysis of local content requirements, whether individual or general, is crucial to strengthen domestic economies and infrastructure, which includes the transfer of technology and knowledge.

**CRedit authorship contribution statement**

**Patrick Sean Mark:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Visualization, Writing – original draft, Writing – review & editing. **Shirinde Joyce:** Writing – review & editing. **Kgarosi Kableo:** Data curation, Formal analysis, Methodology, Validation, Writing – review & editing. **Makinthisa Takalani:** Data curation, Formal analysis, Methodology, Writing – review & editing. **Eurpidou Rico:** Funding acquisition, Methodology, Resources, Writing – review & editing. **Munnik Victor:** Conceptualization, Funding acquisition, Writing – review & editing.

**Declaration of Competing Interest**

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

**Acknowledgements**

The Centre for Environmental Rights for funding to conduct this scoping review.

**Appendix**

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist (Tricco et al., 2018)

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
<b>TITLE</b>			
Title	1	Identify the report as a scoping review.	1
<b>ABSTRACT</b>			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	2
<b>INTRODUCTION</b>			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	3
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	3
<b>METHODS</b>			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	4
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	4
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	4
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	4
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	4
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	4

(continued on next page)

(continued)

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	4
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	4
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	4
<b>RESULTS</b>			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	5–6
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	7–11
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	7–11
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	7–11
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	7–11
<b>DISCUSSION5–10</b>			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	12–16
Limitations	20	Discuss the limitations of the scoping review process.	16
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	16–17
<b>FUNDING</b>			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	24

## Data availability

Data will be made available on request.

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