

# Building low carbon and climate resilient health systems: a rapid review of interventions

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K Diaconu<sup>1</sup>, A Noubani<sup>1</sup>, A Jahanbakhsh<sup>3</sup>, BR Bhatta<sup>2</sup>, SP KC<sup>2</sup>, Y. P. Joshi<sup>2</sup>, S Garcia Lopez<sup>3</sup>, M van der Spek<sup>3</sup>, P Kadetz<sup>1</sup>, S Baral<sup>2</sup>

1. Institute for Global Health and Development, Queen Margaret University, Edinburgh
2. HERDi Nepal
3. Heriot Watt University, Edinburgh

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## Introduction

Climate change is the most pressing global challenge of our time. Its destructive effects are inequitably distributed, with countries that have contributed the least towards its acceleration suffering the most<sup>1</sup>. The impacts of climate change will be devastating for marginalised populations, including indigenous groups, those living in poverty, persons living in high-risk areas, and those with urgent or complex care needs (e.g. women and children or persons with chronic diseases).

The World Bank estimates that by 2030, climate change could be one of the drivers behind over 130 million more people globally living in poverty<sup>2</sup>. The same analysis suggests that by 2050, over 20 million people will die due to climate related health risks (ibid). These estimates are considerably higher than those offered by the World Health Organization (WHO), who note that climate change will cause an additional 250,000 deaths per year between 2030-2050<sup>3</sup>.

Extreme weather events and natural disasters will directly contribute to this burden<sup>2</sup>. Higher temperatures, compromised eco- and food systems, and social unrest and conflict, will also directly affect disease burdens<sup>3</sup>. Health systems themselves will be affected by climate change shocks and stressors, often resulting in reduced capacity. The latter includes the destruction of health facilities and infrastructure, reduced staff availability due to migration in the face of challenging environmental conditions, or even loss of life<sup>2,3</sup>. Despite these challenges, systems will still need to provide services for the increased and changing burden of disease attributable to climate change.

However, as health systems and service delivery are carbon intensive and account for 4-5% of greenhouse gas emissions (GHG) worldwide, they also serve as a contributor to climate change. Specifically, health care's climate footprint is equivalent to 4.4% of global net emissions (2 gigatons of carbon dioxide equivalent). The global health care climate footprint is equivalent to the annual greenhouse gas emissions from 514 coal-fired power plants<sup>4</sup>. Most evidence is from high-income countries and indicates that 50-75% of emissions are due to medical supplies and use of disposable materials, equipment, and pharmaceuticals (REF). Direct emissions from energy use constitute a further 10-20% of total health system emissions and are directly influenced by the age and functionality of existing building infrastructure and surrounding environmental conditions<sup>5</sup>.

Emerging evidence suggests that it is increasingly important to consider the emissions of low-and middle-income countries' (LMICs) health systems, especially as they grapple with service expansion, poor existing infrastructure, and increased climate-related risks<sup>6</sup>. Health systems in LMICs have the opportunity to address these priorities while at the same time considering how to reduce emissions from the outset, or to enhance the resilience of their

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<sup>1</sup> Action for Global Health Network (2021) Health Inequalities and Climate Change: Action for Global Health Position Paper. United Kingdom. Access [here](#).

<sup>2</sup> World Bank Group. Revised Estimates of the Impact of Climate Change on Extreme Poverty by 2030. Access [here](#) and [here](#)

<sup>3</sup> World Health Organisation (2021) Climate Change and Health (website). Access [here](#).

<sup>4</sup> Health Care Without Harm Climate-smart health care series Green Paper Number One, Access [here](#)

<sup>5</sup> Rodríguez-Jiménez, L., Romero-Martín, M., Spruell, T., Steley, Z., & Gómez-Salgado, J. (2023). The carbon footprint of healthcare settings: A systematic review. *Journal of Advanced Nursing*.

<sup>6</sup> Rasheed F N, Baddley J, Prabhakaran P, De Barros E F, Reddy K S, Vianna N A et al. Decarbonising healthcare in low and middle income countries: potential pathways to net zero emissions *BMJ* 2021; 375 :n1284 doi:10.1136/bmj.n1284

systems through decarbonization. The potential for impact is large. Based on existing data, Rasheed and colleagues estimate that the CO<sub>2</sub> intensity per US\$ is lowest in high-income settings (average 0.38), compared to lower- (average 1.44) and upper-middle-income (average 0.87) country settings. An assessment of Aga Khan's Health Services delivery network across 9 LMICs (Afghanistan, India, Kenya, Kyrgyzstan, Pakistan, Syria, Tajikistan, Tanzania, and Uganda) corroborates that health systems' emissions present an important global challenge<sup>7</sup>. Estimates for CO<sub>2</sub> intensity per US\$ are estimated at 0.58 for Tanzania, 0.72 for India and between 0.32-0.45 for Kenya<sup>5</sup>; almost all higher than for high-income settings. These findings are important for global climate change mitigation and adaptation, given global warming is a problem driven by the high volume of CO<sub>2</sub><sup>8</sup> in the atmosphere.

Transforming existing systems into low-carbon and climate-resilient health systems is essential for ensuring the health and wellbeing of future generations<sup>7</sup>. However, while there is guidance on the types of approaches that health systems should adopt to fulfil this goal, there is limited evidence on the feasibility of implementation and effectiveness of these approaches in practice<sup>9</sup>, particularly across diverse contexts. Further, the evidence landscape is wide and fragmented, with many interventions which directly impact the climate resilience of health systems documented across other sectors<sup>10</sup>.

## Aims and Objectives

The aim of this rapid review is to document what interventions have been implemented to build low-carbon and/or climate-resilient health systems in low- and middle-income countries, and document their effectiveness, with due reflection on how contextual features affect the latter.

Associated objectives are:

1. Develop a typology of interventions designed to build low-carbon health systems in LMICs.
2. Develop a typology of interventions designed to develop more climate-resilient health systems in LMICs.
3. Identify how addressing air, water and soil quality have been integrated into interventions for more low-carbon and climate-resilient health systems in LMICs.
4. Assess the effects of interventions to build low-carbon and climate-resilient health systems in LMICs.
5. Understand what factors relating to the intervention, implementation, context or population act as barriers or facilitators to effectiveness.

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<sup>7</sup> Jerome Baddley, Fawzia N. Rasheed (2023) The Aga Khan Development Network's (AKDN) approach to supply chain carbon footprinting for healthcare providers, *Cleaner Logistics and Supply Chain*, Volume 7, 2023, 100109, ISSN 2772-3909, <https://doi.org/10.1016/j.clscn.2023.100109>.

<sup>8</sup> CO<sub>2</sub> has the highest positive radiative forcing of all the human-influenced climate drivers. Other gases like methane are more effective at trapping heat than CO<sub>2</sub> but do not contribute as much to warming.

<sup>9</sup> Mosadeghrad AM, Isfahani P, Eslambolchi L, Zahmatkesh M, Afshari M. Strategies to strengthen a climate-resilient health system: a scoping review. *Global Health*. 2023 Aug 28;19(1):62. doi: 10.1186/s12992-023-00965-2. PMID: 37641052; PMCID: PMC10463427.

<sup>10</sup> Blom IM, Asfura JS, Eissa M et al. A systematic review protocol for identifying the effectiveness of greenhouse gas mitigation interventions for health care systems in low- and middle-income countries [version 1; peer review: 1 approved, 1 approved with reservations] *Wellcome Open Research* 2022, 7:202 <https://doi.org/10.12688/wellcomeopenres.18005.1>

## Methods

### Protocol

A protocol was developed a priori to the review being carried out. There were no deviations from protocol to report.

### Terminology

We adopted standard definitions included in the WHO Framework on Low-carbon and Climate-Resilient Health Systems<sup>11</sup> (see Figure 1 below).

#### Box 1.1 Key definitions

**Health systems** include all the organizations, institutions, people, resources, and actions whose primary purpose is to improve, restore or maintain health. The goals of a health system are improving health and health equity in ways that are responsive, financially fair and make the best or most efficient use of available resources. Six health system building blocks together constitute a complete health system – health service delivery; health workforce; health information; medical technologies; health financing; leadership and governance (5).

**Climate resilient health systems** are those capable of anticipating, responding to, coping with, recovering from, and adapting to climate-related shocks and stress, to bring about sustained improvements in population health, despite an unstable climate (1).

**Low carbon health systems** are those capable of implementing transformative strategies towards reducing GHG emissions in their operations, reducing short- and long-term negative impacts on the local and global environment.

**Climate resilient and low carbon health systems** are those capable of anticipating, responding to, coping with, recovering from, and adapting to climate-related shocks and stress, while minimizing GHG emissions and other negative environmental impacts to deliver quality care and protect the health and well-being of present and future generations.

**FIGURE 1: KEY DEFINITIONS FROM WHO FRAMEWORK ON LOW CARBON AND CLIMATE RESILIENT HEALTH SYSTEMS (SOURCE: WORLD HEALTH ORGANIZATION, 2023: OPERATIONAL FRAMEWORK FOR BUILDING CLIMATE RESILIENT AND LOW CARBON HEALTH SYSTEMS. GENEVA.)**

For the purposes of this review, we defined “intervention” as any solution-oriented change made either to the health system, both institutional and at the community/primary health level, or any action which has an impact on the resilience of the health system and its contribution to greenhouse gas emissions. This framing allowed a focus on a wide range of interventions likely to be implemented in practice, from technical solutions for achieving low-carbon health systems to higher level intervention packages intended to bring about changes in health systems and build climate resilience.

### Research questions

The review focused on the following research questions:

1. What interventions have been implemented in LMICs to develop low-carbon and/or climate-resilient health systems and what are their mechanisms of action and intended targets?

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<sup>11</sup> World Health Organization, 2023: Operational framework for building climate resilient and low carbon health systems. Geneva.

- a. To what extent, and how, can the WHO Operational framework on building climate resilient **or** low-carbon health systems<sup>12</sup> be applied for classifying identified interventions? What alternative classifications may be appropriate?
- b. To what extent, and how, has tackling air, water or soil quality been integrated into interventions that are intended to achieve more climate-resilient **or** low carbon health systems in LMICs?
2. How effective are interventions designed to build low-carbon and climate-resilient health systems in LMICs?
  - a. What metrics, tools and outcomes have been used to assess intervention effectiveness and outcomes?
  - b. What are the costs and the relative value for money of diverse interventions (broadly defined as cost-effectiveness or cost-benefit) and how is value for money being considered and assessed?
  - c. How effective are interventions designed to build low-carbon **or** climate resilient health systems?
  - d. How effective are interventions in maintaining **or** improving health outcomes?
  - e. What are the broader outcomes, including unintended consequences, of interventions?
3. What factors (intervention design, implementation, the context, or population) influence the effectiveness and outcomes of interventions designed to build low-carbon and climate-resilient health systems in LMICs?
  - a. How do intervention design, implementation and effectiveness differ according to country and local context?
  - b. What factors act as barriers or facilitators to intervention implementation and/or to effectiveness of interventions designed to build low-carbon and climate-resilient health systems in LMICs?

### Information sources

Several reviews on linked topics already exist, and a wide range of portals offer information for decision-makers and implementers interested in low-carbon or climate resilient health systems. However, scoping searches of the literature suggest that very few interventions have been implemented, and that where this has happened, it may be necessary to rely on expert contacts to gain access to evidence.

Given the above, a comprehensive list of information sources was searched or consulted (see Table 1). Complementing search efforts, consultation with experts in the field was organised to locate additional documents that should undergo review.

**TABLE 1: INFORMATION SOURCES**

Information source	Sources to be identified
Hand-searches of existing reviews	Scoping searches conducted up to 21/05/2024 identified a set of reviews which include references to potential studies to be included. (Appendix 1 lists all individual reviews that were hand searched.)
Databases	PubMed/Medline, Web of Knowledge, Scopus, Cochrane Library, 3IE, Global Index Medicus, LILACS, Agricultural & Environmental Science Database (AESD), CABI Digital Library, GreenFILE and ELDIS.

<sup>12</sup> World Health Organization, 2023: Operational framework for building climate resilient and low carbon health systems. Geneva.

Websites and/or existing portals	<p>Climate action tracker; Alliance for Transformative Action on Climate and Health; 2021 WHO Health and Climate Change Survey (we will log a data request with WHO), World Bank (especially World Bank Climate Change and Knowledge Portal), Climate Health Information Portal, Climate change and human health literature portal.</p> <p>IMF Climate change dashboard, climate change analytics (<a href="https://climateanalytics.org/">https://climateanalytics.org/</a>), climate change laws (<a href="https://climate-laws.org/">https://climate-laws.org/</a>), International Union for conservation of nature(<a href="https://www.iucn.org/">https://www.iucn.org/</a>), climate displacement and resilience database(<a href="https://belonging.berkeley.edu/climatedisplacement/climate-displacement-and-resilience-database">https://belonging.berkeley.edu/climatedisplacement/climate-displacement-and-resilience-database</a>), <a href="https://www.iea.org/">https://www.iea.org/</a>, <a href="https://idric.org/knowledge-hub/">https://idric.org/knowledge-hub/</a>, <a href="https://www.ipcc.ch/">https://www.ipcc.ch/</a></p>
Expert contact	<p>We fielded inquiries among experts in the field, invited to contribute to the advisory group for the project; advisors included: Dr Carlos F. Dora, Dr Renzo Guinto, Dr Kelly Elimian, Dr Salima Meherali, Iris Blom, Dr Ornella Punzo, Dr. Amod Kumar Pokhrel, Dr. Suraj Bhattraï Dr Marina Romanello</p>

### Search strategies

Diverse keywords were used to search databases and websites/portals identified in Table 1. Keywords focused on climate change and climate change action, environmental determinants and climate risks, health and health sectors and evaluation. Appendix 2 includes full search strategies. Search terms used were in the English language, and this may have unduly affected the sensitivity of searches.

### Study selection

After deduplication using reference management software (Mendeley and Covidence), studies underwent a two-stage screening process guided by the specified Eligibility Criteria. This was conducted using Covidence software, which facilitated title and abstract screening, followed by full-text screening.

Individual reviewers (AN, BB, SK) conducted title and abstract reviews with an inclusive approach, advancing any potentially relevant documents to the full-text screening stage. To ensure quality, a random sample of at least 10% of excluded titles and abstracts was reviewed periodically by two reviewers. Any discrepancies in inclusion were discussed within the team and resolved by consensus. Corrections to the overarching screening process were made as necessary following discussions. Covidence's AI-assisted sorting, which prioritized the most relevant studies at the top, enabled efficient screening until no further relevant studies were identified. We applied a stopping rule whereby screening was halted when no further abstract was advanced to full text screening after 100 abstracts screened. Full-text screening was completed by KD, with any uncertainty resolved through consultation with a secondary reviewer among the team.

### Eligibility criteria

Documents in any language that met the inclusion criteria were included (see Table 6), with no restrictions on publication date. Only full texts freely available to the study team were considered (i.e. some access relied on institutional library subscriptions – where this was the case and the study could not be obtained via author contact, we noted this as a separate exclusion reason). Inclusion was limited to documents evaluating interventions aimed at achieving low-carbon or climate-resilient health systems (per WHO definitions), with no further study design restrictions due to the topic's novelty and scarcity of evaluations. We

also included reviews which captured evaluations and further screened included studies for these.

We limited inclusion to evaluations targeting specific outcomes (see Outcomes section below), based on authors' reporting and definitions.

For a study to be included in the review, the role of the health system – or any of its actors – had to be acknowledged; for example, this meant that interventions outside the health sector were only included if and where a health system link was explicitly named. This means that studies in sectors such as education, economic development and transport were only included if and where health system linkages were explicitly described. Further, studies which reported on health vulnerability assessments of health systems with explicit focus solely on climate sensitive diseases but without explicit linkage to any resulting interventions that aimed to promote low carbon or climate resilient health systems were also excluded.

**TABLE 2: INCLUSION AND EXCLUSION CRITERIA**

Inclusion	Exclusion
Document refers to LMIC contexts (at the time of writing for each document)	Document does not refer to an LMIC.
Document reports result of an evaluation based on primary data collection (qualitative, quantitative, or mixed method) or based on modelling or critical analysis	Document is not an evaluation.
Document reports on at least one of the primary (or secondary outcomes as attached to a primary outcome specified).	Document does not mention any of the outcomes of interest.
	Document mentions an outcome outside of those specified and/or actions outside of the health system.
Full text is available.	Document does not have full text (e.g. conference abstract only).
Document is in public domain and/or can be accessed via expert contacts/author communication.	Document cannot be sourced.

## Outcomes

To be eligible for inclusion in this review, studies reported on an intervention which tackles one of the below primary or secondary outcomes.

*Primary outcomes* considered by the review include: the carbon footprint of the healthcare system; resilience of the healthcare system to respond to climate shocks and stressors; and quality or pollution of air, water, and soil.

*Secondary outcomes* any measured health outcomes as a direct or indirect result of interventions to tackle the above primary outcomes. Any cost-effectiveness and value for money calculations related to the above primary outcomes were also included. This also extended to situations where the primary outcome effects of an intervention were not reported, but where the final cost-benefit for an intervention tackling the primary outcomes are reported.

*Additional outcomes* of relevance and from which data were extracted included:

- environmental sustainability and sustainability of interventions,
- changes in resource use, including for incentives, administration, and services,

- impacts on decision-makers and health providers (motivation, satisfaction, acceptability).
- impacts on patient satisfaction and acceptability.
- impacts on overall financing or resource allocation.
- impacts on health management or information systems.
- equity considerations (e.g., differential impacts for diverse parts of the population) and impacts on community resilience.

## Data extraction

Initially, pilot testing of the AI software Scispace was conducted with a few studies to refine the data extraction process. Following successful testing, full data extraction was carried out using this, with quality checks and data cleaning performed by individual reviewers to ensure the accuracy and consistency of the extracted data from all included studies. The extracted data covered elements outlined in Table 7. Given the anticipated variability and heterogeneity in reported outcomes, all relevant information was included without specifying effect measurements, with data retained as reported by the study authors.

**TABLE 3: DATA ITEMS FOR EXTRACTION**

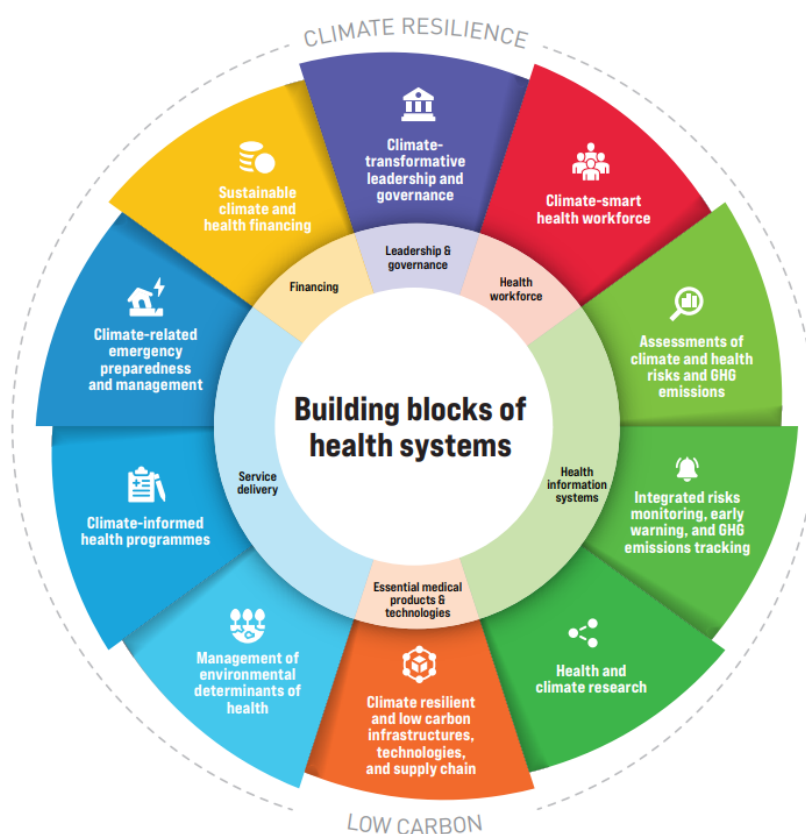
<b>Domain</b>	<b>Variables</b>
Study information	Title; First author; Publication year; Source of funding for study
Context	Country context (country income level (as define by the World Bank at the time when specific interventions were carried out), country climate vulnerability, level of greenhouse gas emissions and Universal health coverage index (Indicator 3.8.1)) Policy context: why were interventions pursued, what were key motivations/ interests around that
Study design and methods	Observational, experimental (quasi-experimental, RCT, qualitative etc.) Methods used (brief description) Setting of study (e.g., clinical, community-based)
Study participants	Sampling unit (country, region, facility, patients, persons) Sample size Characteristics of sampling units Inclusion and exclusion criteria for those sampled
Intervention	Description of the intervention(s) studied (consider design / theory of change / actual implementation of intervention) Stakeholders involved in design vs. implementation Duration of intervention Resource requirements of intervention and funders Components of intervention Intended targets and outcomes
Outcomes	Core outcome information (what is captured, measurement, by whom, timing of assessment) Secondary outcome information (what is captured, measurement, by whom, timing of assessment)
Effect data - quantitative	For each outcome specified above: Effect sizes or estimates (e.g., relative risk, odds ratio, mean difference); Confidence intervals; P-values or significance levels.
Effect data – qualitative	Extraction of any qualitative information (direct quotes) on effects re: any of the specified outcomes above.
Other notes	Notes by study authors; Notes by reviewers

## Analysis

A descriptive and narrative synthesis of all included studies was performed. We first describe study characteristics, including publication trends.

Further, we followed the SWiM analysis and reporting guidelines<sup>13</sup>. Studies were first grouped into similar categories (see below), and then narrative synthesis was used to comment on the effects of interventions. Summary of findings tables offer an overview of all studies reporting on a joint outcome and comment on both positive and negative effects as described in literature.

Each intervention mentioned by the studies underwent a classification process against the WHO 2023 Operational Guidelines for Building Low Carbon and Climate Resilient Health Systems (see Figure 2). This means that interventions were assigned against an intervention category, and type which more directly describes intended intervention targets; the classification was conducted inductively and was refined iteratively as more studies and information was added.



**FIGURE 2: WHO OPERATIONAL FRAMEWORK FOR CLIMATE RESILIENT AND LOW CARBON HEALTH SYSTEMS (SOURCE: WORLD HEALTH ORGANIZATION, 2023: OPERATIONAL FRAMEWORK FOR BUILDING CLIMATE RESILIENT AND LOW CARBON HEALTH SYSTEMS. GENEVA.)**

<sup>13</sup> Campbell M, McKenzie J E, Sowden A, Katikireddi S V, Brennan S E, Ellis S et al. Synthesis without meta-analysis (SWiM) in systematic reviews: reporting guideline *BMJ* 2020; 368 :l6890 doi:10.1136/bmj.l6890

The narrative synthesis was conducted based on the intervention classification. Given high levels of heterogeneity in outcomes discussed and assessed across the body of literature, we comment on effectiveness of intervention in terms of direction of effect for each target outcome (positive, mixed, negative) where this is discernible; where limited information is available, we will label direction of effect as unclear. Substantiating information is then also provided.

Four expert consultations were organized where we presented preliminary findings of the review. We aimed to solicit feedback on face validity and gathered critiques/limitations from experts and recommendations which guided the grouping of studies and further analysis. Consultations reiterated the value of conducting analyses based on climate vulnerability; specifically, to uncover any potential trends of interventions used in different contexts and their potential for impact.

Two setting specific analyses were conducted. First, we classified countries by World Bank income group, using the latest classification for each country as designated in 2023. Second, we used the Notre Dame Global Adaptation Initiative (ND-GAIN) vulnerability assessment to classify countries by climate vulnerability<sup>14</sup>. The ND-GAIN is a comprehensive, open-source index that measures countries' vulnerability to climate change and their readiness to adapt to climate challenges. The initiative evaluates countries across six critical life-supporting sectors (food, water, health, ecosystem services, human habitat, and infrastructure) while also assessing their capacity to leverage investments for adaptation actions through economic, governance, and social indicators. For the purposes of the review, we specifically used ND-GAIN's country vulnerability assessment, which is structured around three key components: exposure (how much a country is affected by climate conditions), sensitivity (how much these conditions impact people and sectors), and adaptive capacity (ability to respond and adjust).

## Quality appraisal

Individual studies underwent a quality assessment, with due consideration for risk of bias. A bespoke tool was developed for the risk of bias assessment, based on the DfID How to Note "Assessing Strength of Evidence" and adapted with criteria from the Mixed Methods Appraisal Tool (see Appendix 4).

One reviewer performed the risk of bias assessment for each included study. This individual assessment was then discussed with a second reviewer, and the reviewers then jointly determined whether each study should be classified as having a high, medium, or low risk of bias. Risk of bias ratings are presented in a visual format (e.g., using a simple graphic) in Appendix 4.

Following the above classification, we attempted to describe the certainty of evidence for each intervention type and outcome targeted. We followed traditional GRADE methods<sup>15</sup>, bearing in mind primarily criteria related to risk of bias of individual studies, imprecision, inconsistency, indirectness and publication bias. Where only one study was available to inform any summary of findings, we additionally downgraded certainty of evidence.

## Findings

### Results of searches and selection

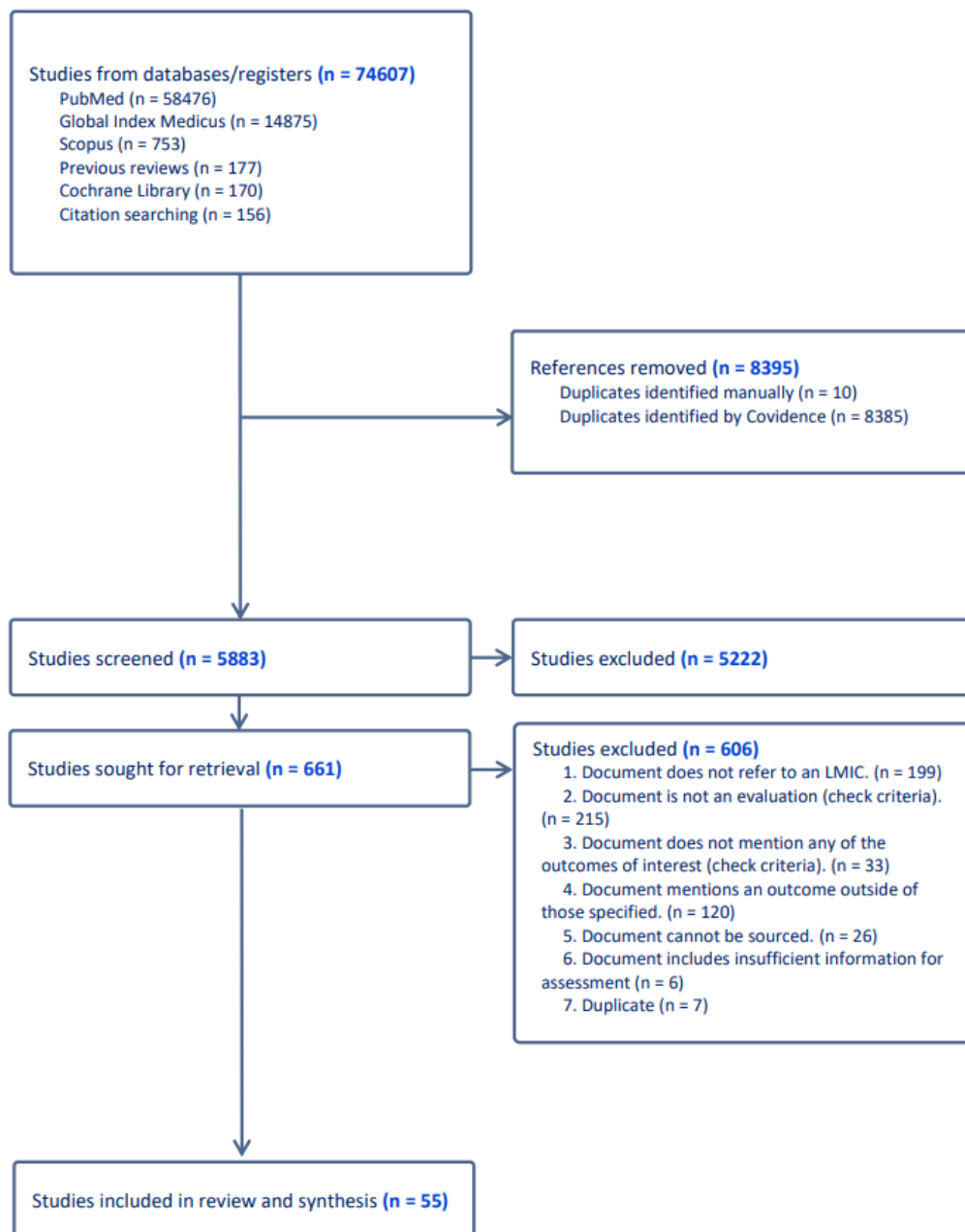
Figure 3 offers an overview of the search and selection process. Initial searches identified 74607 records. After deduplication and prioritisation of studies for screening, and in line with

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<sup>14</sup> <https://gain.nd.edu/our-work/country-index/methodology/>

<sup>15</sup> <https://www.gradeworkinggroup.org/>

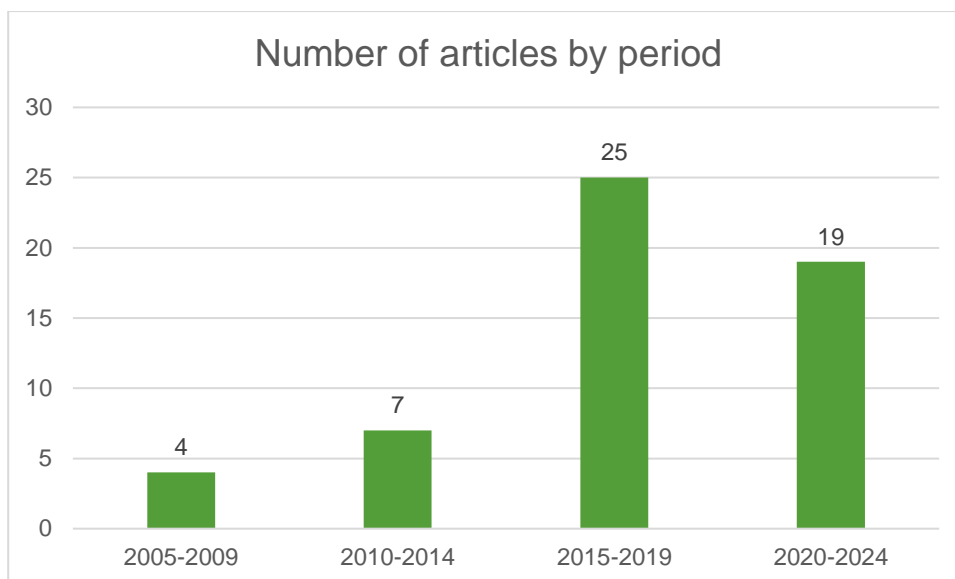
our stopping rule, 5883 unique titles and abstracts screened. Following this step, 661 texts were retained for full text screening and 55 studies were included in the final review. Throughout the findings section, references of studies included in the review are indicated directly as Author, Year.



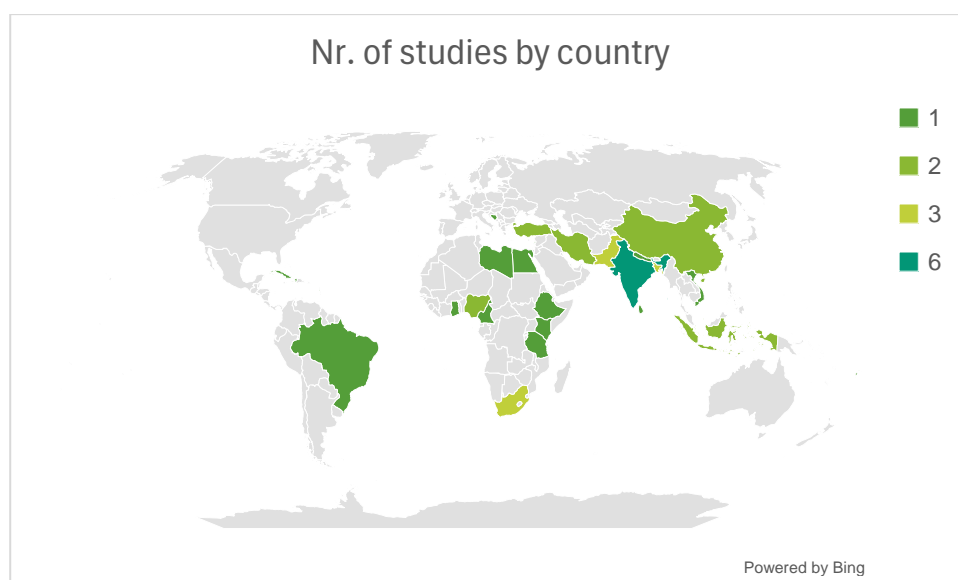
**FIGURE 3: PRISMA CHART**

### Overview of included studies

Most studies were published from 2015 onward (see Figure 4 for distribution of studies over time). Four studies had a cross-country focus with more than 2 countries included – these were generally comparative studies at national or city levels. Three studies noted that they referred to LMICs but did not explicitly identify these. Only three studies (n=3) were conducted in low-income countries (all in Ethiopia), twenty-five (n=25) were conducted in lower middle-income countries and the remaining twenty-two (n=22) in upper middle-income countries. The most frequently mentioned countries were India (n=6) and Bangladesh, Pakistan and South Africa (n=3 each).



**FIGURE 4: DISTRIBUTION OF STUDIES BY YEARS**

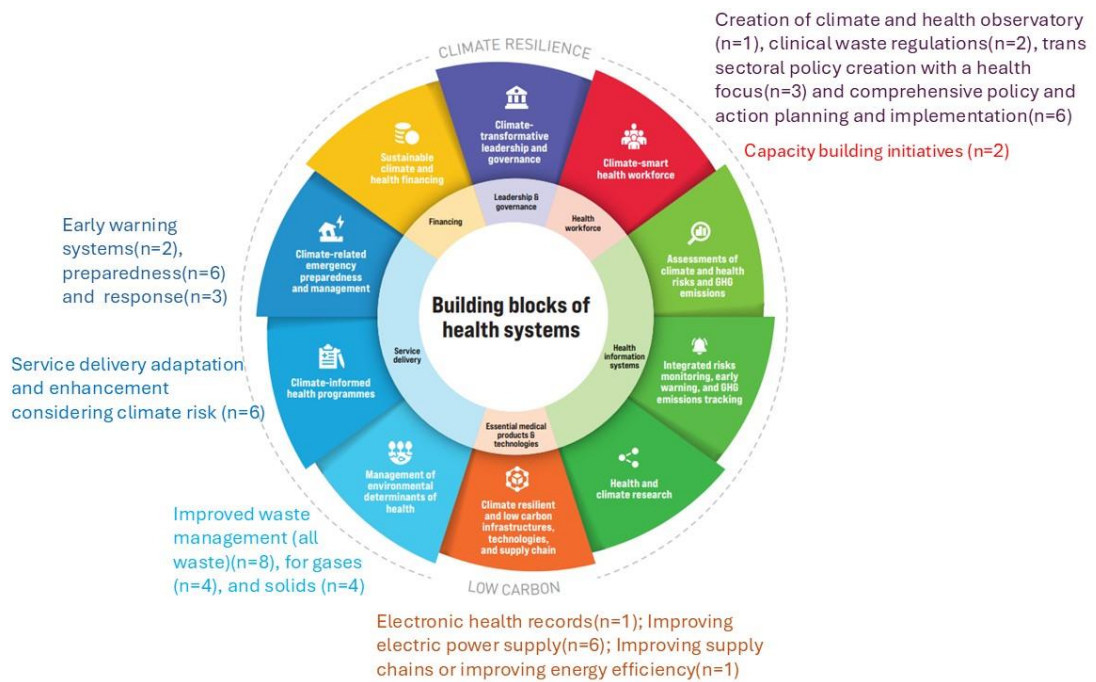


**FIGURE 5: NUMBER OF STUDIES BY COUNTRY**

All studies included primary data collection. Appendix 3 Table 1 presents the broad characteristics of these studies. Just over half of the studies (n=29) used quantitative methods; whereas qualitative methods and mixed designs were used in 11 and 13 studies respectively. A minority of studies was labelled as analytical – these studies took a discursive analytical approach to describe and discuss specific interventions. Studies reported on diverse evaluation types; the majority were formative evaluations (n=16) reporting on interim intervention or programme effects and seeking to learn from these for future implementation. Only one study was a cost-effectiveness study. Intervention and evaluation characteristics

Appendix 3 Table 2 offers a detailed description of interventions as presented in the literature and Figure 6 further offers an overview of these interventions classified against the

WHO Operational Framework. The classification sought to assign each study and intervention described therein against one main category, but in practice, interventions are often multi component.



**FIGURE 6: INTERVENTIONS IDENTIFIED IN LITERATURE CLASSIFIED AGAINST WHO FRAMEWORK (SOURCE: AUTHORS)**

### *Intervention categories and types*

A mixed set of intervention types can be identified across the reviewed literature as seen in Appendix 3 Table 2. Figure 6 offers a brief summary of the types of interventions, classified against the WHO framework categories (see Figure 6). For example, service delivery adaptations documented in literature were classified against “climate informed health programmes”. These broader categories as per the WHO framework are used to discuss interventions in what follows.

The majority of studies focus on interventions which the WHO Operational Framework identifies as ‘low regret’ interventions – specifically those that any health systems can adopt to enhance climate resilience and achieve a lower carbon footprint. The interventions largely refer to putting in place climate resilient and low carbon infrastructure and technologies or improving management of environmental determinants of health.

### *Climate informed health programmes*

Few of the studies reviewed focused on climate-informed health programmes interventions. The aim of interventions in this category was explicitly linked to specific vertical services or programmes. For example, Lusambili (2023) implemented community-designed interventions for heat exposure protection in Kenya, focusing on water access and education for maternal-newborn health. Similarly, Thiel (2017) showcased resource-efficient healthcare delivery through the *Aravind Eye Care System's* cataract surgery model, demonstrating how clinical excellence can be maintained while reducing environmental impact through reusable instruments and efficient protocols.

### *Climate related emergency preparedness and management*

Eleven studies focused on emergency preparedness and management interventions. These studies included interventions which predominantly described strategies aimed at enhancing resilience to climate-related health risks. Interventions described here were either developed de novo or present already in health systems. For example, Jack (2024) developed an urban heat early warning system in African cities, employing a structured process that integrates vulnerability mapping and stakeholder engagement to mitigate heat-related health impacts. Sari (2019) assessed the presence of adaptation and warning systems in public health centres, highlighting the importance of facility-level preparedness and challenges to putting these in place. Some authors focused more generally on strategies enacted at national levels in the health system. For example, Zakrison (2017) examined Cuba's disaster response strategy, which integrates healthcare professionals into frontline response and engages the public in preparedness activities. While, Farley (2017) and Van Minh (2014) focused on flood and storm preparedness in healthcare facilities, addressing health promotion and first-aid solutions.

### *Climate resilient and low-carbon infrastructure*

Eight studies focused on interventions that intend to achieve a more climate-resilient and low carbon infrastructure. Interventions described here focused on improving the electrical supply of health facilities, or, where possible, upgrading existing ways in which electricity is provided to ensure sustained availability of electricity. However, few studies focused on other actions– for example, only one study assessed whether the introduction of electronic medical records would be an effective way to reduce carbon emissions and improve health system resilience. Yet, Kwon (2024), who employed quantitative methods and life-cycle analysis for this assessment in India, determined that electronic medical records were more carbon intensive than paper-based systems.

### ***Climate smart health workforce***

Most studies actively named capacity building of the workforce as one of their intervention strategies and actions, however only two studies focused specifically only on capacity building – with emphasis on creating a workforce empowered to work on climate related issues. These latter studies used survey designs to assess the change in levels of knowledge of the workforce.

### ***Management of environmental determinants of health***

This review identified sixteen studies which evaluated diverse types of waste management interventions. These studies focus specifically on eliminating the public health and wider contamination risks due to medical waste. Eight studies focused on all types of waste including water, but several other studies more specifically focused on gases used in anaesthesia or on solid waste generated as part of medical care. The latter are frequently burned, and as such, interventions were focused on identifying more environmentally friendly alternatives to this process. Most of these studies used life-cycle assessments of new technologies (such as gas evacuation systems or incinerators) and focused on assessing outcomes such as environmental contamination, including air pollution, as their outcomes, or carbon footprint.

### ***Climate transformative leadership and governance***

Leadership and governance interventions encompassed a range of policy-level and regulatory approaches to ensuring climate-resilient healthcare and also a set of interventions focused on putting in place and enacting specific climate-resilient actions. Across these studies, interventions demonstrate a progression from high-level policy frameworks to specific regulatory mechanisms or other concrete actions, with emphasis on multi-sectoral collaboration, stakeholder engagement, and capacity building. Common themes include the integration of health considerations into climate policies, establishment of monitoring systems, and development of regulatory frameworks to ensure implementation at various governmental levels; including health facilities. For example, Obeng (2020) focused on regulatory governance through Water Safety Plans in Ghana, implementing comprehensive monitoring systems for water quality management.

### ***Policy context of intervention implementation***

Overall, studies offered relatively sparse descriptions of national policy contexts. Studies implicitly noted that health systems taking action to achieve low carbon emissions and also climate resilience were normative and desirable goals generally but offered relatively limited details as to local policy relevance. In several instances, exposure to previous climate events (e.g. droughts, floods) were highlighted.

National-level climate and health policies which catalyse climate action were frequently mentioned as a facilitator for action in the health system (see Summary of Findings tables 3). The integration of health and climate policies was noted to be increasingly common, with several studies noting that the availability of national policy frameworks that explicitly link health and climate serves.

However, across the studies reviewed a diverse picture of policy contexts which help catalyse action in the health system emerged. In some instances, the presence of climate policies specifically was noted as a facilitator for building low-carbon and climate resilient health systems. For example, in South Africa, Khine (2023) describes the National Climate Change Adaptation Strategy (NCCAS), with its focus on building climate resilience while addressing historical inequities linked to apartheid. The strategy emphasizes collaborative action between different government levels, NGOs, and private sector partners. And

Stewart-Ibarra (2019) highlights the importance of National Adaptation Plans for Climate Change and the Global Framework for Climate Services (GFCS) in guiding climate service development and stakeholder engagement, including in the health sector.

In other contexts, other sectoral policies were also noted as potentially affecting health system actions for building low-carbon and climate resilient health systems. For example, in Nigeria, Ezirim (2018) documented the implementation of a national healthcare waste management policy established in 2013, which led to improvements in waste management practices across health facilities, though with varying levels of success across different Nigerian states. Similarly, Singh (2020) discusses the growing policy support for solar photovoltaic systems supports enhanced service delivery. Introduction of these technologies was noted to be beneficial for remote healthcare settings.

Having a policy in place is however not always a guarantee for actions being implemented in practice.

### *Stakeholders involved in interventions*

A diverse array of stakeholders spanning across multiple sectors and governance levels was noted to be involved in intervention implementation. Government bodies, including national, provincial, and local authorities, were described as playing a pivotal role, with departments who have clear remits for climate change (e.g. Environmental Affairs) taking the lead in climate adaptation efforts. Municipalities and local governments were often described as being tasked with specific responsibilities (e.g. specifically around waste management, emergency preparedness), highlighting the importance of local governance in implementing climate strategies, including for the health sector.

Healthcare professionals and institutions were the most frequently mentioned stakeholders, with studies naming diverse cadres from physicians and nurses to hospital administrators and public health workers. This diversity underscores the comprehensive approach needed to address health impacts related to climate change. Community and civil society organizations, including CSOs and CBOs, were also discussed in relation to implementation, particularly in community-level health interventions and nutrition programmes. For example, Community-Based Nutrition programmes have been successfully integrated into health services, for which local organizations work effectively alongside government officials in various contexts (Brown, 2016).

Regional and international organizations, such as the Caribbean Public Health Agency (CARPHA) and the Pan American Health Organization (PAHO), have also been identified as important stakeholders, providing crucial support, facilitating collaboration across borders and enhancing the effectiveness of interventions.

The academic and research sectors contribute significantly through training and capacity-building initiatives, ensuring that interventions are informed by the latest scientific insights and tailored to local contexts. However, lack of local data platforms and effective collaboration between academics and local practitioners, communities and the public were noted as challenging effectiveness of interventions.

Despite these efforts, challenges were noted – particularly in achieving effective collaboration and coordination across different government levels. Furthermore, engagement of the private sector was minimally mentioned. For example, Ahmad Khan (2019), Gulis (2023) and Carvalho (2023) are the three studies which include private health providers and facilities in their interventions. Almost all studies noted the importance for coordinated efforts

and inclusive stakeholder engagement to enhance the resilience and sustainability of health systems in the face of climate change.

### *Scale of implementation*

Most interventions were implemented directly at either the facility-level –in which case the focus was usually on one facility– or at sub-national levels –where the focus was on several facilities implementing similar interventions (see Table 2). Few interventions were implemented at national levels and these usually fell into the leadership and governance category.

### *Intervention funding*

Funding sources for interventions were diverse but, in many cases, not explicitly named. The majority of intervention appear to be supported directly by governments (although the level is unclear), but with quite a few also receiving support from research institutions for implementation. Several studies did not report funding sources for the interventions.

## Outcomes and effects of interventions

### *Outcomes assessed across studies*

Outcomes described across the literature and against which interventions were assessed were highly heterogeneous – both in terms of specification and measurement. Inductively, we have identified patterns in the outcomes described, largely grouped under the headings of:

- **Reduced Emissions:** This outcome is primarily concerned with the environmental impact of different types of technologies (e.g. for medical waste incineration or anaesthesia, or different health services). The studies employ precise measurement techniques and basic science approaches, usually using IPCC guidelines to measure GHG emissions from healthcare activities and reporting on emissions in terms of kilograms of CO<sub>2</sub>e.
- **Waste generated and environmental contamination:** Many studies focused on waste management practices in healthcare settings directly referred to solid waste generated, and/or contamination of environment (e.g. water, air, soil) due to this waste. In relation to waste management, studies most often quote kilograms generated per day (kg/day), providing a tangible metric for evaluating waste management efficiency and identifying areas for improvement.
- **Improved Health System Response:** This outcome examined the responsiveness of health systems, particularly in the face of climate emergencies. Studies focused on emergency preparedness and response most frequently focused on such outcomes and used qualitative interpretations, or routine data, to make inferences regarding intervention effectiveness.

Other studies focus more broadly on perceptions of intervention effectiveness, which were captured via either qualitative insights or structured surveys.

### *Summary of intervention effectiveness*

Tables 4-9 provide a systematic overview of the interventions aimed at building low carbon or climate resilient health systems, categorized by intervention type and their reported outcomes.

### *Climate informed health programmes (Table 4)*

In the category of climate-informed health programmes, studies consistently report positive effects. Table 4 summarizes interventions aimed at adapting and enhancing health service delivery in response to climate risks. Key findings include the effectiveness of enhanced disease surveillance, management of climate-sensitive diseases, and public education in improving health service resilience. Facilitators such as senior leadership engagement, cross-sector collaboration, and meteorological data usage to inform adaptations of health services were highlighted. However, the certainty of evidence across this body of work is low due to indirectness, imprecision, and bias. Most studies were conducted in upper-middle-income countries with low climate vulnerability, where interventions showed consistent effectiveness.

**TABLE 4: SUMMARY OF FINDINGS – CLIMATE INFORMED HEALTH PROGRAMMES**

<b>Intervention type</b>	Service delivery adaptation and enhancement in light of climate risk		
<b>Studies contributing</b>	Lock-Wah-Hoon, 2020; Lusambili, 2023; Stewart Ibarra, 2019; Thiel, 2017; Ha, 2019; Venkatesh, 2015		
<b>Outcomes</b>	<b>Narrative summary</b>	<b>Certainty of evidence</b>	<b>Notes on context (income group of country)</b>
Lock-Wah-Hoon, 2020 and Stewart-Ibarra, 2019 focus on perceptions regarding effectiveness of interventions - largely in relation to facilitators	Interventions identified as effective providing valued additions to health services (enhanced surveillance and management of climate sensitive diseases) with facilitators noted to include engagement of senior leaderships, establishment of official collaboration and partnership channels (including across diverse sectors), and use of data (especially meteorological). Authors recommend formal incorporation of climate consideration in national adaptation plans, including for health. Increased public education and civil society awareness is also viewed as promoting effectiveness of interventions.	Low (indirectness, imprecision, risk of bias)	Contexts of upper middle-income countries, similar effectiveness noted.
Lusambili, 2023 focuses on heat exposure risks and mitigation for pregnant women	Accessibility to water supplies, social behavior-change campaigns, and education on the potentially adverse effects of heat on maternal health were identified as the top three sustainable and effective interventions with the highest likelihood of success to mitigate heat exposure impacts on pregnant and postpartum women and newborns in Kilifi, Kenya.	Low (indirectness, imprecision, risk of bias)	All studies in lower-middle income countries.
Thiel, 2017, Venkatesh 2015 and Ha, 2019 all use environmental outcomes specifically emission level and carbon footprint	All studies identified that the technological adaptation to ensure low-carbon footprint were successful, while providing similar standards of care.	Low (indirectness, imprecision, risk of bias)	Thiel, 2017 conducted in upper middle income country; other two studies are basic sciences studies.

### *Climate related emergency preparedness and management (Table 5)*

Table 5 offers an overview of emergency preparedness and response interventions, which generally fall into three categories (see Figure 6). Early warning systems were described in two studies and showed promise; however, implementation challenges were frequently named. The complexity of warning systems and putting these in place in low-resource settings was also noted. Studies focused on emergency preparedness interventions

emphasized the effectiveness of such initiatives but relative neglect of development of preparedness and mitigation plans, when compared to development of emergency response frameworks. Several studies focused on emergency response initiatives, noting their effectiveness. The importance of community engagement, decentralized decision-making, and robust infrastructure emerged as key facilitators for success across studies. Certainty of evidence was low across studies, with studies primarily from lower-middle-income countries with moderate to high climate vulnerability.

**TABLE 5: SUMMARY OF FINDINGS CLIMATE RELATED EMERGENCY PREPAREDNESS AND MANAGEMENT**

<b>Intervention type</b>	<b>Early warning systems (n=2)</b>		
<b>Studies contributing</b>	<b>Jack, 2024 and Sari, 2019</b>		
<b>Outcomes</b>	<b>Narrative summary</b>	<b>Certainty of evidence</b>	<b>Notes on context (income group of country)</b>
Jack 2024 focuses on the use of a complex model to assist with heat forecasting and impacts on health; Sari 2019 instead is focused on comprehensiveness of early warning systems that exist at facility levels.	Both studies flag promise of intervention but note substantive challenges in implementation. Jack, 2024 uses a highly complex model and intervention, which cannot be easily put into practice by non-specialists; similar challenges also flagged by Sari, 2019 who notes that facilities do not have the specialist skills to implement intervention at lower levels of the health system.	Low (indirectness, imprecision, risk of bias)	Jack, 2024 takes place in lower-middle income country; Sari, 2019 in upper middle income country
<b>Intervention type</b>	<b>Emergency preparedness (n=6)</b>		
<b>Studies contributing</b>	<b>Brown, 2016; Rawat, 2022; Van Minh, 2014; Farley, 2017; Araos, 2015, Koka, 2018.</b>		
<b>Outcomes</b>	<b>Narrative summary</b>	<b>Certainty of evidence</b>	<b>Notes on context (income group of country)</b>
All studies share common focus on perception of improved health system response to climate events due to preparedness initiatives, with most studies using qualitative methods, and some using surveys (Farley, 2017) or routine data (e.g. Brown, 2016) to infer effectiveness.	Examples of success were noted where interventions ensured appropriate development of preparedness and response plans including with community and relevant primary care engagement locally, and national engagement ( e.g. Brown 2016, Rawat 2022). Brown 2016 discusses an example of this, in context of nutrition and health service integration specifically, where prior joint preparedness planning assured comprehensiveness of eventual response during El Nino drought. Brown 2016 and Rawat 2022 also noted how decentralised decision-making can facilitate appropriate use of resources and to result in higher community engagement. Farley, 2017, Koka 2018 and Van Minh flagged the lack of such planning generally; they noted that government focus on response prevents appropriate investment into planning and mitigation. nd increased focus on	Low (indirectness, imprecision, risk of bias)	Brown 2016 and Rawat 2022 conducted in low-income setting; the others in lower-middle income settings.

	response as major challenges. All studies noted that lack of infrastructure (including for communication, essential commodities and prepositioning) is a key consideration during planning. Similarly studies flagged that lack of data severely impacts on what planning can be done locally; studies also flagged low human resource capacity in relation to environmental and climate determinants of health and the use of evidence around these domains to inform preparedness.		
<b>Intervention type</b>	<b>Emergency response (n=3)</b>		
<b>Studies contributing</b>	<b>Pasquini, 2015; Zhong, 2014; Zakrison, 2017.</b>		
<b>Outcomes</b>	<b>Narrative summary</b>	<b>Certainty of evidence</b>	<b>Notes on context (income group of country)</b>
Studies focus on perceptions of surge capacity, disaster response, in relation to routine or exceptional climate events (e.g. Zakrison focused on hurricane Irma)	All three studies highlight limitations in surge capacity; noting challenges in human and other resource mobilisation (e.g. beds). Pasquini 2015 notes that prior exposure and learning from previous events can support improved emergency response over time. This is also discussed by Zakrison 2017 who emphasises Cuba's learning from previous response and deployment of key initiatives (citizen engagement, emergency procedure and safety training) during new events. Zhong highlights similar initiatives also in context of China and hospital based responses. All studies discuss that collaboration and dense social networks, particularly at local levels, are needed to facilitate an effective initial and repeat response. All studies noted positive impacts of effective emergency response on mortality but did not provide sufficient comparator data.	Low (indirectness, imprecision, risk of bias)	All conducted in upper middle income countries.

### Climate resilient and low-carbon infrastructure (Table 6)

Studies in this category examine interventions like supply chain improvements, electronic health records, and renewable energy systems. For example, solarizing vaccine cold chains in Lebanon reduced wastage and costs, while transitioning electronic health records to renewable energy reduced emissions (Ngcamu 2024). Studies on renewable power systems showed resilience to outages and general reduction in emissions. These interventions necessitated comprehensive planning and collaboration with local stakeholders to address geographical and structural challenges. The use of electronic health records (EHR) presents mixed results (Kwon 2024). While EHR systems offer modernization benefits, they currently produce higher greenhouse gas emissions compared to paper records. However, transitioning to renewable energy sources could mitigate these emissions, aligning EHR systems with environmental sustainability goals. Certainty of evidence is low, with contexts ranging from low- to upper-middle-income countries with moderate to high climate vulnerability.

**TABLE 6: SUMMARY OF FINDINGS CLIMATE RESILIENT AND LOW CARBON INFRASTRUCTURE**

Intervention type	Improving supply chains (n=1)		
Studies contributing	Ngcamu 2024		
<b>Outcomes</b>	<b>Narrative summary</b>	<b>Certainty of evidence</b>	<b>Notes on context (income group of country)</b>
Expected outcomes include reduced vaccine wastage, improved temperature stability, significant operational cost savings, and increased public trust in immunization systems.	The study found that solarization of the vaccine cold chain system in Lebanon significantly reduces vaccine wastage and ensures stable temperatures for vaccine storage. Over 1,000 solar direct-drive (SDD) units were installed across more than 800 health facilities, enhancing the resilience of health services. The initiative resulted in substantial operational cost savings by decreasing reliance on non-renewable energy sources.	Low (limited body of evidence, 1 study only)	Upper middle income country.
Intervention type	Electronic health records (n=1)		
Studies contributing	Kwon 2024		
<b>Outcomes</b>	<b>Narrative summary</b>	<b>Certainty of evidence</b>	<b>Notes on context (income group of country)</b>
The study aimed to estimate and compare the environmental emissions associated with paper medical record-keeping and its replacement by an electronic medical record (EMR) system at a high-volume eye care facility in southern India via LCA.	The study found that the electronic medical record (EMR) system emitted significantly more greenhouse gases (GHGs) than the paper medical record system, with emissions of 195,000 kg CO <sub>2</sub> e per year for EMR compared to 20,800 kg CO <sub>2</sub> e for paper records. A major contributor to EMR emissions was electricity usage (90% of total emissions). However, transitioning to renewable energy sources could reduce EMR emissions to approximately 24,900 kg CO <sub>2</sub> e, making them comparable to paper records.	Low (limited body of evidence, 1 study only)	Lower middle income country.
Intervention type	Improving electric power supply (6)		

Studies contributing	Oladigbolu, 2021; De 2023; Chowdhury 2021; Singh 2020, Beitelmal 2022 and Sun 2017		
<b>Outcomes</b>	<b>Narrative summary</b>	<b>Certainty of evidence</b>	<b>Notes on context (income group of country)</b>
Oladigbolu, 2021; De 2023 and Chowdhury 2021 focus on assessment of emissions.	Optimized hybrid or renewable systems offer similar level of resilience in case of outages, but result in significant reductions in emissions, as high as 80% reduction in CO2 compared to standard.	Low (indirectness, imprecision, risk of bias)	Two settings falling into lower-income group (Oladigbolu 2021 and Chowdhury 2021) where increased interest in renewable and hybrid solutions is present; compared to De 2023.
Singh 2020, Beitelmal 2022 and Sun 2017 all use diverse outcomes - energy demand satisfaction, consumption and costs. Singh 2020 and Beitelmal directly focus on different energy supply systems, investigates changes to infrastructure and effects.	All studies suggest that interventions are highly effective and reduce emissions; Sun 2017 notes that infrastructure changes (remodels) are more difficult to accomplish compared to introduction of alternative electric supply technologies as for the other two studies.	Low (indirectness, imprecision, risk of bias)	Singh and Beitelmal conducted in low vulnerability settings, Sun in moderate - findings appear similar.

### *Climate smart health workforce (Table 7)*

Only two studies focused on capacity building interventions, including digital training to reduce carbon footprints and improve climate-related knowledge and skills. Digital training showed environmental benefits but lower satisfaction, while training generally was noted as an appropriate mechanism for building health care professionals' confidence to engage with climate initiatives. Certainty of evidence is low due to limited studies.

**TABLE 7: SUMMARY OF FINDINGS CLIMATE SMART HEALTH WORKFORCE**

Intervention type	Capacity building (specific elements)		
Studies contributing	Gandhi 2023 and Carvalho 2023		
<b>Outcomes</b>	<b>Narrative summary</b>	<b>Certainty of evidence</b>	<b>Notes on context (income group of country)</b>
Carbon footprint of said health worker training initiatives.	Gandhi 2023 found that a digital training initiative decreased carbon footprint significantly but resulted in reduced satisfaction among attendees; hybrid formats were preferred.	Low (limited body of evidence , 1 study only)	Lower middle income country.
Knowledge, awareness and confidence to engage with climate initiatives via training initiatives; Gandhi assessed carbon footprint of said initiatives.	Carvalho 2023 identified that a digital course on climate issues resulted in significant improvements in communication, engagement, and application of climate-related knowledge and skills. Participants reported increased confidence in discussing climate change and health, with 93.2% indicating that the course enhanced their confidence to some extent. Self-selection bias affected results.	Low (limited body of evidence , 1 study only)	NA - mixed country.

### Management of environmental determinants (Table 8)

Waste management interventions which focus on tackling environmental determinants of health were the most frequently described interventions across literature. Interventions differed in their focus – some focused on multi-component approaches, regular monitoring, and fostering a culture of waste management in healthcare facilities. Other interventions were specifically focused on solid or gas waste management. All interventions in this category demonstrated predominantly positive effects. The evidence indicates that alternative waste management processes focusing on low carbon and sustainable alternatives resulted in reduced environmental contamination (see Table 8). However, studies consistently noted implementation challenges, particularly regarding the need for extensive stakeholder collaboration. Certainty of evidence is low, with studies spanning upper-middle-income countries with low climate vulnerability to lower-middle-income countries with moderate to high vulnerability.

**TABLE 8: SUMMARY OF FINDINGS MANAGEMENT OF ENVIRONMENTAL DETERMINANTS**

Intervention type	Improved waste management (all types of waste, n=8)		
Studies contributing	Sapkota, 2014; Gulis, 2013; Ezirim, 2018; Aslan, 2019; Hassan, 2008; Ciplak, 2015; Azami-Aghdash, 2023, Ali 2016		
Outcomes	Narrative summary	Certainty of evidence	Notes on context (income group of country)
Sapkota, 2014, Aslan, 2019, Hassan, 2008 and Azami Aghdash all use performance scores for waste management.	Studies emphasise the use of multiple component interventions to improve waste management and reduce volume and size of medical waste, as well as emissions. Studies noted that plans for waste management alone are insufficient to ensure effective management, improved and regular monitoring as well as working on culture of waste management in facilities generally is needed.	Low (indirectness, risk of bias)	See climate vulnerability - the low vulnerability contexts are upper middle income countries; the high vulnerability contexts are lower-middle income countries.
Gulis, 2013, Ezirim, 2018 and Ciplak 2015 utilised diverse outcome measures, including identification of risks and opportunities for waste management, level of waste management adaptations for sustainability implemented and perceptions on waste management.	Gulis 2023 identified that inappropriate waste management in clinical settings resulted in cross-contamination, physical injuries in addition to health pollution; conducting health impact assessments of waste management regularly - in addition to formal policies on this - was recommended. Ezirim identified that introduction of such policies can result in significant change (proxied by outcomes such as facilities developing work plans and enacting basic measures, e.g. segregation). Ciplak 2015 similarly emphasised effectiveness of waste segregation and importance of context specific plans; autoclaving coupled with landfilling with energy recovery was identified as optimal waste management option. Ali 2016 similarly reinforces the need for effective segregation, and additionally identifies that an integrated waste management system combining composting, incineration, and material recycling was found to be the most effective solution, resulting in the least emissions.	Low (indirectness, imprecision, risk of bias)	Autoclaving and solutions which contain more components recommended only in the upper middle income countries.

Intervention type	<b>Improved waste management (gases, n=4)</b>		
Studies contributing	Bozic, 2019; Braz 2017; Kumar 2014; Rauchenwald 2020		
<b>Outcomes</b>	<b>Narrative summary</b>	<b>Certainty of evidence</b>	<b>Notes on context (income group of country)</b>
Bozic 2019, Braz 2017 and Rauchenwald 2020 focus on trace gas levels and bacteriological contamination in air	Evacuation systems can significantly decrease air pollution and bacteriological presence, when adjusted to appropriate heat and humidity; evacuation systems must be adapted to environmental conditions.	Moderate (risk of bias)	Upper middle income countries
Kumar 2014 focuses on awareness and practice of environmentally friendly anesthesia practices	Generally low awareness among anesthesiologists of negative impacts of gases on environment; The majority (90%) used circle systems, and 87% frequently employed low flows. A significant portion (79%) advocated for total intravenous anesthesia (TIVA) as an alternative to reduce environmental impact.	Low (limited body of evidence, 1 study only)	Lower middle income country
Intervention type	<b>Improved waste management (solid waste, n=4)</b>		
Studies contributing	Khan 2019, Raila 2017, Javied 2018, Gupta 2006		
<b>Outcomes</b>	<b>Narrative summary</b>	<b>Certainty of evidence</b>	<b>Notes on context (income group of country)</b>
Environmental contamination	Studies all identify that lack of segregated waste management, lack of waste management plans and highly decentralised and uncoordinated health waste waste management systems contribute to environmental contamination, predominantly via landfill. Integrated solid waste management systems are promoted solutions, however effectiveness varies in practice due to poor waste management culture at facility level, lack of knowledge and awareness among staff of potential health and environmental risks; lack of coordinated pick up and transportation of waste. Non-incineration interventions recommended for future research.	Low (risk of bias)	One country is upper middle income, the rest lower middle income; findings are similar.

### *Climate transformative leadership and governance (Table 9)*

Leadership and governance were described in several studies. However, pathways of action for these interventions were more opaque, with many focused on creating an ecosystem which could promote actions in the health system generally. Interventions in this category focused on creation of climate and health observatories that could provide data and evidence to the health system, clinical waste regulation which could act as benchmarks for health facilities, and trans-sectoral policy creation. These latter interventions aim to integrate health considerations into climate policies and strengthen health systems.

The effects of interventions in this category appear promising, but less conclusive. However, this is likely due to the complex nature of the interventions and limited appropriate evaluations in the space. The majority of studies did not use robust designs to assess effects

and certainty of evidence is low due to indirectness and bias, with studies conducted in low- to upper-middle-income countries with moderate to high climate vulnerability.

**TABLE 9: SUMMARY OF FINDINGS CLIMATE TRANSFORMATIVE LEADERSHIP AND GOVERNANCE**

Intervention type	Creation of climate and health observatory (n=1)		
Studies contributing	Barcellos, 2016		
<b>Outcomes</b>	<b>Narrative summary</b>	<b>Certainty of evidence</b>	<b>Notes on context (income group of country)</b>
Creation and use of indicators and evidence for informing climate and health action	Study highlights early promise and success via the creation of the observatory; notes that this had to be highly intersectoral and user-led in development to ensure appropriate use.	Low (limited body of evidence, 1 study only)	Upper middle income country
Intervention type	Clinical waste regulation (n=2)		
Studies contributing	Zakaria 2005, Bellan 2012		
<b>Outcomes</b>	<b>Narrative summary</b>	<b>Certainty of evidence</b>	<b>Notes on context (income group of country)</b>
Contamination due to waste management and perception of processes at facility level	Both studies highlight that waste management at clinical facilities under current processes results in contamination above legal limits. The waste management regulation was noted to lower contamination initially but lack of enforcement and monitoring affected effectiveness.	Low (indirectness, imprecision, risk of bias)	Both middle income countries, noting similar challenges.
Intervention type	Trans-sectoral policy creation with a health focus (n=3)		
Studies contributing	Bhopal 2021, Morrow 2014, Wright 2019		
<b>Outcomes</b>	<b>Narrative summary</b>	<b>Certainty of evidence</b>	<b>Notes on context (income group of country)</b>
Perceptions of level of integration of health considerations into policies and extent to which improved national response has been enabled	Across all three settings, national policies focused on climate change have sought to integrate health considerations but have been deemed to do so with insufficient detail so as to prompt concrete action. Importantly, the health impacts of climate change are often indirectly addressed or minimally considered despite common concerns being named. Emergence of vector-borne diseases, water-borne diseases, malnutrition, and displacement-related health issues are recurrently mentioned, but limited guidance on how the health sector or system should adapt are made, resulting in insufficient action in these spaces. Recommendations for Improvement include the Explicit inclusion of health impacts in climate policies; strengthening health systems minimally through naming and introducing early warning systems, consideration of what enhanced services are needed to address/respond to climate risks. Finance mechanisms for the above should be also included in national policies.	Low (indirectness, imprecision, risk of bias)	Findings similar across settings, but urgency underscored for low-income countries given extensive plans for economic development which could impact on climate risks.
Intervention type	Comprehensive policy and action planning and implementation (n=6)		

Studies contributing	Mousavi 2020, Shezi 2019, Weimann 2017, Obeng 2020, Schnitter 2019, Hartinger 2024		
Outcomes	<b>Narrative summary</b>	<b>Certainty of evidence</b>	<b>Notes on context (income group of country)</b>
Outcomes vary depending on configuration of actions implemented; commonly discussed are the intensity and diversity of actions implemented.	All interventions were multi component, involved development of a guiding national/regional policy and further action plans focused on health systems and climate mainstreaming. In some cases the health system played an ancillary part (e.g. Obeng 2020 in Ghana discusses water safety planning and the involvement of the health system in water monitoring and testing and surveillance of disease). In most cases, the health system was directly responsible for implementation of all interventions - generally these were diverse but complementary, with complementarity directly built in to ensure successful implementation and effectiveness as well as creation of a culture of climate action. For example, Weimann 2017 focuses on policies introduced in a South African hospital to reduce its carbon footprint, energy consumption, and hazardous waste, while promoting sustainability in a resource-constrained public healthcare setting. Across all studies, the limited levels of knowledge among health care staff and facility staff re: climate impacts (and confidence to act on these) has been emphasised. Enablers to action have been identified as improved stakeholder engagement and coordination, improved public and community awareness and engagement and the existence of a dedicated policy to spearhead action.	Low (indirectness, imprecision, risk of bias, study design)	All countries are middle income, no difference in findings.

## Risk of bias in included studies

Overall, the risk of bias across the thirty-one identified quantitative studies is high, with ten noted to be at moderate risk of bias, and nine at high risk of bias. Quantitative studies generally received positive assessments for clarity of research methods and design. However, a consistent issue was the lack of appropriate links to raw data, with all studies receiving negative assessments in this area. Additionally, while most studies showed low risk of funding source influence, there were occasional uncertainties in situating findings within the broader context.

The eleven mixed methods studies showed a more varied distribution of risk of bias, but generally the picture is still skewed towards studies of moderate risk of bias (n=5) or high risk (n=2). While all studies clearly situated evidence and posed clear research questions, there were significant concerns regarding the appropriateness of design and methodology, with all studies receiving negative assessments in this area. There was a high level of uncertainty regarding the influence of funding sources, and most studies failed to appropriately link to raw data.

The eight qualitative studies were of generally better quality than studies using other methods. Two studies of moderate and high risk of bias specifically were identified. Studies generally performed well in terms of situating evidence and posing clear research questions, with all studies receiving positive assessments in these areas. However, there were notable concerns regarding the appropriateness of design and methodology, as well as the clarity of research methods. Additionally, there was significant uncertainty in situating findings within the broader context, which may reflect challenges in addressing context-specific cultural factors.

## Sub-group analyses

We conducted two types of sub-group analyses: by income group and country climate vulnerability. The main focus of analyses was on understanding whether the type of implemented interventions and/or their effects differed by context. This analysis is summarised in the Summary of Findings Tables (Tables 4-9) for each intervention type and category. Generally, there was limited variability in findings or effectiveness of interventions by context, however the distribution of interventions by context is notably different.

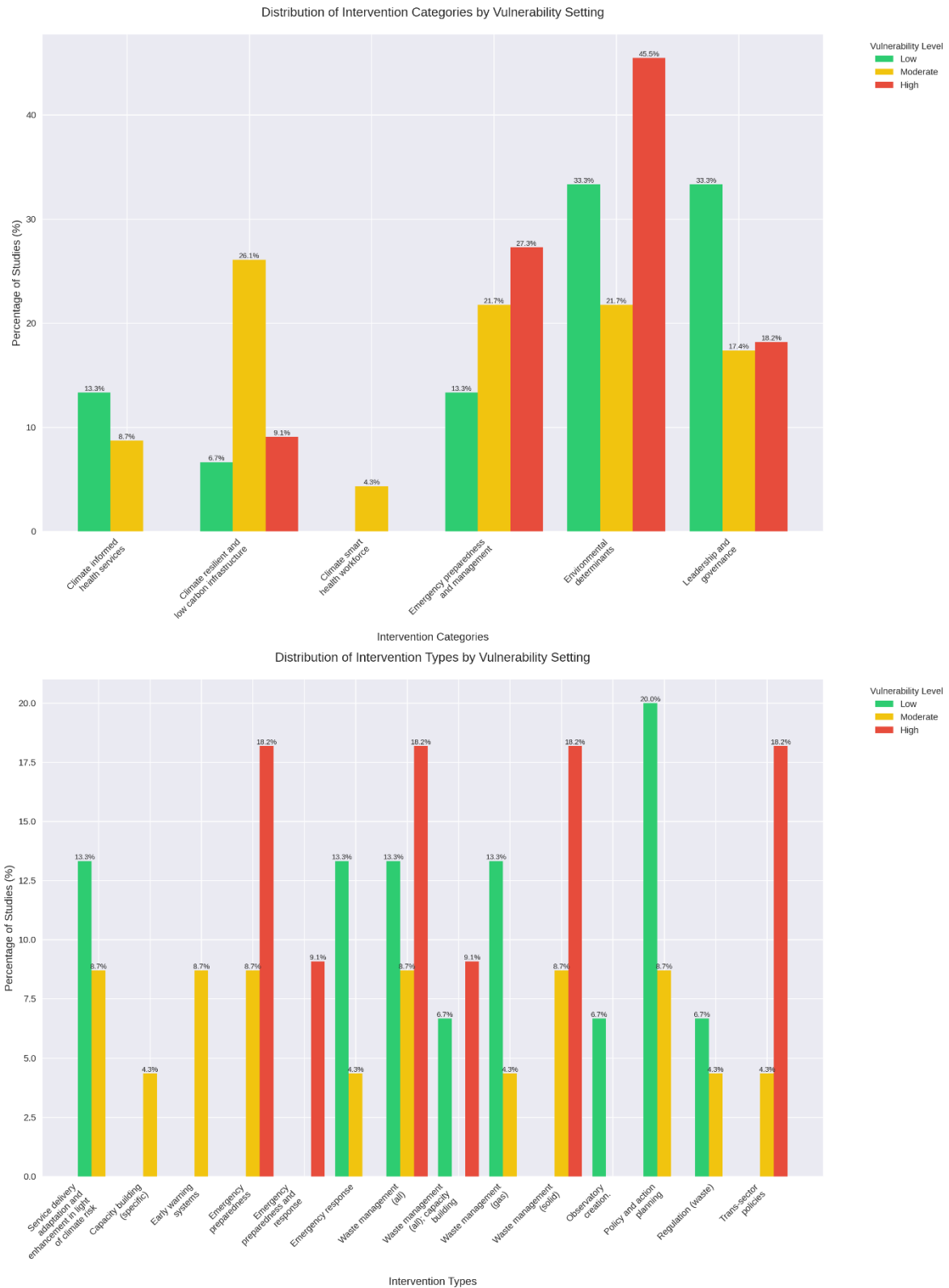
### *Analysis by country income group*

When considering diverse income groups (proxied by World Bank income classification), it is notable that a small proportion of studies were conducted in low-income countries (all three studies identified were conducted in Ethiopia). Two of the studies focused on emergency preparedness interventions. The focus of interventions is much more diverse across low-middle and upper-middle income countries, where almost all intervention categories are represented. Climate resilient infrastructure and technology focused interventions were more commonly discussed in middle-income countries (both lower and upper) but absent in low-income countries. Leadership and governance interventions were almost exclusively implemented in upper middle-income countries, potentially due to higher levels of governance and coordination present in higher income settings.

### *Analysis by country climate vulnerability*

When classifying countries according to their climate vulnerability, a more nuanced trend emerges (see Figure 8). Studies in settings with high climate vulnerability were increasingly focused on emergency preparedness interventions and waste management interventions seeking to manage environmental determinants. In contrast, settings with low climate

vulnerability were more equally focused on leadership and governance interventions as well as those interventions seeking to manage environmental determinants.



**FIGURE 7: INTERVENTIONS BY CLIMATE VULNERABILITY OF COUNTRY**

## Overview of excluded studies

Two major types of study were excluded.

First, we excluded studies which described actions taken in sectors other than health – but which may directly impact on climate related health burdens and on the actions of the health sector itself. Most studies in this category focused on introducing emissions controls which would then serve as signals for behaviour change both for the economic sector as well as individuals. Several studies discussed the introduction of policy to guide behaviours in specific sectors – e.g. manufacturing among others. A modest number of studies also focused on waste management outside of the health sector; however proportionally to the health sector and emphasis on waste within this, this was much lower than expected. Relatively few studies focused on the introduction of interventions that promoted use of renewable energies or that would directly address carbon capture and/or removal.

Second, we excluded studies conducted in high-income countries. A brief AI-assisted analysis of the abstracts of these studies suggests that a similar but more diverse menu of interventions are implemented across these settings as well. In contrast to findings from LMICs, policy and regulatory approaches are most frequently mentioned across studies in this category, suggesting emphasis on leadership and governance as an entry point for supporting climate change mitigation and adaptation in healthcare. Introduction of energy efficiency or saving measures, or renewable energy in hospitals is a second major point of focus for interventions, with further focus also on emergency preparedness and response. The latter is focused particularly on assessing vulnerability and implementing adaptation measures for climate resilience. While the majority of studies in LMICs included elements stakeholder capacity building, and the majority of studies focused on waste management interventions, fewer studies in HIC settings focused on these measures. Several studies also focused on the introduction of telemedicine approaches to reduce emissions; for example by thus diverting the need for patients to travel to receive care.

## Discussion

### Overview of findings

This review identified 55 primary studies, mostly published from 2015 onwards, with a focus on interventions designed to build low-carbon or climate resilient health systems in LMICs. Studies were predominantly conducted in middle-income countries.

Interventions were classified into six categories based on the WHO Operational Framework<sup>16</sup>, although this was difficult to do (see impressions of the field). Interventions focused predominantly on clinical and health waste management approaches to improve management of environmental determinants of health (n=16). Notably, these were the studies that used assessments of water, soil and air quality as part of their outcomes.

A similar number of studies focused on evaluating climate-transformative leadership and governance (n=12) and climate-related emergency preparedness and management (n=11) interventions. The majority of interventions were classified as "low-regret" interventions by the WHO framework (i.e. interventions recommended for all health systems). Interventions in this category refer to introduction of climate-resilient and low-carbon infrastructure and technologies and improving the management of environmental determinants of health via improved waste management. There were no interventions identified that focused on sustainable climate and health financing. Studies which documented assessments of climate

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<sup>16</sup> World Health Organization, 2023: Operational framework for building climate resilient and low carbon health systems. Geneva.

and health risks and greenhouse gas emissions, but where no follow-up action of assessments was taken were purposefully excluded from the review.

Evaluations across all categories generally suggest that interventions may have positive effects. Findings were generally similar even when accounting for contextual differences such as country income group. However, interventions deployed differed by context, with contexts experiencing high climate vulnerability increasingly focused on emergency response rather than other intervention types.

Certainty of evidence was low across the studies. This is largely due to concerns over individual study risk of bias, as well as indirectness and imprecision. Outcomes across the body of evidence are highly heterogeneous, and not easily comparable or synthesised.

## Overview of consultations

To validate findings of the review, we carried out a series of expert consultations where experts were invited to engage with preliminary findings. Generally experts acknowledged that findings conformed to their impressions of the field – generally viewed as lacking a robust evidence base. Several important observations regarding the field were made.

First, experts acknowledged one challenge for reviews of this type relates to boundaries of health systems being contested. For example, early on in the review, the research team made the decision to exclude actions carried out by other sectors such as transport, economic development or others where linkages to the health system or sector were absent. However, arguably, one of the roles of the health system should be to spearhead discussions with other sectors to identify intersectoral actions which could result in significant health benefits. Indeed, we identified and included several studies under the umbrella of climate transformative leadership and governance that attempted to do exactly this and that achieved promising results.

Second, experts discussed the challenges with the evidence landscape overall and how this influences decision making. Experts generally noted that greenhouse gas emissions of the health system are often not accurately measured and that the general impression is that health systems in low-income settings should expand, even if incurring a growing carbon footprint. Hence, experts felt that limited attention was paid to interventions to build low-carbon health systems.

Experts also noted that the evidence landscape appears dominated by studies which focus on interventions in other sectors (e.g. alternative transport initiatives, better manufacturing etc). Studies in this space were often noted to be based on modelling alone rather than data from implemented interventions. These evaluations were noted to show potentially huge impacts of interventions on health outcomes, but the robustness of studies was called into question. Experts also felt that given the available evidence in the field generally it was not possible to for decision-makers to weight up interventions across sectors. For example, experts discussed clearly under-researched areas which should be prioritised in future – such as climate informed health programmes. While the latter are usually taken to mean introduction of programmes for climate sensitive diseases, experts also discussed opportunities here for adapting service delivery platforms and interventions to ensure sustainability. Opportunities for learning across diverse country contexts were flagged here.

## Strengths and limitations

Despite not applying any time restrictions for searches, the majority of literature identified is recent. Given the extremely high number of search results, we used AI to assist with title and abstract screening; this may have meant we missed some studies. Further, while we

attempted to locate grey literature, given the inclusion criteria focused on evaluations, it was unlikely that grey literature studies would be included. As noted in the Methods section, searches used terms in English. While searches retrieved documents in other languages (predominantly Spanish, Portuguese and German), we may have missed studies that were not classified against English keywords.

### Impressions of the field

The field is nascent and highly heterogeneous. The main sources of heterogeneity relate to interventions themselves, outcomes evaluated and evaluation types.

For the review, we attempted to use the WHO operational framework for classification, but there were major challenges with this. Many interventions are interconnected, and some interventions aim to create a positive ecosystem for others. For example, interventions in the climate transformative leadership and governance category generally seek to put in place comprehensive policies and action plans that can guide health systems (or other sectors) in implementing more discrete actions (e.g. waste management). Further, many interventions are highly complex and involve multiple complementary components. Even interventions that are relatively reduced in scope – e.g. for clinical waste management – were noted to be facilitated by explicit inclusion of coordination, planning and monitoring elements.

Evaluations rarely unpack the full theory of change behind interventions, nor do studies list individual intervention components systematically enough to enable comparisons. The designs used across the field are also not robust enough to ascertain effects of these types of complex interventions. Longitudinal and time-series studies, realist or complexity science informed research, would be beneficial for unpacking effectiveness, yet we found none of these types of research.

Interventions seem predominantly implemented at reduced scale (at facility or sub-national levels), with the majority of evaluations focused on relatively discrete outcomes, but with limited comparability of outcomes across studies. The focus on sub-national and facility levels could be due to the decentralised nature of health systems in many low- and middle-income countries, however, it also suggests a potentially future problem area around how interventions are coordinated and/or scaled.

The outcomes evaluated across studies – as well as methods used for operationalising outcomes - are highly heterogeneous. We noted a high diversity in outcomes, ranging from very specific measurements of carbon emissions or environmental contamination to qualitative impressions of intervention effectiveness or structured knowledge and practice assessment. Evaluated studies do not follow the guidance on indicators set by the WHO Operational Framework, and indeed, Blom (2024) and colleagues<sup>17</sup> suggest that indicators proposed in the framework are insufficient and inappropriate for guiding evaluation efforts.

In addition to the development of standard metrics and frameworks for evaluating intervention effectiveness, we recommend the development of a clearer intervention taxonomy, also aligned with contextual information. The WHO Operational Framework suggests that health systems should take on different pathways for development, depending on current status in relation to universal health coverage and greenhouse gas emissions in the health sector. This may be needed, but studies identified here suggest that certain type

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<sup>17</sup> Blom IM, Rasheed FN, Singh H, Eckelman MJ, Dhimal M, Hensher M, Guinto RR, McGushin A, Ning X, Prabhakaran P, Romanello M, van Alphen D, Watts N, Yu JC, Zavaleta-Cortijo C, MacNeill AJ, Sherman JD. Evaluating progress and accountability for achieving COP26 Health Programme international ambitions for sustainable, low-carbon, resilient health-care systems. *Lancet Planet Health*. 2024 Oct;8(10):e778-e789. doi: 10.1016/S2542-5196(24)00206-7. PMID: 39393379.

of initiatives are easier to implement in diverse contexts – e.g. studies in upper middle income countries with low climate vulnerability seemed increasingly focused on leadership and governance interventions; whereas those studies in high climate vulnerability areas focused on emergency response.

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## Appendices

### Appendix 1: List of systematic reviews for which primary studies were screened

Avis, William; Bartington, Suzanne (2020). Monitoring Air Quality in Low- Income and Lower Middle-Income Countries. The Institute of Development Studies and Partner Organisations. Report. <https://hdl.handle.net/20.500.12413/15694>

Avis, W. & Bartington, S. (2020). Interventions in LICs and LMICs to improve air quality and/or mitigate its impacts. K4D Helpdesk Report. Brighton, UK: Institute of Development Studies. <https://k4d.ids.ac.uk/resource/interventions-in-lics-and-lmics-to-improve-air-quality-and-or-mitigate-its-impacts/>

Blom IM, Eissa M, Mattijssen JC, Sana H, Haines A, Whitmee S. Effectiveness of greenhouse gas mitigation intervention for health-care systems: a systematic review. *Bull World Health Organ.* 2024 Mar 1;102(3):159-175B. doi: 10.2471/BLT.23.290464. Epub 2023 Jan 31. PMID: 38420573; PMCID: PMC10898283.

Bouزيد M, Hooper L, Hunter PR. The effectiveness of public health interventions to reduce the health impact of climate change: a systematic review of systematic reviews. *PLoS One.* 2013 Apr 25;8(4):e62041. doi: 10.1371/journal.pone.0062041. PMID: 23634220; PMCID: PMC3636259.

Chersich, M.F., Wright, C.Y. Climate change adaptation in South Africa: a case study on the role of the health sector. *Global Health* **15**, 22 (2019). <https://doi.org/10.1186/s12992-019-0466-x>

Cristiano, W., De Marchi, C., di Domenico, K. *et al.* The elephant in the room in greenhouse gases emissions: rethinking healthcare systems to face climate change. A rapid scoping review. *Environ Sci Eur* **36**, 24 (2024). <https://doi.org/10.1186/s12302-024-00839-3>

Hough E, Cohen Tanugi-Carresse A. Supporting Decarbonization of Health Systems-A Review of International Policy and Practice on Health Care and Climate Change. *Curr Environ Health Rep.* 2024 Jun;11(2):266-278. doi: 10.1007/s40572-024-00434-x. Epub 2024 Feb 15. PMID: 38358612; PMCID: PMC11082023.

Kadetz P. et al (unpublished) Contributing factors that support and thwart climate resilient health systems: a scoping review

Khan MZ, Kazi BM, Bile KM, Magan M, Nasir JA. Environmental health needs and launching of an environmental health protection unit in Pakistan. *East Mediterr Health J.* 2010;16 Suppl:S69-75. PMID: 21495591.

Khine, M.M.; Langkulsen, U. The Implications of Climate Change on Health among Vulnerable Populations in South Africa: A Systematic Review. *Int. J. Environ. Res. Public Health* **2023**, *20*, 3425. <https://doi.org/10.3390/ijerph20043425>

Mishra LD, Agarwal A, Singh AK, Sriganesh K. Paving the way to environment-friendly greener anaesthesia. *J Anaesthesiol Clin Pharmacol.* 2024 Jan-Mar;40(1):9-14. doi: 10.4103/joacp.joacp\_283\_22. Epub 2023 Apr 7. PMID: 38666164; PMCID: PMC11042111.

Mosadeghrad, A.M., Isfahani, P., Eslambolchi, L. *et al.* Strategies to strengthen a climate-resilient health system: a scoping review. *Global Health* **19**, 62 (2023).

<https://doi.org/10.1186/s12992-023-00965-2>

Qin RX, Velin L, Yates EF, El Omrani O, McLeod E, Tudravu J, Samad L, Woodward A, McClain CD. Building sustainable and resilient surgical systems: A narrative review of opportunities to integrate climate change into national surgical planning in the Western Pacific region. *Lancet Reg Health West Pac.* 2022 Feb 23;22:100407. doi: 10.1016/j.lanwpc.2022.100407. PMID: 35243461; PMCID: PMC8881731.

Rocque RJ, Beaudoin C, Ndjaboue R, et al Health effects of climate change: an overview of systematic reviews *BMJ Open* 2021;11:e046333. doi: 10.1136/bmjopen-2020-046333

Rodríguez-Jiménez, L., Romero-Martín, M., Spruell, T., Steley, Z., & Gómez-Salgado, J. (2023). The carbon footprint of healthcare settings: A systematic review. *Journal of Advanced Nursing*, 79, 2830–2844. <https://doi.org/10.1111/jan.15671>

Urrutia-Pereira M, Chong-Neto HJ, Winders TA, Solé D. Environmental impact of inhaler devices on respiratory care: a narrative review. *J Bras Pneumol.* 2023 Jan 13;48(6):e20220270. doi: 10.36416/1806-3756/e20220270. PMID: 36651436; PMCID: PMC9747156.

## Appendix 2: Search strategies

We include the main searches used for database and search engines below. Websites were searches with simple key words and variations ((low carbon OR climate resilient) AND (health)).

Search engines, databases	Search terms
PubMed	(((("climate change"[Title] OR "extreme weather event*"[Title] OR "climate crisis"[Title] OR "changing climate"[Title] OR "global warming"[Title] OR "greenhouse gas*"[Title] OR "greenhouse effect"[Title] OR "environmental harm"[Title] OR "environmental degradation"[Title] OR "climate stressor*"[Title] OR "climate hazard*"[Title] OR "fossil fuel"[Title] OR action[Title] OR mitigation[Title] OR adaptation[Title] OR "adaptation to the impacts of climate change"[Title] OR "climate action"[Title] OR policy[Title] OR policies[Title] OR guideline*[Title] OR strategy[Title] OR strategies[Title] OR "climate mitigation"[Title] OR "climate assessment"[Title] OR "responses to climate change"[Title] OR "climate resilient*"[Title] OR resilien*[Title] OR "green infrastructure"[Title] OR "renewable energy"[Title] OR "green development"[Title] OR "green supply chain"[Title] OR Decarbonization[Title] OR "greenhouse gas emission*"[Title] OR emission*[Title] OR "anthropogenic emission*"[Title] OR "greenhouse effect"[Title] OR "Paris Agreement"[Title] OR "carbon neutral"[Title] OR "carbon footprint reduction"[Title] OR "net zero carbon"[Title] OR "carbon footprint"[Title] OR "greenhouse gas*"[Title] OR "life cycle assessment"[Title] OR "CO2 emission*"[Title] OR "net zero"[Title] OR "zero emissions"[Title] OR "healthcare emission*"[Title] OR "COP 26 Health Program"[Title] OR carbon[Title] OR "CO"[Title] OR "CO2"[Title] OR methane[Title] OR "CH4"[Title] OR "nitrous oxide"[Title] OR "N2O"[Title] OR hydrofluorocarbon[Title] OR "HFC"[Title] OR "PFC"[Title] OR perfluorocarbon[Title] OR "F-gas"[Title] OR "fluorinated gas"[Title] OR "sulphur hexafluoride"[Title] OR "SF6"[Title] OR "nitrogen trifluoride"[Title] OR "NF3"[Title] OR "eco efficient"[Title] OR "energy saving"[Title] OR "short-lived climate pollutant"[Title] OR "black carbon"[Title] OR "energy efficient"[Title]) OR ("air quality"[Title] OR "ambient air quality"[Title] OR "air quality"[Title] OR "air pollution"[Title] OR "atmospheric pollution"[Title] OR "clean air"[Title] OR "water quality"[Title] OR "water cycle"[Title] OR "water pollution"[Title] OR "soil quality"[Title] OR "soil health"[Title] OR "soil condition"[Title] OR "soil degradation"[Title] OR "soil contamination"[Title] OR waste[Title] OR garbage[Title] OR "waste management"[Title] OR "healthcare waste" meteorolog* "[Title] OR temperature "[Title] OR "heat"[Title] OR "temperature increase"[Title] OR rainfall[Title] OR "irregular rainfall"[Title] OR "temperature extreme*" flood*[Title] OR drought*[Title] OR "tsunami"[Title] OR "extreme weather"[Title] OR heatwave[Title] OR avalanche[Title] OR landslide[Title] OR "cold wave"[Title])) AND (health[Title/Abstract] OR wellbeing[Title/Abstract] OR "health status"[Title/Abstract] OR "health outcome"[Title/Abstract] OR "physical health"[Title/Abstract] OR "mental health"[Title/Abstract] OR "health sector"[Title/Abstract] OR "public health"[Title/Abstract] OR "health policy"[Title/Abstract] OR "public provider"[Title/Abstract] OR "private

	<p>provider"[Title/Abstract] OR "health insurance"[Title/Abstract] OR "health premium"[Title/Abstract] OR "health assessment"[Title/Abstract] OR "health system*"[Title/Abstract] OR "health facility"[Title/Abstract] OR "health facilities"[Title/Abstract] OR "healthcare facilities"[Title/Abstract] OR "primary health care"[Title/Abstract] OR "district health service"[Title/Abstract] OR "district health system"[Title/Abstract] OR "primary care"[Title/Abstract] OR "healthcare"[Title/Abstract] OR "health supply chain"[Title/Abstract] OR "health service"[Title/Abstract] OR "delivery of health"[Title/Abstract] OR "health delivery"[Title/Abstract] OR hospital[Title/Abstract] OR clinic[Title/Abstract] OR "emergency room"[Title/Abstract] OR "urgent care"[Title/Abstract] OR "secondary care"[Title/Abstract] OR "tertiary care"[Title/Abstract] OR "quaternary care"[Title/Abstract] OR "diagnostic care"[Title/Abstract] OR "rehabilitative care"[Title/Abstract] OR "preventive care"[Title/Abstract] OR "palliative care"[Title/Abstract]) AND (Evaluation[Title/Abstract] OR assessment[Title/Abstract] OR appraisal[Title/Abstract] OR analysis[Title/Abstract] OR examination[Title/Abstract] OR audit[Title/Abstract] OR validation[Title/Abstract] OR Outcome[Title/Abstract] OR impact[Title/Abstract] OR effectiveness[Title/Abstract] OR efficacy[Title/Abstract] OR efficiency[Title/Abstract] OR performance[Title/Abstract] OR benefits[Title/Abstract] OR improvements[Title/Abstract] OR changes[Title/Abstract] OR success[Title/Abstract] OR "failure*"[Title/Abstract])) AND (ffrft[Filter])</p>
Scopus	<p>(( ( TITLE-ABS-KEY ( [ "climate change" ] OR [ "extreme weather events" ] OR [ "climate crisis" ] OR [ "changing climate" ] OR [ "global warming" ] OR [ "greenhouse gases" ] OR [ "greenhouse effect" ] OR [ "environmental harm" ] OR [ "environmental degradation" ] OR [ "climate stressors" ] OR [ "climate hazards" ] OR [ "fossil fuel" ] ] AND [ "climate risks" ] OR [ "flood" ] OR [ "drought" ] OR [ "tsunami" ] OR [ "extreme weather" ] OR [ "heatwave" ] OR [ "avalanche" ] ] OR [ "adaptation to the impacts of climate change" ] OR [ "climate action" ] OR [ "policies" ] OR [ "guidelines" ] OR [ "strategies" ] OR [ "climate mitigation" ] OR [ "climate assessment" ] OR [ "responses to climate change" ] OR [ "green infrastructure" ] OR [ "renewable energy" ] OR [ "green development" ] OR [ "green supply chain" ] ] AND [ "decarbonization" ] OR [ "greenhouse gas emissions" ] OR [ "emissions" ] OR [ "anthropogenic emission" ] OR [ "greenhouse effect" ] OR [ "paris agreement" ] OR [ "carbon neutral" ] OR [ "carbon footprint reduction" ] OR [ "net zero carbon" ] OR [ "carbon footprint" ] OR [ "greenhouse gases" ] OR [ "life cycle assessment" ] OR [ "co2 emissions" ] OR [ "net zero" ] OR [ "zero emissions" ] OR [ "healthcare emissions" ] OR [ "cop 26 health program" ] OR [ "carbon" ] OR [ "co" ] OR [ "co2" ] OR [ "methane" ] OR [ "ch4" ] OR [ "nitrous oxide" ] OR [ "n2o" ] OR [ "hydrofluorocarbon" ] OR [ "hfc" ] OR [ "pfc" ] OR [ "perfluorocarbon" ] OR [ "f-gas" ] OR [ "fluorinated gas" ] OR [ "sulphur hexafluoride" ] OR [ "sf6" ] OR [ "nitrogen trifluoride" ] OR [ "nf3" ] OR [ "eco efficient" ] OR [ "energy saving" ] OR [ "short-lived climate pollutant" ] OR [ "black carbon" ] OR [ "energy efficient" ] ] ] OR [ "air quality" ] OR [ "ambient air quality" ] OR [ "air quality" ] OR [ "air pollution" ] OR [ "atmospheric pollution" ] OR [ "clean air" ] OR [ "quality of the air" ] OR [ "water quality" ] OR [ "quality of the</p>

	<p>water" ] OR [ "drinking water quality" ] OR [ "water cycle" ] OR [ "soil quality" ] OR [ "soil health" ] OR [ "quality of soil" ] OR [ "soil condition" ] OR [ "soil degradation" ] OR [ "waste" ] OR [ "garbage" ] OR [ "waste management" ] OR [ "healthcare waste" ] OR [ "meteorological condition" ] OR [ "temperature" ] OR [ "rainf" ] OR [ "heat" ] OR [ "temperature increase" ] OR [ "irregular rainf" ] OR [ "climate resilien*" ] OR [ "resilien*" ] ) ) AND ( full AND text ) ) AND ( ( TITLE-ABS-KEY ( [ "health" ] OR [ "wellbeing" ] OR [ "health status" ] OR [ "health outcome" ] OR [ "physical health" ] OR [ "mental health" ] OR [ "health sector" ] OR [ "public health" ] OR [ "health policy" ] OR [ "public provider" ] OR [ "private provider" ] OR [ "health insurance" ] OR [ "health premium" ] OR [ "health assessment" ] OR [ "health system" ] OR [ "health facilities" ] OR [ "healthcare facilities" ] OR [ "primary health care" ] OR [ "district health service" ] OR [ "district health system" ] OR [ "primary care" ] OR [ "healthcare" ] OR [ "health supply chain" ] OR [ "health service" ] OR [ "delivery of health" ] OR [ "health delivery" ] OR [ "hospital" ] OR [ "clinic" ] OR [ "emergency room" ] OR [ "urgent care" ] OR [ "secondary care" ] OR [ "tertiary care" ] OR [ "quaternary care" ] OR [ "diagnostic care" ] OR [ "rehabilitative care" ] OR [ "preventive care" ] OR [ "palliative care" ] ) ) ) AND ( full AND text ) ) ) AND ( full AND text )</p> <p><i>Applied restriction to free full text.</i></p>
Cochrane	<p>((Extreme weather events) OR (climate crisis) OR (changing climate) OR (global warming )OR (greenhouse gases) OR (greenhouse effect) OR environmental harm OR environmental degradation OR climate stressors OR climate hazard OR fossil fuel OR Adaptation to the impacts of climate change OR climate action OR policies OR guidelines OR strategies OR climate mitigation OR climate assessment OR responses to climate change OR climate resilient OR climate resilience OR resilient OR resilience OR Renewable energy OR green development OR green supply chain OR Greenhouse gas emissions OR emissions OR anthropogenic emission OR greenhouse effect OR Paris Agreement OR carbon neutral OR carbon footprint reduction OR net zero carbon OR carbon footprint OR greenhouse gases OR life cycle assessment OR CO2 emissions OR net zero OR zero emissions OR healthcare emissions OR COP 26 Health Program OR carbon OR CO OR CO2 OR methane OR CH4 OR nitrous oxide OR nitrus oxide OR N2O OR Hydrofluorocarbon OR HFC OR PFC OR perfluorocarbon OR F-gas OR fluorinated gas OR sulfur hexafluoride OR SF6 OR nitrogen trifluoride OR NF3 OR emission OR eco efficient OR energy saving OR short-lived climate pollutant OR black carbon OR energy efficient OR Ambient air quality OR air pollution OR atmospheric pollution OR clean air OR quality of the air OR Quality of the water OR drinking water quality OR water cycle OR water pollution OR Soil health OR quality of soil OR soil condition OR soil degradation OR soil contamination OR Waste OR garbage OR waste management OR healthcare waste OR Temperature OR rainfall OR heat OR temperature increase OR rainfall OR irregular rainfall OR temperature extremes OR Flood OR drought OR tsunami OR</p>

	<p>extreme weather OR heatwave OR avalanche OR landslide OR cold wave):ti</p> <p><i>Replicated once for reviews, once for trials.</i></p>
3ie	Climate change AND health
Global Index Medicus (including regional databases)	<p>Climate change</p> <p>Air quality</p> <p>Water quality</p> <p>Soil quality</p> <p>Extreme heat or temperature increase</p> <p>Climate disaster</p>
Agriculture and environmental sciences	<p>title("climate change" OR "extreme weather events" OR "climate crisis" OR "changing climate" OR "global warming" OR "greenhouse gases" OR "greenhouse effect" OR "environmental harm" OR "environmental degradation" OR "climate stressor*" OR "climate hazard*" OR "fossil fuel" OR "adaptation to the impacts of climate change" OR "climate action" OR "policies" OR "guidelines" OR "strategies" OR "climate mitigation" OR "climate assessment" OR "responses to climate change" OR "climate resilient " OR "climate resilience" OR "resilient" OR "resilience" OR "Renewable energy" OR "green development" OR "green supply chain" OR "green infrastructure" OR "renewable energy" OR "green development" OR "green supply chain" OR "decarbonization" OR "greenhouse gas emission*" OR "emissions" OR "anthropogenic emission" OR "greenhouse effect" OR "Paris Agreement" OR "carbon neutral" OR "carbon footprint reduction" OR "net zero carbon" OR "carbon footprint" OR "greenhouse gases" OR "life cycle assessment" OR "CO2 emissions" OR "net zero" OR "zero emissions" OR "healthcare emissions" OR "COP 26 Health Program" OR "carbon" OR "CO" OR "CO2" OR "methane" OR "CH4" OR "nitrous oxide" OR "N2O" OR "hydrofluorocarbon" OR "HFC" OR "PFC" OR "perfluorocarbon" OR "F-gas" OR "fluorinated gas" OR "sulphur hexafluoride" OR "SF6" OR "nitrogen trifluoride" OR "NF3" OR "eco efficient" OR "energy saving" OR "short-lived climate pollutant" OR "black carbon" OR "energy efficient" OR "air quality" OR "ambient air quality" OR "air quality" OR "air pollution" OR "atmospheric pollution" OR "clean air" OR "quality of the air" OR "water quality" OR "quality of the water" OR "drinking water quality" OR "water cycle" OR "soil quality" OR "soil health" OR "quality of soil" OR "soil condition" OR "soil degradation" OR "waste" OR "garbage" OR "waste management" OR "healthcare waste" OR "meteorological condition" OR "temperature" OR "rainfall" OR "heat" OR "temperature increase" OR "irregular rainfall" OR "climate risks" OR "flood" OR "drought" OR "tsunami" OR "extreme weather" OR "heatwave" OR "avalanche" OR "landslide" OR "cold wave") AND title("health" OR "wellbeing" OR "health status" OR "health outcome" OR "physical health" OR "mental health" OR "health sector" OR "public health" OR "health policy" OR "public provider" OR "private provider" OR "health insurance" OR "health premium" OR</p>

	<p>"health assessment" OR "health system" OR "health facilities" OR "healthcare facilities" OR "primary health care" OR "district health service" OR "district health system" OR "primary care" OR "healthcare" OR "health supply chain" OR "health service" OR "delivery of health" OR "health delivery" OR "hospital" OR "clinic" OR "emergency room" OR "urgent care" OR "secondary care" OR "tertiary care" OR "quaternary care" OR "diagnostic care" OR "rehabilitative care" OR "preventive care" OR "palliative care") AND title(Evaluation OR assessment OR appraisal OR analysis OR Examination OR audit OR validation OR Outcome OR impact OR effectiveness OR efficacy OR efficiency OR performance OR benefits OR improvements OR changes OR success OR failures)</p>
CABI	<p>("climate change" OR "extreme weather event*" OR "climate crisis" OR "changing climate" OR "global warming" OR "greenhouse gas*" OR "greenhouse effect" OR "environmental harm" OR "environmental degradation" OR "climate stressor*" OR "climate hazard*" OR "fossil fuel" OR "action" OR "mitigation" OR "adaptation" OR "adaptation to the impacts of climate change" OR "climate action" OR policy OR policies OR guideline* OR strategy OR strategies OR "climate mitigation" OR "climate assessment" OR "responses to climate change" OR "climate resilien*" OR "resilien*" OR "green infrastructure" OR "renewable energy" OR "green development" OR "green supply chain" OR "Decarbonization" OR "greenhouse gas emission*" OR emission* OR "anthropogenic emission*" OR "greenhouse effect" OR "Paris Agreement" OR "carbon neutral" OR "carbon footprint reduction" OR "net zero carbon" OR "carbon footprint" OR "greenhouse gas*" OR "life cycle assessment" OR "CO2 emission*" OR "net zero" OR "zero emissions" OR "healthcare emission*" OR "COP 26 Health Program" OR carbon OR "CO" OR "CO2" OR methane OR "CH4" OR "nitrous oxide" OR "N2O" OR hydrofluorocarbon OR "HFC" OR "PFC" OR perfluorocarbon OR "F-gas" OR "fluorinated gas" OR "sulphur hexafluoride" OR "SF6" OR "nitrogen trifluoride" OR "NF3" OR "eco efficient" OR "energy saving" OR "short-lived climate pollutant" OR "black carbon" OR "energy efficient" OR "air quality" OR "ambient air quality" OR "air quality" OR "air pollution" OR "atmospheric pollution" OR "clean air" OR "quality of the air" OR "water quality" OR "quality of the water" OR "drinking water quality" OR "water cycle" OR "water pollution" OR "soil quality" OR "soil health" OR "quality of soil" OR "soil condition" OR "soil degradation" OR "soil contamination" OR "waste" OR "garbage" OR "waste management" OR "healthcare waste" OR "meteorological condition" OR "temperature" OR "heat" OR "temperature increase" OR "rainfall" OR "irregular rainfall" OR "temperature extreme*" OR "climate risks" OR "flood" OR "drought" OR "tsunami" OR "extreme weather" OR "heatwave" OR "avalanche" OR "landslide" OR "cold wave") AND ("health" OR "wellbeing" OR "health status" OR "health outcome" OR "physical health" OR "mental health" OR "health sector" OR "public health" OR "health policy" OR "public provider" OR "private provider" OR "health insurance" OR "health premium" OR "health assessment" OR "health system*" OR "health facility" OR "health facilities" OR "healthcare facilities" OR "primary health care" OR "district health service" OR "district health system" OR "primary care" OR "healthcare" OR "health supply chain" OR "health service" OR "delivery of health" OR "health delivery")</p>

	OR "hospital" OR "clinic" OR "emergency room" OR "urgent care" OR "secondary care" OR "tertiary care" OR "quaternary care" OR "diagnostic care" OR "rehabilitative care" OR "preventive care" OR "palliative care")
Green File	<p>TI ("climate change" OR "extreme weather events" OR "climate crisis" OR "changing climate" OR "global warming" OR "greenhouse gases" OR "greenhouse effect" OR "environmental harm" OR "environmental degradation" OR "climate stressor*" OR "climate hazard*" OR "fossil fuel" OR "adaptation to the impacts of climate change" OR "climate action" OR "policies" OR "guidelines" OR "strategies" OR "climate mitigation" OR "climate assessment" OR "responses to climate change" OR "green infrastructure" OR "renewable energy" OR "green development" OR "green supply chain" OR "decarbonization" OR "greenhouse gas emission*" OR "emissions" OR "anthropogenic emission" OR "greenhouse effect" OR "Paris Agreement" OR "carbon neutral" OR "carbon footprint reduction" OR "net zero carbon" OR "carbon footprint" OR "greenhouse gases" OR "life cycle assessment" OR "CO2 emissions" OR "net zero" OR "zero emissions" OR "healthcare emissions" OR "COP 26 Health Program" OR "carbon" OR "CO" OR "CO2" OR "methane" OR "CH4" OR "nitrous oxide" OR "N2O" OR "hydrofluorocarbon" OR "HFC" OR "PFC" OR "perfluorocarbon" OR "F-gas" OR "fluorinated gas" OR "sulphur hexafluoride" OR "SF6" OR "nitrogen trifluoride" OR "NF3" OR "eco efficient" OR "energy saving" OR "short-lived climate pollutant" OR "black carbon" OR "energy efficient" OR "air quality" OR "ambient air quality" OR "air quality" OR "air pollution" OR "atmospheric pollution" OR "clean air" OR "quality of the air" OR "water quality" OR "quality of the water" OR "drinking water quality" OR "water cycle" OR "soil quality" OR "soil health" OR "quality of soil" OR "soil condition" OR "soil degradation" OR "waste" OR "garbage" OR "waste management" OR "healthcare waste" OR "meteorological condition" OR "temperature" OR "rainfall" OR "heat" OR "temperature increase" OR "irregular rainfall" OR "climate risks" OR "flood" OR "drought" OR "tsunami" OR "extreme weather" OR "heatwave" OR "avalanche" OR "landslide" OR "cold wave") AND</p> <p>TI ("health" OR "wellbeing" OR "health status" OR "health outcome" OR "physical health" OR "mental health" OR "health sector" OR "public health" OR "health policy" OR "public provider" OR "private provider" OR "health insurance" OR "health premium" OR "health assessment" OR "health system" OR "health facilities" OR "healthcare facilities" OR "primary health care" OR "district health service" OR "district health system" OR "primary care" OR "healthcare" OR "health supply chain" OR "health service" OR "delivery of health" OR "health delivery" OR "hospital" OR "clinic" OR "emergency room" OR "urgent care" OR "secondary care" OR "tertiary care" OR "quaternary care" OR "diagnostic care" OR "rehabilitative care" OR "preventive care" OR "palliative care")</p>
ELDIS	climate AND health, climate change AND health systems

### Appendix 3: Supplementary tables

**TABLE 1 CHARACTERISTICS OF INCLUDED STUDIES**

Identifier	Title	Funder of study	Study aim	Country	Evaluation type	Method category	Methods used	Overview of outcomes studied
Adel Zakaria, 2005.	Assessment of Combustion Products of Medical Waste Incinerators in Alexandria."	Not reported	<p>The aim of the study is to evaluate the emissions and ashes from six medical waste incinerators located in hospitals in Alexandria.</p> <p>The research focuses on analyzing five air pollutants in the emissions, which include smoke, lead, carbon monoxide, sulfur dioxide, and nitrogen dioxide.</p> <p>Additionally, the study examines ash samples for bacterial count, volatile substances, lead, and cadmium, while also visually observing the shape and color of the ash.</p> <p>The ultimate goal is to assess the environmental and public health</p>	Egypt	Outcome evaluation	Quantitative	<p>The study employed isokinetic sampling to collect air samples from the stacks of medical waste incinerators, ensuring accurate representation of emissions.</p> <p>Air contaminants such as carbon monoxide, nitrogen dioxide, sulfur dioxide, and carbonaceous particulates were measured using a combustion analyzer.</p> <p>Ash samples were taken manually and analyzed for total bacterial count, volatile substances, and heavy metals (lead and cadmium) using atomic absorption spectroscopy.</p> <p>The volatile substances were determined after</p>	<p>Emissions and ashes from six medical waste incinerators located in hospitals in Alexandria, focusing on air pollutants such as carbon monoxide (CO), nitrogen dioxide (NO<sub>2</sub>), sulfur dioxide (SO<sub>2</sub>), and carbonaceous particulate.</p>

			threats posed by these incinerators and to recommend specific emission limits.				igniting ash samples in a muffle furnace, while non-volatile substances were calculated as the residue. Statistical analyses were performed to compare emissions across different incinerators.	
Adelaide Lusambili, 2023.	Process and outputs from a community codesign workshop on reducing impact of heat exposure on pregnant and postpartum women and newborns in Kilifi, Kenya.	Natural Environment Research Council (grant numbers NET0136131 and NET01363X1), the Research Council of Norway (grant number 312601), The Swedish Research Council for Health, Working Life and Welfare in collaboration with the Swedish Research Council (Forte) (grant number 2019-01570), and the National Science Foundation (NSF) (grant number ICER-2028598).	The aim of the study was to examine the impact of ambient heat exposure on the health of pregnant and postpartum women, as well as their newborns, in Kilifi, Kenya. It sought to identify effective interventions to mitigate heat-related health outcomes in this vulnerable population, particularly in the context of climate change. The study emphasized the importance of integrating local-indigenous knowledge with conventional	Kenya	Impact evaluation	Qualitative	The research employed qualitative methods to explore the impacts of heat exposure on pregnant and postpartum women and newborns in Kilifi, Kenya. A two-day codesign workshop was conducted, involving diverse participants including community members, policy makers, and service providers. Discussions focused on key domains such as behavioral practices, health facilities, home	The study focused on the outcomes related to the impact of heat exposure on pregnant and postpartum women and their newborns in Kilifi, Kenya. It aimed to identify effective interventions to mitigate health risks associated with increasing ambient heat due to climate change. The codesign workshop resulted in the ranking of accessibility to water supplies, social behavior-change campaigns, and education as the top three interventions with

			<p>approaches to develop sustainable adaptation strategies. Ultimately, the research aimed to inform community codesign workshops that would prioritize interventions based on local needs and cultural practices.</p>				<p>environment, water scarcity, and education. Data from the workshop was transcribed, coded, and intervention priorities were ranked based on success likelihood, cost-effectiveness, implementation feasibility, and sustainability. The workshop also aimed to build capacity among facilitators and participants regarding heat-related health risks.</p>	<p>the highest likelihood of success. Additionally, family support was recognized as a significant factor in enhancing the effectiveness of these interventions.</p>
<p>Amal Brown, 2016.</p>	<p>Interventions to build resilience of the health system to the El Niño drought in Ethiopia</p>	<p>The research was funded by the Bill and Melinda Gates Foundation, ECHO, and the Governments of Canada, Germany, Japan, Sweden, the United Kingdom, and the United States.</p>	<p>The aim of the study is to examine how UNICEF supported Ethiopia in building the resilience of its health system in response to the El Niño drought. It focuses on linking nutrition development programs with a coordinated emergency response to enhance the</p>	<p>Ethiopia</p>	<p>Impact evaluation</p>	<p>Mixed methods</p>	<p>Narrative and author led analysis.</p>	<p>The outcome studied was the impact of linking nutrition development programs with a coordinated emergency response to the El Niño drought in Ethiopia during 2015-2016. The integration of severe acute malnutrition (SAM) treatment into routine health services and the scale-up of the</p>

			health system's ability to withstand and recover from external shocks, such as drought.					Community Based Nutrition (CBN) program were crucial for a rapid and high-quality response. This approach helped avert a humanitarian catastrophe by improving the nutritional status of vulnerable populations and enhancing the resilience of the health system. A strong nutrition information system was also essential for risk-informed planning and timely interventions.
Anand Bhopal, 2021.	Climate change and health in Ethiopia: To what extent have the health dimensions of climate change been integrated into the Climate-Resilient Green Economy?	The provided contexts do not contain any information regarding the source of funding for the study.	The aim of the study is to evaluate the extent to which health dimensions of climate change have been integrated into Ethiopia's Climate-Resilient Green Economy (CRGE) initiative. It seeks to understand the health impacts of climate change and how these have been considered within	Ethiopia	Process evaluation	Qualitative	The paper employed a scoping review methodology to explore the health dimensions of Ethiopia's Climate-Resilient Green Economy (CRGE) initiative. This approach aimed to identify research gaps and included various sources and types of evidence, which are valuable for mapping key concepts in	The study aimed to evaluate the extent to which health dimensions of climate change have been integrated into Ethiopia's Climate-Resilient Green Economy (CRGE) initiative. It focused on understanding the health impacts of climate change, including the increased spread of vector and water-borne

			<p>the CRGE framework, which has primarily focused on economic development and financial aspects in its early years. The study also aims to identify research gaps and provide insights for policymakers to enhance the integration of health considerations into climate action strategies.</p>				<p>underexplored areas. The review followed the five-stage framework outlined by Arksey and O'Malley (2005). Data were collected using a descriptive-analytic method, focusing on author, year, document type, stated purpose, and health dimensions. The literature search included government policy documents, published articles, and nongovernmental reports from multiple databases.</p>	<p>diseases, flooding incidents, and the overall vulnerability of the health sector. The research also sought to identify gaps in the integration of health considerations within the CRGE and to explore potential health co-benefits from non-health interventions. The findings are intended to inform policymakers about the necessary adaptations to improve health and build climate resilience.</p>
<p>Angeli Rawat, 2022</p>	<p>The Contribution of Community Health Systems to Resilience: Case Study of the Response to the Drought in Ethiopia</p>	<p>The research was supported by a grant from the Rockefeller foundation</p>	<p>The aim of the study was to identify salient factors that can improve health system resilience by exploring the successes and challenges experienced by a community-based health system during the drought response in Ethiopia.</p>	<p>Ethiopia</p>	<p>Process evaluation</p>	<p>Qualitative</p>	<p>The research employed focus group discussions (FGDs) primarily at the community level and key informant interviews (KIIs) at district, sub-national, or national levels to gather data. Purposive sampling was utilized to identify</p>	<p>The effectiveness of organized community groups in linking with the health system and facilitating timely responses. The significance of training, preparedness, and adaptable human resource structures to ensure service continuity and</p>

			<p>The research specifically sought to understand barriers and facilitators to community engagement and participation in the health system at the community level, as well as the effectiveness of Health Extension Workers (HEWs) during the drought response, particularly in the provision of maternal, newborn, and child health (MNCH) services. The study was part of a broader four-country initiative focused on building resilience in community-based health systems.</p>				<p>initial participants, followed by snowball sampling to ensure diversity across the health system. Data collection was conducted in participants' preferred languages, facilitated by semi-structured interview guides, and included simultaneous translation for non-English speakers. All interviews were audio recorded, transcribed verbatim, and translated into English, with accuracy checks performed by UNICEF team members.</p>	<p>health system resilience.</p>
<p>Anna M. Stewart-Ibarra, 2019.</p>	<p>Co-developing climate services for public health: Stakeholder needs and perceptions for the prevention and control of Aedes-transmitted diseases in the Caribbean.</p>	<p>Anna M. Stewart-Ibarra, Moory Romero, Sadie J. Ryan, Adrian R. Trotman, and Mercy J. Borbor-Cordova.</p>	<p>The aim of the study was to identify the perceptions and needs of health and climate stakeholders in the Caribbean regarding the development of climate services for the</p>	<p>Barbados and Dominica.</p>	<p>Formative evaluation</p>	<p>Mixed methods</p>	<p>The study employed qualitative and quantitative methods, including interviews and surveys, to gather data from stakeholders in the health and climate sectors.</p>	<p>The study focused on the perceptions and needs of health and climate stakeholders in the Caribbean regarding the development of climate services for the prevention and control of</p>

			<p>management of arboviral diseases, such as dengue fever. This involved understanding how stakeholders from both sectors perceive the linkages between climate variability and public health impacts, as well as their requirements for effective climate-driven early warning systems. The study sought to enhance interdisciplinary dialogue and partnerships among practitioners, decision-makers, and scientists to improve decision support models and intervention strategies.</p>				<p>A total of 41 interviews and 32 surveys were conducted to assess stakeholder perceptions and needs regarding climate services for arboviral diseases. The survey instrument was developed based on prior large-scale surveys and was specifically tailored for health sector stakeholders. Responses from the interviews and surveys were audio recorded, transcribed, and coded for analysis. The study protocols were reviewed and approved by relevant Institutional Review Boards.</p>	<p>Aedes-transmitted diseases, particularly arboviral diseases like dengue fever. It aimed to identify the actions stakeholders would take in response to climate-driven alerts and the utility of different forecasts. The research highlighted the urgent concerns of stakeholders about the impacts of climate variability on health and the need for effective solutions to mitigate these effects.</p>
Aravind P. Gandhi, 2023	Impact of virtual continued medical education on carbon footprint and awareness of digital sobriety: A retrospective cross-sectional study among	Not specifically mentioned	The aim of the study was to assess the impact of virtual continuing medical education (CME) on the environment, specifically	India	Summative evaluation	Quantitative	A retrospective cross-sectional study design was employed, utilizing a Google form-based online questionnaire to collect data from registrants of	The study assessed the impact of virtual CMEs on carbon emissions, focusing on the environmental benefits compared to physical CMEs.

	public health professionals in India.		<p>focusing on the carbon footprint associated with these events. Additionally, the study sought to evaluate the participants' perception, knowledge, attitude, and practices regarding digital sobriety during the virtual CMEs. By comparing the carbon emissions of virtual CMEs to potential emissions from physical CMEs, the study aimed to highlight the environmental benefits of adopting virtual formats in medical education. Ultimately, the research aimed to raise awareness about digital sobriety among public health professionals in India.</p>				<p>virtual CMEs in India. The study assessed the carbon emissions of both virtual and potential physical CMEs, estimating the carbon footprint based on user numbers, usage hours, and server usage. Statistical analyses were conducted using MS Excel and SPSS v20, applying tests such as Chi-square, Fisher's exact test, and Mann-Whitney test to evaluate the significance of categorical and continuous variables. Ethical approval was obtained from the Institutional Ethics Committee, and virtual informed consent was secured from participants.</p>	<p>It evaluated participants' awareness, knowledge, attitude, and practices toward digital sobriety—a strategy for reducing the carbon footprint of online activities.</p> <p>The carbon footprint from virtual CMEs was quantified as 0.787 metric tons of CO2 equivalent (MT CO2 Eq).</p> <p>It also compared the emissions of virtual CMEs to their physical counterparts, revealing a 99.7% reduction in carbon emissions through the virtual format (289.308 MT CO2 Eq saved).</p>
Arefeh Mousavi, 2020	Health system plan for implementation of Paris agreement on climate change (COP 21):	The research received no external funding.	The aim of the study was to provide an evidence-based framework for policy-making in the health system	Iran	Formative evaluation	Qualitative	The study employed a qualitative research methodology, specifically utilizing the Delphi	The outcome measures in the study were defined by extracting health-related components from

	<p>a qualitative study in Iran</p>		<p>of Iran to mitigate the adverse effects of climate change on public health. It sought to enhance the adaptation of the health system in response to climate change challenges by identifying relevant components of the Paris Agreement on climate change. The study utilized the Delphi method to gather expert opinions and classify components related to health functions and policymaking, ultimately aiming to improve public health strategies in the context of climate change.</p>				<p>method to extract relevant components of the Paris Agreement on climate change related to Iran's health system.</p> <p>The Delphi method involved systematic feedback from a group of 23 experts in health and climate change, who provided their opinions on the same questions multiple times to reach a consensus.</p> <p>Data analysis was conducted using SPSS software version 25, focusing on descriptive indices such as mean and percentage of consensus, with a threshold of 75% for inclusion of components.</p> <p>The process included three rounds of feedback, allowing experts to review and adjust their</p>	<p>the Paris Agreement on climate change that directly or indirectly affect public health measures.</p>
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							opinions based on peer input.	
Bethuel Ngcamu, 2024.	Achieving sustainable, environmentally viable, solarized vaccine cold chain system and vaccination program-an effort to move towards clean and green energy-driven primary healthcare in Lebanon."	Not reported	The aim of the study is to summarize the utilization of solar energy to enhance vaccine storage and support the vaccination process in Lebanon. It focuses on assessing the feasibility of implementing a solarized vaccine cold chain system, highlighting the benefits of transitioning from traditional energy sources to renewable energy solutions. The study emphasizes the importance of solarization in ensuring reliable vaccine storage, reducing operational costs, and minimizing vaccine wastage, particularly in the context of Lebanon's ongoing economic and energy crises. Ultimately, it	Lebanon	Formative evaluation	Quantitative	The methodology employed by MoPH and UNICEF involved a two-level approach for solarizing the vaccine cold chain system, which included a cold chain inventory assessment based on the EVM assessment 2021 recommendations. A facility-level cold chain inventory analysis was conducted to identify the status and gaps in cold chain equipment, leading to a prioritization plan for upgrading and replacing non-functional or outdated equipment. Additionally, a 'Feasibility and Energy Need Assessment' was performed for 275 Primary Health Care Centers (PHCCs) to determine their	Key outcomes included reduced costs of ownership, improved reliability of vaccine storage, and enhanced public trust in government immunization services.

			seeks to provide a robust framework for other regions facing similar challenges.				suitability for solarization.	
Bilal Ahmed Khan, 2019.	Greenhouse gas emission from small clinics solid waste management scenarios in an urban area of an underdeveloping country: A life cycle perspective."	this work was supported by the National Natural Science Foundation of China (71271114).	The aim of the study was to investigate the environmental effects of solid waste management from small clinics in an urban area of a developing country, specifically focusing on greenhouse gas (GHG) emissions. It utilized a life cycle analysis (LCA) approach to evaluate different waste management scenarios and their associated GHG emissions. The study sought to identify the most suitable waste management scenario that could effectively reduce GHG emissions while being practical for resource-constrained economies. Ultimately, the	Pakistan	Impact evaluation	Quantitative	The study utilized a life cycle analysis (LCA) approach to evaluate the environmental impact of solid waste management in small clinics. Three different waste management scenarios were designed: the first involved open landfilling, the second mixed waste incineration, and the third an integrated approach combining composting, material recovery, and incineration of hazardous waste. Data collection included quantifying solid waste from 371 clinics over 30 days, focusing on proper segregation, transportation, and treatment methods.	The outcome measures in the study were defined through the evaluation of greenhouse gas (GHG) emissions associated with different solid waste management scenarios for small clinics.

			findings are intended to assist policymakers in planning effective solid waste management strategies for small clinics.				The study also employed the Intergovernmental Panel on Climate Change (IPCC) guidelines for calculating greenhouse gas emissions.	
Binaya Sapkota, 2014.	Impact of intervention on healthcare waste management practices in a tertiary care governmental hospital of Nepal.	The research did not receive any grant from any public or commercial funding agency, or not-for-profit sectors.	The aim of the study was to evaluate the impact of healthcare waste management (HCWM) practices in a tertiary care governmental hospital in Nepal, focusing on the processes of collection, segregation, transportation, treatment, and ultimate disposal of healthcare waste. It sought to determine the effectiveness of interventions implemented to improve these practices, as well as to assess the pre-and post-intervention performance scores using the Individualized Rapid Assessment Tool	Nepal.	Impact evaluation	Quantitative	The study employed the Individualized Rapid Assessment Tool (IRAT), developed by the United Nations Development Program Global Environment Facility project, to collect data on healthcare waste management practices before and after the intervention. Data collection involved responses from focal nurses, physicians, and waste handlers in the gynaecology, obstetrics, paediatrics, medicine, and orthopaedics wards at the Government of Nepal Civil Service Hospital. Regular monitoring visits	The study evaluated the impact of healthcare waste management (HCWM) practices before and after interventions at a tertiary care governmental hospital in Nepal. The pre-intervention evaluation revealed a poor outcome with a score of 26%, indicating inadequate waste management practices, lack of a dedicated HCWM committee, and absence of proper policies and training. Post-intervention, the evaluation showed significant improvement, with a score of 86%, reflecting the effectiveness of the implemented

			(IRAT). The study aimed to provide insights that could help policymakers devise effective waste management regulations to protect public health and the environment.				were conducted to assess compliance with waste management practices, and pretest and posttest evaluation scores were analyzed to measure improvements.	training programs, policy development, and waste segregation practices. The results highlighted the importance of regular monitoring and dedicated participation in achieving HCWM outcomes.
Cassandra Thiel, 2017.	Cataract surgery and environmental sustainability: Waste and lifecycle assessment of phacoemulsification at a private healthcare facility.	Fulbright-Nehru Academic and Professional Excellence Award through the United States India Educational Foundation, New Delhi, India. Dr. Saeedi received support from a Career Development Grant (No. K23 EY025014) from the U.S. National Institutes of Health, Bethesda, Maryland, USA.	The aim of the study was to measure the waste generation and lifecycle environmental emissions associated with cataract surgery via phacoemulsification in a resource-efficient setting, specifically within the Aravind Eye Care System in southern India. The study utilized a hybrid environmental lifecycle assessment framework, incorporating manual waste audits, purchasing data, and staff interviews to quantify the	India	Summative evaluation	Quantitative	The study employed manual waste audits to quantify the waste generated from cataract surgeries. Purchasing data and interviews with Aravind staff were utilized to gather information on materials and their usage. A hybrid environmental lifecycle assessment framework was applied to measure environmental emissions associated with phacoemulsification. Waste from each surgical case was separated by material type and	The study focused on measuring waste generation and lifecycle environmental emissions associated with cataract surgery via phacoemulsification at the Aravind Eye Care System in southern India. It quantified the environmental emissions, including solid waste and greenhouse gases, generated per surgery. The results indicated that Aravind generates approximately 250 grams of waste and nearly 6 kilograms of

			environmental emissions linked to the surgical process. It sought to analyze material use and the resulting environmental effects and costs, thereby providing insights into sustainable practices in cataract surgery.				weighed during the audits. Data on waste disposal routes and costs were obtained from the housekeeping department and direct observations.	carbon dioxide-equivalents per phacoemulsification, which is about 5% of the carbon footprint of similar surgeries in the United Kingdom. The majority of emissions were linked to the sterilization process of reusable instruments.
Christopher Jack, 2024.	Leveraging data science and machine learning for urban climate adaptation in two major African cities: a HE 2 AT Center study protocol.	Fogarty International Center, the National Institute of Environmental Health Sciences (NIEHS), and the Office of Strategic Coordination (OSC) of the National Institutes of Health under Award Number U54 TW 012083.	The study aims to understand the complexities of heat-related health impacts in the African cities of Abidjan and Johannesburg, which face challenges from rapid urban growth and climate change. The specific objectives include mapping intraurban heat risk and exposure using health, socioeconomic, climate, and satellite imagery data. Additionally, the study seeks to create a stratified heat-health forecast model to	Côte d'Ivoire (specifically in Abidjan) and South Africa (specifically in Johannesburg)	Impact evaluation	Quantitative	The study employs a multifaceted methodology that integrates health, climate, environmental, and socioeconomic datasets to build models of heat-related health outcomes. It utilizes advanced data analysis techniques, including statistical evaluation, machine learning, and deep learning, to assess heat-health dynamics. Remote sensing data from satellite sensors, such as Landsat and	The study focuses on understanding the complexities of heat-related health impacts in urban environments, specifically in Abidjan and Johannesburg. It aims to map intraurban heat risk and exposure, create a stratified heat-health forecast model, and establish an early warning system for heatwave alerts. Potential health outcomes of interest include cardiovascular events, respiratory issues, kidney conditions, and

			<p>predict adverse health outcomes and establish an early warning system for timely heatwave alerts. Ultimately, the goal is to foster climate-resilient cities that protect disproportionately affected populations from heat hazards.</p>				<p>MODIS, will be used to estimate air temperature and create urban temperature hazard maps. The research also involves a systematic identification of relevant clinical trials and cohort studies through a dual independent review process. Ethical considerations include informed consent for secondary data usage and protection of identifiable information.</p>	<p>mental health impacts exacerbated by heat exposure. The research will integrate various datasets, including health, socioeconomic, climate, and environmental data, to build comprehensive models of heat-related health outcomes.</p>
<p>Cordelia Kwon,2024.</p>	<p>The Environmental Impacts of Electronic Medical Records Versus Paper Records at a Large Eye Hospital in India: Life Cycle Assessment Study.</p>	<p>The study was funded by Dr. David Chang and the American Society of Cataract and Refractive Surgery (ASCRS) organization for their contributions to the article processing fees.</p>	<p>The aim of the study was to estimate and compare the environmental emissions associated with paper medical record-keeping and its replacement, the electronic medical record (EMR) system, at a high-volume eye care facility in southern India. The study utilized life cycle</p>	<p>India.</p>	<p>Outcome evaluation</p>	<p>Quantitative</p>	<p>The study employed life cycle assessment (LCA) methodology as per the ISO 14040 standard to estimate and compare the environmental emissions of paper medical record-keeping and electronic medical record (EMR) systems. Life cycle inventory (LCI) was created using</p>	<p>The study aimed to estimate and compare the environmental emissions associated with paper medical record-keeping and its replacement by an electronic medical record (EMR) system at a high-volume eye care facility in southern India. It utilized life cycle assessment (LCA) methodology to</p>

			<p>assessment (LCA) methodology as per the ISO 14040 standard to evaluate the carbon footprint of both systems. By understanding the emissions from these record-keeping systems, the study sought to inform strategies for decarbonizing healthcare practices and promote sustainable healthcare solutions.</p>				<p>SimaPro software and the Ecoinvent database, focusing on the production, use, and disposal of materials. Sensitivity analyses and Monte Carlo assessments were conducted to account for variations in practices and to estimate uncertainty in the models. The study included data on consumable supplies and energy consumption for both systems.</p>	<p>evaluate greenhouse gas (GHG) emissions from both systems, focusing on production, use, and disposal impacts. The results indicated that the EMR system emitted significantly more GHGs than the paper system, with a major influence from electricity sources. The study also highlighted the potential for reducing EMR emissions through renewable energy sources.</p>
Emilia Raila, 2017	<p>Black carbon emission reduction strategies in healthcare industry for effective global climate change management.</p>	<p>The research leading to the results was not funded by any institution or donor.</p>	<p>The primary aim of the study was to determine if black carbon (BC) emissions from healthcare waste incineration could be reduced by using cardboard sharps healthcare waste containers instead of plastic ones. The researchers sought to investigate the relationship between burning</p>	Haiti.	Summative evaluation	Quantitative	<p>The study employed an observational quantitative methodology, utilizing primary data on smoke density to assess black carbon (BC) emissions during incineration. Researchers utilized Ringelmann smoke charts to evaluate smoke intensity during different phases of</p>	<p>The outcome studied was the comparison of black carbon (BC) emissions during the incineration of plastic versus cardboard sharps healthcare waste (HCW) containers. The research found that the average BC emissions from plastic containers were significantly higher (<math>17.77 \pm 8.38\%</math> smoke)</p>

			<p>temperature and smoke levels during the incineration of these two types of containers. The study aimed to provide quantitative evidence that could inform policy formulation and promote the use of non-incineration disposal technologies in healthcare waste management. Ultimately, the research focused on reducing BC emissions to improve health and climate conditions.</p>				<p>incineration for both plastic and cardboard sharps healthcare waste (HCW) containers. Data collection involved two trained smoke readers and a certified visible emissions reader, ensuring quality measurements through pilot tests and field training. The study analyzed 20 incineration cycles, with a focus on comparing emissions from plastic and cardboard containers.</p>	<p>compared to cardboard containers (<math>6.81 \pm 4.79\%</math> smoke), with a mean difference of <math>10.96\%</math> smoke, indicating that plastic containers produce 2.61 times more emissions than cardboard. This study highlights the importance of container material in influencing smoke emissions during HCW incineration, providing critical data for policy formulation in healthcare waste management.</p>
Gabriel Gulis, 2013	Health Impact Assessment and Evaluation of a Clinical Waste Management Policy for Cameroon	Institute of Public Health, University of Southern Denmark	<p>The aim of the study was to conduct a health impact assessment (HIA) to evaluate the development of a clinical waste management policy for Cameroon. It sought to assess stakeholders' knowledge regarding the potential health</p>	Cameroon	Formative evaluation	Qualitative	<p>The study employed a comprehensive Health Impact Assessment (HIA) methodology, which included stages such as screening, scoping, risk appraisal, and evaluation and reporting. No formal screening tool was utilized due to the absence of</p>	<p>Physical injuries , environmental contamination and cross contamination</p>

			<p>impacts that any clinical waste management policy would have on the community. The study also aimed to develop recommendations for decision-makers on improving clinical waste management in Cameroon based on the results from the HIA process. Additionally, it emphasized the necessity for working partnerships to facilitate the consultation process with stakeholders involved in clinical waste management.</p>				<p>existing policy documents on clinical waste management in Cameroon at the time of the study. Scoping involved identifying 15 stakeholders through consultations and gathering evidence to support the HIA process via emailed questionnaires. Responses were analyzed using Stata 11 to identify key themes relevant to the HIA evaluation objectives.</p>	
Georgina Morrow, 2014	Accounting for health in climate change policies: a case study of Fiji	Partly funded by Rotary International through an Ambassadorial Scholarship	<p>The aim of the study was to investigate the extent to which the Fiji National Climate Change Policy (NCCP) and relevant sectoral policies account for the human health effects of climate change. It specifically focused on three</p>	Fiji	Process evaluation	Qualitative	<p>The study employed a three-pronged policy analysis framework developed by Walt and Gilson, which broadens the scope of traditional policy analysis. This framework includes an evaluation of the content of the Fiji</p>	<p>The study investigated three major health impacts of climate change in Fiji: dengue fever, diarrhoeal disease, and malnutrition. It aimed to assess how these health impacts were addressed within the Fiji National Climate Change</p>

			<p>major health impacts: dengue fever, diarrhoeal disease, and malnutrition, which pose significant threats to human health in Fiji. The study employed a three-pronged policy analysis approach to evaluate the content, context, processes, and actors involved in the development of these policies. The findings aimed to inform future policy revisions to better incorporate health considerations related to climate change.</p>				<p>National Climate Change Policy (NCCP), the context of its development, and the processes involved in policy formulation. Additionally, the analysis considered the actors involved in the policy-making process, recognizing their influence on the policy's content and context. The study also assessed relevant sectoral policies to determine the extent to which they incorporated climate change and health considerations.</p>	<p>Policy (NCCP), National Climate Change Adaptation Strategy (NCCAS), and the Public Health Act. The analysis showed that these health impacts were largely overlooked, with minimal direct acknowledgment in the main texts of the NCCP and NCCAS, although some references were found in related documents.</p>
<p>Graça Carvalho, 2023.</p>	<p>Climate and health capacity building for health professionals in the Caribbean: A pilot course.</p>	<p>The provided contexts do not contain any information regarding the source of funding for the study.</p>	<p>The aim of the study was to address the lack of health workforce capacity in the Caribbean to implement climate mitigation and adaptation measures. It sought to increase communication about climate and health among health</p>	<p>Caribbean region, with participants primarily from Jamaica, the United States of America, Trinidad and Tobago, Guyana, and the Bahamas.</p>	<p>Summative evaluation</p>	<p>Quantitative</p>	<p>The study utilized a longitudinal survey method to assess the effectiveness of a climate and health training course for health professionals in the Caribbean. Participants completed pre-course and post-course surveys to evaluate changes in communication,</p>	<p>The study focused on the outcomes of a climate and health capacity-building course for health professionals in the Caribbean, specifically assessing changes in communication, engagement, and application of climate and health knowledge and</p>

			<p>professionals, equipping them with relevant knowledge and skills for practical application. The study also aimed to engage health professionals with climate and health initiatives within their communities, thereby fostering a proactive approach to the health impacts of climate change. Ultimately, the study intended to change health professional behaviors towards addressing climate impacts on health through a structured educational course.</p>				<p>engagement, and application of climate and health knowledge and skills. The surveys included multiple-choice questions to gauge the frequency of discussions about climate change and health, as well as participants' confidence in engaging with climate initiatives. Data from registration, course participation, and survey responses were organized and analyzed using R Studio.</p>	<p>skills. Longitudinal surveys indicated significant improvements in participants' confidence to engage with climate and health initiatives, with 87.9% reporting increased confidence post-course. Additionally, 93.9% of participants believed the knowledge gained would significantly alter their professional practice. The course aimed to enhance health professionals' roles in climate mitigation and adaptation efforts.</p>
Helena Wright, 2019.	Confronting Climate Change in Bangladesh Policy Strategies for Adaptation and Resilience	Not reported	<p>The study aims to investigate the impacts of climate change on various sectors in Bangladesh, particularly focusing on health systems, internal displacement, and governance. It seeks to identify knowledge gaps and recommend</p>	Bangladesh	Impact evaluation	Quantitative	<p>The study was conducted in the coastal zone of Bangladesh, identified as the most vulnerable area to climate change. An inventory of adaptation practices was prepared by collating literature on observed</p>	<p>the outcomes of agricultural adaptations in Bangladesh, particularly in the coastal areas, focusing on their health benefits and equity outcomes.</p>

			<p>pathways for climate-resilient health systems, emphasizing the importance of ecosystem-based adaptation strategies.</p> <p>The research also highlights the role of media and education in raising public awareness and preparing communities for climate-related disasters.</p> <p>Overall, the study aims to connect researchers with stakeholders to enhance the effectiveness of climate change research and responses in Bangladesh.</p>				<p>adaptations to climate stressors, including floods and changes in temperature and rainfall.</p> <p>A protocol was developed to collect evidence of adaptation, focusing solely on crop agriculture due to the responsibilities of the agriculture ministry.</p> <p>Literature was gathered from both printed and electronic sources, including academic databases and documents from various organizations.</p> <p>A national workshop was held in Dhaka to share and validate the findings of the inventory.</p>	
Idoteyin Ezirim, 2018	Role of National Policy in Improving Health Care Waste Management in Nigeria	Funded with technical and financial support from the World Bank.	The aim of the study was to determine the level of implementation of the 2013 national healthcare waste management policy across the 36 states and the Federal Capital	Nigeria	Summative evaluation	Mixed methods	<p>The study used both quantitative and qualitative methods for data collection.</p> <p>The qualitative component involved interviews with 12 key informants</p>	The outcome studied was the level of implementation of the 2013 national healthcare waste management policy across 36 states and the Federal Capital

			<p>Territory in Nigeria. Additionally, the study sought to assess whether the implementation of this policy has positively impacted healthcare waste management practices in health facilities. The research involved conducting an environmental safeguard audit and included a comprehensive review of healthcare waste management practices in 1,921 health facilities, selected using a probability proportional to size sampling method.</p>			<p>from the State Ministry of Health and the State Agency for the Control of AIDS, one from each geopolitical zone (six states).</p> <p>The quantitative study was conducted across 1,921 public and private health facilities.</p> <p>A probability proportional to size (PPS) sampling method was employed to select the sample from health facilities offering HIV/AIDS services.</p> <p>Sampling involved two stages: first by local government (districts) and second by type of health facility (primary, secondary, and tertiary).</p> <p>The checklist used in the study was adapted from an environmental and social safeguard</p>	<p>Territory in Nigeria.</p>
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Jamiu Oladigbolu, 2021	Comparative study and sensitivity analysis of a standalone hybrid energy system for electrification of rural healthcare facility in Nigeria.	The support of the deanship of graduate studies at King Abdul-Aziz University for postgraduate scholarship	The aim of the study was to investigate the techno-economic viability of hybrid energy systems (HES) for electrifying a rural healthcare facility in northern Nigeria. The research focused on evaluating different configurations of HES, including solar PV, wind, diesel generators, and batteries, to determine the optimal system for the healthcare center. The study also aimed to conduct a sensitivity analysis to understand how variations in key parameters, such as solar radiation and diesel fuel	Nigeria	Formative evaluation	Quantitative	The paper employs the HOMER software tool developed by the US National Renewable Energy Laboratory (NREL) for the techno-economic viability assessment of hybrid energy systems (HES) designed for a rural healthcare facility in Nigeria. It conducts a comparative study of various system configurations, including solar PV, wind, diesel generator (DG), and battery systems, to determine the optimal combination for cost-effectiveness and environmental impact. Sensitivity analysis is	Key variables for measuring outcomes included Net Present Cost (NPC), Cost of Energy (COE), operating cost, electricity generation, load served per annum, and renewable fraction.

			prices, impact the performance and cost-effectiveness of the proposed energy systems.				performed to evaluate the impact of varying parameters such as solar radiation, diesel fuel price, minimum battery state-of-charge, and healthcare facility load demand on the system's performance.	
Jelena Božić, 2019.	Indoor Air Quality in the Hospital: The Influence of Heating, Ventilating and Conditioning Systems.	The contexts provided do not mention the source of funding for the study.	The main aim of the study was to assess the degree of fungal and bacterial contamination in the University Clinical Centre in Banja Luka, specifically in relation to the HVAC system. The study sought to evaluate the concentration of airborne bacteria and fungi in the indoor hospital environment through experimental assessment. It aimed to provide a scientific basis for indoor air quality control and to expand risk prevention programs for the hospital.	Bosnia and Herzegovina	Outcome evaluation	Quantitative	The study employed a methodology that involved testing for the presence of bacteria and fungi, as well as measuring microclimatic parameters such as temperature and relative humidity in the University Clinical Centre in Banja Luka. Representative samples were collected from various clinics, including the Clinic of Cardiovascular Diseases and the Infectious Diseases Clinic, with sampling conducted in 22 rooms equipped with HVAC	The study focused on assessing the degree of fungal and bacterial contamination in the indoor environment of a hospital, specifically the University Clinical Centre in Banja Luka, in relation to the HVAC system. It measured airborne bacteria and fungi concentrations expressed in colony-forming units per cubic meter of air (CFU/m <sup>3</sup> ) alongside microclimatic parameters such as temperature and relative humidity. The results

			Additionally, the study analyzed the correlation between microbial concentrations and microclimatic parameters, particularly relative humidity.				systems and 13 rooms without HVAC. A portable bio-impactor air sampler was utilized for microbial air monitoring, collecting viable organisms through air aspiration onto agar plates. Correlation analysis was performed to examine the relationship between microorganism concentrations and relative humidity.	indicated that all hospital rooms were generally contaminated, with average levels of bacteria at 587 CFU/m <sup>3</sup> and fungi at 308 CFU/m <sup>3</sup> . The study also highlighted the influence of relative humidity on the growth of airborne microorganisms.
Jessica Farley, 2017	Evaluation of flood preparedness in government healthcare facilities in Eastern Province, Sri Lanka.	The study was supported by a University of Washington Thomas Francis Jr. Fellowship to JMF.	The aim of the study was to assess the flood preparedness of public healthcare facilities in Trincomalee District, Eastern Province, Sri Lanka, specifically focusing on their functional preparedness for flood events and general disaster preparedness.	Sri Lanka	Outcome evaluation	Mixed methods	The evaluation conducted in the study was a cross-sectional, descriptive, mixed methods study. Surveys were utilized to gather quantitative data from 31 government healthcare facilities using a pre-tested, structured questionnaire. In-depth interviews were conducted with randomly selected	Perceptions of overall preparedness for a major flood.

							Medical Officers in Charge or their equivalents to gather qualitative insights.	
La De, 2023.	A Comparison of Grid-Connected Local Hospital Loads with Typical Backup Systems and Renewable Energy System Based Ad Hoc Microgrids for Enhancing the Resilience of the System."	The research was funded by the Ministry of Foreign Affairs of Denmark, DANIDA Fellowship Centre.	The aim of the study was to enhance the resilience of the electric power system during power outages caused by extreme weather conditions and natural disasters. It specifically focused on comparing two different energy system scenarios: one utilizing a diesel generator alongside a utility electric grid and local electric loads, and the other employing a grid-connected ad hoc microgrid with a photovoltaic system and battery energy storage. The research sought to evaluate these systems from technological, economic, and environmental perspectives, particularly in the	Indonesia, specifically on Lombok Island.	Summative evaluation	Quantitative	The paper employs a comparative analysis of two energy systems to enhance the resiliency of a local hospital load during power outages. System 1 consists of a utility electric grid (UEG) and local electric load (ELL) with a diesel generator (DG), while System 2 is a grid-connected microgrid (MG) featuring photovoltaic (PV) systems and battery energy storage (BES). The HOMER Grid software is utilized for simulating a 3-day power outage scenario to evaluate the performance of both systems. The study measures resiliency through the concept of 'survivability,' focusing on the	The outcome in the study was measured by the term "survivability," which refers to the probability of the system having an electric supply during a power outage until the system is restored.

			context of a critical hospital load on Lombok Island, Indonesia.				probability of maintaining electric supply during outages.	
Leandro Gobbo Braz, 2017	Comparison of waste anesthetic gases in operating rooms with or without an scavenging system in a Brazilian University Hospital	The study was funded by Fundac,ao de Amparo a Pesquisa do Estado de Sao Paulo (FAPESP) and Conselho Nacional de Desenvolvimento Cientifico e Tecnologico (CNPq).	The aim of the study was to compare the trace concentrations of the inhalational anesthetics isoflurane and sevoflurane in operating rooms (ORs) with and without a central scavenging system. The study sought to measure waste concentrations of these anesthetics at different locations and times during surgeries to assess occupational exposure levels. It aimed to determine whether the presence of a scavenging system effectively reduced the concentrations of these anesthetics to within the recommended safety limits established by health agencies.	Brazil	Outcome evaluation	Quantitative	The study was conducted in a hospital with 13 operating rooms (ORs), seven without a scavenging system and six with a partial scavenging system. Anesthesia was maintained using isoflurane or sevoflurane during the first general anesthesia of the day in 24 patients. Residual concentrations of anesthetics were measured using a portable infrared analyzer at three sites: the anesthesiologist's area, the nursing assistant's area, and near the anesthesia workstation. Measurements were taken at two time points: 30 and 120 minutes after surgery began. Statistical analyses included	trace concentrations of inhalational anesthetics isoflurane and sevoflurane in operating rooms with and without a central scavenging system.

							Student's t-test and ANOVA to compare various factors.	
Malcolm Araos, 2015	Public Health Adaptation to Climate Change in Large Cities: A Global Baseline	The study was funded by the CIHR Applied Public Health Chairs Program, a SSHRC Insight Grant, the Trottier Public Science Policy Fellowship (Faculty of Science, McGill University), and the Fonds de la Recherche en Sante du Que bec (FRSQ) Bourse de Carrier.	The aim of the study is to assess the state of public health adaptation to climate change in urban areas globally, specifically focusing on cities with populations exceeding 1 million. It seeks to create a global baseline for urban public health adaptation by systematically analyzing adaptation initiatives reported in municipal planning documents. The study identifies gaps in adaptation efforts, particularly in the Global South, and highlights the need for improved reporting, monitoring, and evaluation of public health initiatives addressing climate-related health risks.	The research mentions several cities, including New York City (USA), Toronto (Canada), and Durban (South Africa), indicating that the study encompasses multiple countries.	Outcome evaluation	Qualitative	<p>The study employs systematic data collection methods to assess public health adaptation in urban municipalities with populations exceeding 1 million.</p> <p>It analyzes health adaptation planning by reviewing publicly available climate change plans from municipalities, categorized into Municipal Adaptation Plans (MAPs), Climate Action Plans (CAPs), adaptation web pages, and external documents developed by consulting firms or research groups.</p> <p>A systematic classification method is utilized to quantitatively retrieve data</p>	The study defines outcome measures as the publicly reported initiatives and adaptation strategies documented in municipal planning documents

							<p>related to health adaptation initiatives, focusing on variables such as health risk targeted, adaptation type, and the importance of climate change as a driver of change.</p> <p>Data collection occurred between January 2 and March 29, 2014, ensuring a consistent source for the initiatives analyzed.</p>	
Manar Aslan, 2019	How blameless are hospitals in climate change? An example of a province in Turkey	Not reported	<p>The aim of the study is to determine the climate-friendly practices of state hospitals in a province in Turkey. It seeks to evaluate the hospitals' performance in various green practices, including waste management, water management, energy management, material selection, and sustainable</p>	Turkey	Process evaluation	Quantitative	<p>The study employed a descriptive methodology to assess the extent of green applications in public hospitals in Turkey, specifically focusing on 21 hospitals in Konya province. Data collection involved the use of a Green Practices Assessment Form, which included both open-ended and yes-or-no</p>	<p>The outcome measures in the study were defined through the assessment of hospitals' green practice performance, which included various aspects such as waste management, water management, energy management, material selection, and sustainable facilities.</p>

			<p>facilities. The study emphasizes the importance of raising awareness among hospital personnel regarding environmental protection and social responsibility. Additionally, it aims to encourage hospitals to adopt environmentally friendly strategies to improve their carbon footprints and enhance the quality of healthcare services.</p>				<p>questions regarding various sustainability initiatives. The assessment covered areas such as waste management, water management, energy management, material selection, and sustainable facilities. Information was gathered from hospital leadership, including presidents, vice-presidents, and chief physicians, to evaluate the hospitals' green practice performance.</p>	
Manzurul Hassan, 2008.	Pattern of medical waste management: existing scenario in Dhaka City, Bangladesh.	Not reported	<p>The aim of the study is to document the handling practices of medical waste management in Dhaka City, Bangladesh, focusing on collection, storage, transportation, and disposal methods used by Health Care Establishments</p>	Bangladesh	Process evaluation	Mixed methods	<p>The study design includes both qualitative and quantitative methods. Quantitative data was collected through a structured questionnaire survey to address the generation of different medical wastes according to amount and sources from</p>	<p>The expected outcomes include a reduction in The improper disposal of medical waste, thereby minimizing health risks associated with hazardous materials.</p>

			<p>(HCE). It seeks to quantify the types and amounts of medical waste generated, highlighting the proportion of hazardous versus non-hazardous waste. The study also aims to identify the existing management practices and the factors contributing to improper medical waste management, such as lack of awareness and appropriate policies.</p>				<p>various Health Care Establishments (HCE). Qualitative data was gathered through in-depth interviews with nurses, hospital managers, doctors, and cleaners to enhance understanding of existing management practices of medical wastes.</p>	
Mustafa Ali, 2016	<p>Application of life cycle assessment for hospital solid waste management: A case study.</p>	<p>The research was funded by the China Specialized Research Fund for Doctoral Program of Higher Education, the National Natural Science Foundation of China, and the Major Program of National Social Science Foundation of China.</p>	<p>The aim of the study was to determine and compare the environmental burden of hospital waste through various waste treatment scenarios using a life cycle assessment (LCA) approach. The study specifically focused on quantifying the greenhouse gas</p>	Pakistan	Outcome evaluation	Quantitative	<p>The study employed a life cycle assessment (LCA) approach to evaluate the environmental aspects of hospital waste management scenarios. It involved a survey conducted at a major hospital in Pakistan, where waste was quantified by category from</p>	<p>The outcome measures in the study were defined based on the greenhouse gas (GHG) emissions associated with different hospital waste disposal scenarios.</p>

			(GHG) emissions associated with different disposal methods, including landfilling, incineration, composting, and material recycling. It sought to identify the most effective waste management strategies that could minimize emissions and promote sustainable practices in hospital waste management. The findings are intended to assist policymakers in formulating an integrated hospital waste management plan.				November 2014 to January 2015.	
Nesli Ciplak,2015.	Assessing future scenarios for health care waste management using a multi-criteria decision analysis tool: A case study in the Turkish West Black Sea Region."	Not reported	The aim of the study is to identify the best possible health care waste management option in the West Black Sea Region of Turkey. It considers various aspects including economic, social, environmental, and technical factors through a	Turkey	Impact evaluation	Quantitative	The paper employs a multi-criteria decision analysis (MCDA) technique to enhance the decision-making mechanism for health care waste (HCW) management, ensuring it is environmentally, economically, technically sound,	CO2 emission. water usage

			<p>multi-criteria decision analysis framework. The research develops and compares three different health care waste management scenarios using a decision-making software called Right Choice. The study emphasizes the importance of an efficient health care waste segregation scheme and the need for a multidisciplinary approach in decision-making.</p>				<p>and socially viable. A decision-making computer tool called Right Choice is utilized to analyze the results, generating numerical scores for various scenarios based on stakeholder judgments. The methodology involves constructing a decision tree, assessing scenarios against multiple criteria, and assigning relative weights to these criteria through stakeholder questionnaires. Sensitivity analysis is conducted to evaluate how changes in criterion weightings affect the final selection of HCW management options.</p>	
Panin Asirifua Obeng, 2020	Water Safety Planning and Implementation in a Ghanaian Small-scale	Not reported	The aim of the study was to qualitatively verify the existence of a Water Safety Plan (WSP) for the	Ghana	Summative evaluation	Mixed methods	The interventions studied were delivered in a small-scale water supply system setting,	The outcome measures in the study were defined through the assessment of water quality

	Water Supply System		Assin Fosu Small Town Water Supply System (AFSTWSS) and to assess whether any existing plans adequately provide for water safety protection. Additionally, the study sought to qualitatively evaluate the compliance of the water system operator with any existing WSP. It also aimed to quantitatively and qualitatively establish whether the water supplied to consumers under the current water quality management practices meets relevant quality standards.				specifically the Assin Fosu Small Town Water Supply System in Ghana. The study involved various components of the water supply system, including boreholes, treatment units, and public standpipes.	parameters, including bacteriological safety and aesthetic quality (pH, colour, turbidity).
Philip Koka,2018.	Disaster preparedness and response capacity of regional hospitals in Tanzania: a descriptive cross-sectional study.	Not reported	The aim of the study was to assess the current state of disaster preparedness and response capacity among regional hospitals in Tanzania. It specifically focused on evaluating three main components of emergency	Tanzania	Formative evaluation	Quantitative	The study design was a descriptive cross-sectional study. It evaluated disaster preparedness, equipment availability, and disease burden in all district and regional hospitals in Tanzania. The study was	Outcome measures included assessments of triage, communication, security, and surge capacity infrastructures within the hospitals.

			care: disaster preparedness, equipment availability, and disease burden in all district and regional hospitals.				conducted between May 2012 and December 2012.	
Putri Nilam Sari, 2019.	Climate Change: How is the Adaptation of Public Health Services? Case Studies in the City of Padang	The research was funded by the Faculty of Public Health, Andalas University through the DIPA funding in the year of 2019.	The aim of the study is to assess the extent of adaptation by Public Health Centers (PHCs) in Indonesia to address the challenges posed by climate change. It seeks to identify specific indicators of adaptation within PHCs, focusing on their preparedness and response capabilities to climate-related health risks. The research involves observing adaptation indicators, conducting in-depth interviews, and reviewing relevant documents across three PHCs located in vulnerable sub-districts.	Indonesia	Formative evaluation	Mixed methods	Observation of adaptation indicators/checklist, in-depth interviews, and document reviews as evaluation methods to assess the adaptation of Public Health Centers (PHCs) to climate change. Data collection involved a checklist filled through observation and interview methods, ensuring a comprehensive evaluation of the PHCs' adaptation efforts. Triangulation techniques were employed to validate the data, enhancing the trustworthiness of the findings.	Indicators such as early warning systems for drought, collaboration with climate-related institutions, and participation in reducing greenhouse gas emissions.

			Ultimately, the study aims to provide insights that can guide the development of comprehensive strategies for enhancing health system adaptation to climate change.					
Rebekka Schnitter, 2018.	An Assessment of Climate Change and Health Vulnerability and Adaptation in Dominica.	Health Canada.	<p>The aim of the study was to conduct a climate change and health vulnerability and adaptation assessment in Dominica, a small island developing state in the Caribbean.</p> <p>The assessment sought to identify the impacts of climate variability and change on health and health systems, particularly focusing on infectious diseases and food and waterborne diseases.</p> <p>It aimed to inform health sector decision-makers about adaptation options to address health vulnerabilities and build resilience against climate</p>	The study was conducted in Dominica, a Caribbean small island developing state located in the Lesser Antilles.	Formative evaluation	Mixed methods	<p>The methodology for the vulnerability and adaptation assessment in Dominica followed the general approach developed by the WHO, although a comprehensive assessment of all health issues was not feasible due to time and resource constraints.</p> <p>A qualitative mixed-methods approach was employed, which is suitable for small island developing states where quantitative data may be limited.</p> <p>Stakeholder engagement activities included key informant interviews, focus groups, and a national workshop</p>	<p>The study focused on assessing the health impacts of climate change in Dominica, particularly examining the vulnerability and adaptation of the health sector to climate-related risks.</p> <p>It identified four priority health areas: vector-borne diseases, waterborne and water-related diseases, foodborne diseases, and food security.</p> <p>The assessment revealed that the population is already experiencing health impacts from climate variability, including increased risks of</p>

			change. The study also intended to provide insights and lessons learned that could benefit other small island developing states undertaking similar assessments.				to gather insights from various stakeholders. An ecological time series study was conducted to model the incidence of gastroenteritis in relation to rainfall extremes.	infectious diseases and food insecurity. The study aimed to inform health sector decision-makers about adaptation options to enhance resilience against these climate-sensitive health outcomes.
Saber Azami-Aghdash, 2023	Improving the hospital waste management at the Farabi hospital in Malekan -Iran: An action research study	The study was supported by Tabriz University of Medical Sciences	The aim of the study was to improve hospital waste management (HWM) at the Farabi Hospital in Malekan, Iran, through an action research approach. It sought to identify significant issues in the waste management process, prioritize them, and implement targeted interventions over six months. The study also aimed to enhance the knowledge of hospital staff regarding HWM standards and reduce the volume of both general	Iran	Formative evaluation	Mixed methods	<p>The research employed a mixed-methods approach, specifically a quantitative-qualitative action research study conducted in 2020 at Farabi Hospital in Malekan City.</p> <p>The Simmons model was utilized, which consists of six major steps to guide the action research process.</p> <p>A reliable and valid checklist developed by the Ministry of Health and Medical Education was used for a comprehensive evaluation of the waste</p>	<p>The study focused on improving hospital waste management (HWM) at the Farabi Hospital in Malekan, Iran, through an action research approach.</p> <p>Key outcomes included a significant increase in participants' knowledge of HWM standards, which improved from <math>64 \pm 13.8</math> to <math>84.6 \pm 20.6</math> after training.</p> <p>General waste production was reduced by 27.7% in garbage bags and 23.4% in weight, while infectious waste</p>

			and infectious waste produced. Ultimately, the research intended to establish a replicable model for improving HWM in other hospitals across Iran or similar contexts.				management process.  Quantitative evaluation methods included descriptive statistics and inferential statistics, such as paired t-tests and Wilcoxon tests, to assess the effectiveness of interventions.	output decreased by 22.8% in bags and 32.1% in weight.  The adherence rate to HWM norms increased from 10 to 33 items post-intervention.
Santosh Singh,2020	Design and economic analysis of a stand-alone hybrid photovoltaic energy system for remote healthcare centre."	Not reported	The aim of the study is to design and conduct an economic analysis of a stand-alone hybrid photovoltaic (PV) energy system tailored to meet the daily electrical load demand of a remote healthcare center in Madhya Pradesh, India. It focuses on optimal design and sizing of the hybrid PV system, which includes components such as PV generators, batteries, inverters, and diesel generators, based on the specific load requirements. Additionally, the	India	Process evaluation	Quantitative	The paper employs an optimal design and sizing methodology for a hybrid photovoltaic (PV) energy system tailored to the daily electrical load demand of a remote healthcare center. It utilizes the Hybrid Optimization Model for Electric Renewable (HOMER) software for economic analysis and selection of the optimum hybrid PV energy system. The study includes a detailed comparison of	The outcome measures in the study were defined by evaluating the energy demand satisfaction, system cost, and pollution levels of the hybrid PV-diesel-battery system compared to conventional systems. -

			study evaluates the environmental benefits and cost-effectiveness of the hybrid system compared to conventional energy systems.				environmental aspects between the hybrid PV system and conventional systems, focusing on greenhouse gas emissions and life cycle costs. Additionally, it calculates annual cost savings and payback periods for the proposed energy system.	
Saurabh Gupta, 2006	Report: biomedical waste management practices at Balrampur Hospital, Lucknow, India	The study acknowledges funding and cooperation from Dr. T. R. Kolanu, Faculty, Centre for Energy, Environment Technology, Administrative Staff College of India, Bella Vista, Hyderabad.	The aim of the study was to investigate the biomedical waste management practices at Balrampur Hospital, a significant healthcare establishment in Lucknow, India. It sought to highlight the serious health hazards posed by careless and indiscriminate disposal of biomedical waste, which can contribute to the spread of diseases such as hepatitis and AIDS among healthcare workers and the general public.	India	Process evaluation	Mixed methods	The research involved gathering and compiling relevant data and information from the hospital, including interviews with on-duty doctors, support staff, and waste collectors, to estimate waste generation figures over a one-week period.	The study focused on the biomedical waste management practices at Balrampur Hospital in Lucknow, India, highlighting the serious health hazards posed by improper disposal methods. It revealed that infectious and non-infectious wastes were mixed and disposed of with municipal waste, leading to potential disease spread among waste handlers and the public. The research emphasized the lack of treatment

			<p>The study aimed to assess the current practices of waste segregation, collection, and disposal, emphasizing the need for improved environmental management systems and strict enforcement of legal provisions.</p>					<p>facilities for infectious waste and the need for strict enforcement of legal provisions and improved environmental management systems. The study concluded that education, training, and commitment from healthcare staff are essential for effective waste management.</p>
<p>Shuang Zhong, 2014.</p>	<p>Disaster resilience in tertiary hospitals: a cross-sectional survey in Shandong Province, China</p>	<p>The study was supported by a QUT-CSC joint PhD scholarship.</p>	<p>The aim of the study was to explore the status of disaster resilience among tertiary hospitals in Shandong Province, China. It sought to define hospital disaster resilience as the ability to resist, absorb, and respond to the shock of disasters while maintaining critical functions and recovering to its original state or adapting to a new one</p>	<p>China</p>	<p>Formative evaluation</p>	<p>Quantitative</p>	<p>The study utilized a cross-sectional survey method to assess disaster resilience in tertiary hospitals in Shandong Province, China, involving a stratified random sample of 50 hospitals. A questionnaire was developed based on an established framework, consisting of 9 sections and 166 items, primarily formatted as binary variables (yes/no). Factor analysis was employed to</p>	<p>disaster resilience of tertiary hospitals in Shandong Province, China, which is defined as the ability of hospitals to resist, absorb, and respond to disasters while maintaining critical functions and recovering to their original state or adapting to a new one.</p> <p>-</p>

							extract key factors of disaster resilience from eight domains, resulting in four primary factors: medical care capability, management mechanism, resources, and safety. Descriptive statistics, including mean scores and confidence intervals, were used to analyze the data, with comparisons made across different hospital categories.	
Stella Hartinger,2024.	The 2023 Latin America report of the Lancet Countdown on health and climate change: the imperative for health-centred climate-resilient development.	Wellcome Trust.	The aim of the study is to provide evidence to public decision-making with the purpose of improving the health and wellbeing of Latin American populations. It seeks to reduce social inequities through climate actions that focus on health. The report emphasizes the importance of monitoring and	Latin America, multiple countries such as Argentina, Brazil, Colombia, Costa Rica, Ecuador, Panama, and Peru.	Impact evaluation	Qualitative	The methodology includes tracking population exposure to heatwaves and assessing climate risk at the municipal level through self-reported data from the Carbon Disclosure Project. Additionally, it analyzes social media engagement and scientific publications	The study focuses on the impacts of climate change on health in Latin America, highlighting the urgent need for health-centered climate-resilient development. It examines the Mosquito Risk Index (MoRI) to assess the risk of mosquito-borne diseases, particularly dengue, influenced by

			<p>understanding the dynamics of climate-related hazards and population exposure over time. This understanding is critical to inform climate policies that minimize health impacts, increase climate resilience, and enhance overall population health and wellbeing.</p>				<p>related to health and climate change in Latin America to understand how evidence is used in decision-making.</p>	<p>climatic changes and urban vulnerabilities. The economic consequences of climate change, including heat-related mortality and labor productivity losses, are also analyzed, revealing significant financial impacts on national economies. The report emphasizes the necessity for targeted interventions and policies to mitigate health risks while promoting environmental justice and health equity.</p>
<p>Tamal Chowdhury, 2021.</p>	<p>Design of a stand-alone energy hybrid system for a makeshift health care center: A case study.</p>	<p>Not reported</p>	<p>The aim of the study is to design a stand-alone energy hybrid system for a temporary health care center located in Saint Martin Island, Bangladesh. This research addresses the increasing energy demand and emissions</p>	<p>Bangladesh</p>	<p>Formative evaluation</p>	<p>Quantitative</p>	<p>The research employs Homer software to simulate the hybrid energy system, utilizing data on solar and wind resources for analysis. It addresses optimization problems related to economic, environmental, and reliability</p>	<p>reduction in CO2 emissions</p>

			<p>associated with temporary health care centers established due to the COVID-19 pandemic. The study highlights the power management of hospital loads and utilizes Homer Pro software to develop the preliminary model, which integrates various renewable energy sources. Ultimately, the study seeks to optimize energy consumption while ensuring environmental sustainability and economic viability.</p>				<p>aspects of the energy system. The study includes mathematical modeling to evaluate the performance of components such as inverters and generators, considering their costs and operational efficiencies. Additionally, demand-side management techniques are applied to optimize energy consumption and enhance system reliability. The analysis also incorporates sensitivity analysis to assess the impact of discount rates on net present cost and cost of energy.</p>	
Tanya Zakrison, 2017	The Medical, Public Health, and Emergency Response to the Impact of 2017 Hurricane Irma in Cuba.	Not reported	The aim of the study is to analyze the medical, public health, and emergency response to Hurricane Irma's impact in Cuba, highlighting the effectiveness of the country's	Cuba	Impact evaluation	Mixed methods	Narrative and author led analysis of medical, public health and emergency response of country	The study focused on the outcomes of Cuba's response to Hurricane Irma, particularly examining the effectiveness of its disaster management strategies.

			<p>disaster management strategies. It seeks to identify and discuss five defining attributes of Cuba's hurricane response that can inform other island and coastal nations vulnerable to similar disasters.</p>					<p>It highlighted the swift recovery of Cuba despite significant damage, economic hardships, and lack of external support. The research identified five key attributes of Cuba's hurricane response: learning from past disasters, integrating healthcare professionals, engaging the public, utilizing technology, and incorporating scientific planning. The study also noted the low mortality rate during the impact phase of the hurricane, attributing it to effective preparedness and response measures.</p>
<p>Wesam H. Beitelmal, 2022</p>	<p>Renewable Energy as a Source of Electricity for Murzuq Health Clinic During COVID-19</p>	<p>No specific grant from public, commercial, or non-profit sectors</p>	<p>The aim of the study is to investigate the techno-economic assessment of three different hybrid energy systems for the</p>	<p>Libya</p>	<p>Formative evaluation</p>	<p>Quantitative</p>	<p>The study utilized HOMER (Hybrid optimization model for electric renewables) software to evaluate the feasibility of hybrid</p>	<p>The study defines outcome measures through the evaluation of Net Present Cost (NPC), Cost of Energy (COE), and operating</p>

			<p>Murzuq health clinic in Libya, particularly during the COVID-19 pandemic. It seeks to evaluate the feasibility of employing renewable energy sources to provide a sustainable and efficient electricity supply to the clinic, which has experienced increased energy demand due to extended operating hours and a higher number of electrical appliances. The study utilizes HOMER software to analyze and optimize the energy supply systems, focusing on minimizing costs and maximizing reliability and environmental benefits.</p>				<p>energy systems for the Murzuq health clinic. This involved specifying hybrid configurations, capacities, climatic data, and load demand profiles to balance energy generation and consumption while calculating costs. Measured load and weather data were collected and used in simulations to ensure the electrical needs of the health clinic were met. The methodology focused on identifying the lowest hybrid energy cost system that satisfies the clinic's energy demands.</p>	<p>costs of the hybrid energy systems, focusing on economic feasibility.</p>
Yizhao Sun. 2017.	A Comparative Study of Design Strategies for Lobby of Outpatient Department of Hospital Buildings	National Natural Science Foundation of China through a grant to Tianjin University for the design theory and	The aim of the study is to clarify the relationship among lobby design, energy consumption, and daylight	China	Formative evaluation	Quantitative	The methodology of the study is divided into two main stages. Stage one focuses on the impact of space-design	The outcome measures in the study were defined by evaluating the energy consumption and

	in Cold Climate Region in China."	methodology of non-residential building spaces with low energy consumption in cold climate regions program (Grant No.51338006).	environment in outpatient departments of hospital buildings, specifically in cold climate regions of China. The study seeks to explore effective design strategies for outpatient lobbies that enhance the healthcare environment while minimizing energy consumption. It involves investigating the thermal and daylighting environments of current hospitals in Tianjin and conducting simulations to analyze how various design factors impact energy consumption and physical environments.				factors, including different positions, orientations, and heights of the lobby, on energy consumption and daylight availability through simulations. Stage two examines the effects of facade-design factors, specifically window-wall ratio and skylight ratio, on energy consumption and daylight performance. Simulations are conducted using Design Builder software, utilizing climatic data from Tianjin, China, characterized by a temperate and monsoonal climate. The results from these simulations inform effective design strategies for outpatient department lobbies in hospitals.	daylight availability associated with different lobby designs in outpatient departments of hospital buildings. The study focused on specific factors such as space-design (position, orientation, height) and facade-design (window-wall ratio, skylight ratio) to assess their impact on the physical environment.
Natalia Bellan, 2012	Critical analysis of the regulations regarding the disposal of medication waste	Not reported	The aim of the study is to discuss management models for the disposal of	Brazil.	Summative evaluation	Qualitative	Analytic study, focused on contrasting local regulations in Brazil with	Environmental impacts resulting from contamination with

			<p>medication waste and the recommendations made by pertinent national and international legislation. It seeks to analyze the management structure for medication waste in relation to international legislation and environmental regulations, as well as national legislation concerning solid waste from health services.</p> <p>The study intends to clarify the possible impacts of improper medication disposal on the environment and public health, while proposing alternatives for efficient medication disposal to reduce sanitary risks.</p>				international standards and/or as relevant existing national standards.	medical waste disposed.
Christovam Barcellos, 2016	An observatory to gather and disseminate information on the health-related effects of environmental	Government funded research.	This report sought to critically examine proposals, potentials, and challenges of environmental health	Brazil	Formative evaluation	Analysis	Focus on analysis of requirements for setting up an observatory, including requirement analysis,	Climate-sensitive diseases and their determinants

	and climate change		observatories with an emphasis on climate change processes. A critical review of existing environmental health observatories was performed and the implementation of the Brazilian Climate and Health Observatory (C&HO) is described.				negotiation, prototyping stages	
Jerome Lock-Wah-Hoon, 2020	Exploring Vector-Borne Disease Surveillance and Response Systems in Beijing, China: A Qualitative Study from the Health System Perspective	Ministry of Health, Welfare and Sports of the Netherlands, in the context of the Memorandum of Understanding (2013) with the National Health and Family Planning Commission of the People's Republic of China (NHFPC).	Aim is to optimise VBD surveillance and monitoring and gain understanding of system characteristics and experiences in to date non-endemic regions at risk of becoming endemic in the future. Therefore, this study qualitatively analyses the nature and flexibility of VBD surveillance and response in Beijing.	China	Formative evaluation	Qualitative	Semi-structured interviews, thematic content analysis	VBD surveillance system characteristics and experiences
Lorena Pasquini, 2015.	What enables local governments to mainstream	NA	The aim of the study is to explore the enabling factors that allow	South Africa	Process evaluation	Qualitative	semi-structured interviews to gather qualitative data from officials	Factors that enable local governments, specifically

	<p>climate change adaptation?  Lessons learned from two municipal case studies in the Western Cape, South Africa.  -</p>		<p>local governments to effectively mainstream climate change adaptation within their municipalities.</p>				<p>and councillors in two municipalities, Cape Town and Hessequa, focusing on their experiences with extreme weather events and climate change adaptation.</p>	<p>municipalities in the Western Cape of South Africa, to successfully mainstream climate change adaptation.</p>
<p>Rengaraj Venkatesh, 2015</p>	<p>Carbon footprint and cost-effectiveness of cataract surgery</p>	<p>NA</p>	<p>The aim of the study is to raise awareness about the cost-effectiveness and carbon footprint associated with various cataract surgery techniques, specifically comparing manual small-incision cataract surgery (MSICS), phacoemulsification, and femtosecond laser-assisted cataract surgery.  - It seeks to highlight the significant contribution of cataract surgery to global climate change and the environmental impact of these surgical procedures.</p>	<p>Unclear - measurements seem sourced across settings, including HIC</p>	<p>Cost-effectiveness</p>	<p>Mixed methods</p>	<p>The measurement of the carbon footprint in cataract surgery involves assessing the gaseous emissions resulting from the full life cycle of the surgical process, focusing on direct emissions from building energy use, travel of patients and staff, and indirect procurement emissions related to the production and disposal of goods and services used in the surgery. Cost-effectiveness analysis is utilized to evaluate the resources spent per outcome achieved, often expressed in terms of dollar per</p>	<p>Cost-effectiveness and environmental impact of various cataract surgery techniques, including manual small-incision cataract surgery (MSICS), phacoemulsification, and femtosecond laser-assisted cataract surgery (FLACS).</p>

							quality-adjusted life year (QALY).	
Sabiha-Javied,2008.	Heavy metal pollution from medical waste incineration at Islamabad and Rawalpindi, Pakistan	The research was funded by the Higher Education Commission (HEC) of Pakistan, which provided the opportunity for one of the authors, Sabiha-Javied, to work at PIEAS.	The aim of the study was to investigate the concentration of heavy metals remaining in the ash of incinerated medical waste generated by hospitals in Islamabad and Rawalpindi, Pakistan.	Pakistan	Outcome evaluation	Quantitative	Collecting ash samples from five incinerators over five weeks, totaling 25 samples. The concentration of heavy metals such as Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb), and Zinc (Zn) was determined using Flame Atomic Absorption Spectrometry (FAAS). - Each ash sample was digested with a mixture of nitric acid (HNO <sub>3</sub> ) and hydrochloric acid (HCl) before analysis. - The recovery efficiency of the samples was validated using standard reference materials, ensuring accuracy in the measurements.	The concentration of heavy metals in the ash produced from the incineration of medical waste in hospitals located in Islamabad and Rawalpindi, Pakistan.
Busisiwe Shezi, 2019.	Environmental health practitioners potentially play a	The study was funded by the South African Medical Research	The aim of the study was to understand the roles of	South Africa	Process evaluation	Quantitative	A cross-sectional survey method using convenience sampling at a	The current state of EHPs' involvement in climate change

	key role in helping communities adapt to climate change	Council and the National Research Foundation.	Environmental Health Practitioners (EHPs) in implementing climate change-related adaptation actions within communities, particularly focusing on vulnerable population groups in South Africa.				conference for Environmental Health Practitioners (EHPs) in South Africa. A structured questionnaire was utilized, which included both closed and open-ended questions, allowing for quantitative and qualitative analyses.	adaptation and their perceived importance of various interventions.
Verena Rauchenwald,2020.	New Method of Destroying Waste Anesthetic Gases Using Gas-Phase Photochemistry.	The study was partially sponsored by Infuser ApS, as mentioned in the conflicts of interest section.	The aim of the study is to test the removal efficiency of commonly administered anesthetics, specifically nitrous oxide, desflurane, and sevoflurane, using a novel photochemical anesthetic exhaust gas destruction system. - The study seeks to evaluate the effectiveness of this technology in reducing the environmental impact of waste anesthetic gases, which are potent greenhouse gases contributing to climate change.	Not applicable	Outcome evaluation	Quantitative	The measurement of inlet and outlet reactor concentrations of nitrous oxide, sevoflurane, and desflurane was conducted using an infrared gas analyzer, specifically the Cardiocap5 and Capnomac Ultima from Datex-Ohmeda.	Removal efficiency of waste anesthetic gases, specifically nitrous oxide, sevoflurane, and desflurane, using a novel photochemical exhaust gas destruction system.

E Weimann, 2017	Tackling the climate targets set by the Paris Agreement (COP 21) : green leadership empowers public hospitals to overcome obstacles and challenges in a resource-constrained environment	NA	The aim of the study is to explore and implement strategies for reducing the carbon footprint of Groote Schuur Hospital (GSH) in Cape Town, South Africa, through various green leadership projects. It focuses on enhancing energy efficiency, minimizing waste, and transitioning to renewable energy sources to mitigate the effects of climate change on public health. The study also seeks to engage hospital staff in sustainability initiatives, fostering a culture of continuous improvement and environmental responsibility within the healthcare sector.	South Africa	Impact evaluation	Mixed methods	Participatory and analytic.	Reducing the carbon footprint and environmental impact of Groote Schuur Hospital (GSH) in Cape Town, South Africa. It aimed to decrease energy, coal, and water consumption, thereby minimizing greenhouse gas emissions and hazardous waste production.
Michaela Ha, 2019	Reduced Environmental Impact of the Reusable Respimat Soft Mist TM Inhaler Compared with	The study was funded by Boehringer Ingelheim.	The aim of the study was to compare the product carbon footprints (PCFs) of the propellant-free Respimat	NA	Outcome evaluation	Quantitative	Primary data were collected from relevant supply chain members using customized data collection	Environmental benefits of using a reusable Respimat inhaler (environmental footprint)

	Pressurised Metered-Dose Inhalers		inhaler with those of pressurised metered-dose inhalers (pMDIs) to assess their environmental impacts. It sought to identify life cycle hotspots and determine the potential quantitative environmental benefits of using a reusable RespiMat device.				templates, which were then cross-checked for completeness and plausibility. The PCFs were calculated according to the Intergovernmental Panel on Climate Change guidelines and expressed as carbon dioxide equivalent (CO <sub>2</sub> eq) per kilogram, allowing for comparison of greenhouse gas emissions.	
Nishant Kumar, 2014.	How green is my operation theater?	NA	The aim of the study was to ascertain the awareness regarding global warming and the anesthesia practices contributing to it among qualified anesthesiologists in the city of Delhi. The researchers sought to evaluate the level of knowledge about greenhouse gases and their implications in anesthesia practices. The study aimed to identify gaps in knowledge and	India	Formative evaluation	Quantitative	A questionnaire for qualified anesthesiologists in Delhi, which included 19 items related to awareness of the greenhouse effect and anesthesia practices.	The awareness of anesthesiologists in Delhi regarding global warming and the specific anesthesia practices contributing to it.

			practice that could be addressed to enhance the contribution of anesthesiologists to a cleaner environment.					
Hoang Van Minh, 2014	Primary healthcare system capacities for responding to storm and flood-related health problems: a case study from a rural district in central Vietnam.	NR	The aim of the study was to assess the capacities of the primary healthcare system in a rural district of central Vietnam to respond to health issues associated with storms and floods. This assessment was crucial for informing policy-making in Vietnam, particularly in the context of climate change and natural disasters.	Vietnam	Outcome evaluation	Mixed methods study design	<p>The study used both quantitative and qualitative methods for data collection.</p> <p>The qualitative component involved interviews with 12 key informants from the State Ministry of Health and the State Agency for the Control of AIDS, one from each geopolitical</p>	Diverse health care system capacities (matched to health system blocks).

**TABLE 2: INTERVENTION DETAILS BY STUDY**

Study ID	Intervention	Intervention implementation	Stakeholder involvement	Funders	Country	Scale	Setting	Policy context
Adel Zakaria, 2005.	The intervention recommended in the research paper is to set specific reasonable emission limits for medical waste incinerators in Egyptian Environmental law. Additionally, it suggests transferring the existing incinerators out of residential areas. The design of this intervention is based on the findings of the study, which highlighted the incomplete combustion and the potential serious impact of emissions from the incinerators on the surrounding environment.	Limited further details.	Not reported.	Government	Egypt	Facility level.	The interventions studied were delivered in medical waste incinerators located in six hospitals in Alexandria. These incinerators were situated in high-density residential areas, indicating a potential impact on the surrounding environment. The study focused on the emissions and ashes from these incinerators, assessing their effects on public health and the environment.	Study emphasizes the need for establishing reasonable emission limits tailored for medical waste incinerators to protect public health and the environment. The study suggests that the emissions from these incinerators pose a serious threat, particularly as they are located in high-density residential areas, necessitating urgent policy reform.
Adelaide Lusambili, 2023.	The intervention focuses on reducing the impact of heat exposure on pregnant and postpartum	The implementation of the intervention involved a diverse group of participants, including	A total of twenty-one participants engaged in the codesign discussions, contributing their insights and	The CHAMNHA project, which includes the codesign workshop, was funded by	Kenya	Sub-national	The interventions were studied in a rural community setting in Kilifi, Kenya, where	Recognition of heat related risks generally in Kenya.

	women and newborns in Kilifi, Kenya. It includes accessibility to water supplies, social behavior-change campaigns, and education as the top three most sustainable and effective interventions. The design of the intervention is based on qualitative research regarding heat impacts and the specific needs and contexts of the local community in Kilifi.	beneficiaries (micro-level), community influencers (meso-level), and policy makers from various ministries (macro-level). The intervention was implemented through a community codesign workshop that involved diverse participants, including community members, policy makers, and service providers, to discuss and prioritize strategies to reduce heat exposure impacts on pregnant and postpartum women and newborns. The workshop emphasized the importance of contextualizing local setups, considering cultural practices, and ensuring budget flexibility to enhance the likelihood of successful outcomes.	experiences. Six facilitators, trained prior to the workshop, played a crucial role in guiding the discussions and ensuring effective communication among participants. The facilitators included individuals with prior experience in the target community, enhancing the relevance and applicability of the interventions discussed.	multiple organizations: the Natural Environment Research Council, the Research Council of Norway, the Swedish Research Council for Health, Working Life and Welfare, and the National Science Foundation.			participants were drawn from a diverse group including community members, policy makers, and service providers. Discussions focused on various settings such as home environments, health facilities, and the broader community context, particularly in relation to heat exposure and its impact on maternal and neonatal health.	
Anand Bhopal, 2021.	The Climate-Resilient Green	The implementation of	The implementation of the Climate-	Government.	Ethiopia	National	Not reported.	Imperative to address climate

	<p>Economy (CRGE) was launched in Ethiopia in 2011. The CRGE is designed as a multisectoral approach aimed at developing a climate-resilient, middle-income economy within 15 years. It is based on the goals of human and economic development while achieving net-zero growth in carbon emissions, primarily through reversing deforestation and increasing forest cover. The strategy incorporates various sectors, including health, agriculture, transport, and energy, to address the impacts of climate change and promote public health benefits.</p>	<p>interventions within Ethiopia's Climate-Resilient Green Economy (CRGE) strategy has been gradual, with health dimensions being integrated only tentatively over time. Initially, the focus was on establishing the financial basis for the green economy, while health impacts were not prioritized until later years. Health-specific resilience plans were first released between 2014-2015, followed by a broader National Adaptation Plan for Health in 2018. The integration of health adaptations, such as improving public health infrastructure and early warning systems, remains essential for building climate resilience and addressing vulnerabilities in the health sector.</p>	<p>Resilient Green Economy (CRGE) in Ethiopia involved various stakeholders, including government ministries, regional authorities, and health sector representatives. The Ethiopian government played a crucial role, with the Federal Ministry of Health contributing to health-specific resilience plans. Additionally, the CRGE strategy received strong cross-governmental commitment, which has been sustained despite changes in leadership. The health technical subcommittee was established to address health dimensions, although it faced delays in initiating health-specific analyses. The involvement of the public health community and independent reviews also highlighted the need for integrating health into climate policies.</p>					<p>change while promoting low-carbon development. The scoping review identified various national and regional policy documents that outline health impacts and vulnerabilities related to climate change, emphasizing the need for integration of health dimensions into climate policies. Key documents include the CRGE Vision, the National Adaptation Plan, and various sector-specific policies that aim to enhance climate resilience and public health. The review highlights gaps in the integration of health considerations within the CRGE, suggesting that further analysis and updates to regional adaptation plans are necessary for effective implementation.</p>
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<p>Angeli Rawat, 2022</p>	<p>The intervention refers to the community-based health system's response to the drought in Ethiopia, which included organized community groups linked to the health system, effective community health workforce, adaptable human resource structures, training, and strong government leadership with decentralized decision-making.</p>	<p>The intervention was implemented through organized community groups linked with primary health care units. These groups identified problems, conducted surveillance, mobilized communities, and provided health education during the drought. The article confirms that HEWs expanded their responsibilities, including delivering drugs, immunizations, and treating diseases. They also coordinated with international partners, ensuring integrated service delivery. Emphasis was placed on training health workers and communities, preparing them to respond effectively to health needs during the drought. Regular meetings between community groups and the health system facilitated communication,</p>	<p>Stakeholders involved in implementing the intervention include community groups, Health Extension Workers (HEWs), and facility-based health care workers (HCWs).</p>	<p>Health facility.</p>	<p>Ethiopia</p>	<p>Sub-national</p>	<p>The interventions were studied in community-based health systems within drought-affected regions of Ethiopia, specifically in the Somali Region (Sitti Zone), Southern Nations, Nationalities, and Peoples' Region (Hawassa), and Tigray Region (Eastern Zone). These settings included both agrarian and developing regions with limited infrastructure, as well as urban, peri-urban, and rural areas.</p>	<p>The document highlights the need for decentralized decision-making to enhance community resilience during health crises, such as droughts. This approach allows local leaders to allocate resources effectively, addressing the immediate needs of affected populations. The study emphasizes the importance of intersectoral engagement, suggesting that addressing broader population needs, such as food and water security, is essential for building resilience in health systems.</p>
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		improved accountability, and ensured responsiveness.						
Anna M. Stewart-Ibarra, 2019.	The intervention focuses on developing climate services for public health, specifically aimed at managing arboviral diseases such as dengue fever in the Caribbean. It is designed based on the need for an integrated approach that includes research, operations, data sharing, outreach, and education to effectively address the health impacts of climate variability.	The intervention was implemented through a collaborative approach involving health and climate stakeholders from Barbados and Dominica, focusing on the development of climate services for arboviral diseases. The study emphasized the importance of establishing formal collaboration agreements, national committees, and data-sharing protocols to enhance communication and partnerships among involved sectors. Additionally, the intervention aimed to build local capacities and promote the integration of climate services into public health decision-making.	The implementation of the intervention involved stakeholders from both the health and climate sectors in the Caribbean, specifically from the countries of Dominica and Barbados. Key actors included public decision makers and practitioners who participated in interviews and surveys to express their perceptions and needs regarding climate services for arboviruses. Additionally, regional institutions such as the PAHO, CARPHA, and CIMH were identified as significant partners in climate-arbovirus surveillance and control efforts. The involvement of non-governmental organizations, such as the Red Cross, was also noted as part of the collaborative network.	The contexts do not provide specific information regarding who is funding the interventions related to climate services for health in the Caribbean. There is mention of increasing buy-in from decision makers and funding from international development agencies as a strategy proposed by regional climate interviewees, but no specific funding sources are identified. Therefore, the exact details about funding for the intervention itself are not available in the	Barbados and Dominica.	Cross-country	The settings included national vector control, environmental health, and epidemiology offices, as well as workshops organized by health and climate organizations. The study involved a total sample size of 73 individuals, comprising 32 respondents from the health sector and 41 from the climate and health sectors combined. Among the 41 interview participants, 31 were from the health sector and 10 from the climate sector.	The study emphasizes the importance of integrating climate considerations into health sector decision-making through National Adaptation Plans for Climate Change, which could mandate the inclusion of climate in health policies. The Global Framework for Climate Services (GFCS) serves as the policy mechanism guiding the development of these climate services, promoting stakeholder engagement at all levels.

				provided contexts.				
Aravind P. Gandhi, 2023	The intervention in the study is the implementation of virtual Continuing Medical Education (CME) sessions conducted in a digitally sober manner. This approach aims to reduce the carbon footprint associated with online events while promoting awareness of digital sobriety among participants. The concept of digital sobriety is based on strategies to control environmental emissions from online activities, which include minimizing the use of energy-intensive digital resources and reducing unnecessary digital activities.	The implementation of the intervention involved a collaborative effort among several authors and institutions; sessions were conducted by study authors.	Research led.	Not reported.	India	Sub-national	The interventions studied were delivered in a virtual setting due to the COVID-19 pandemic, specifically through online platforms like Zoom for continuing medical education (CMEs). The study assessed the impact of these virtual CMEs on participants' perceptions and practices regarding digital sobriety. The CMEs were organized by the Department of Community Medicine and School of Public Health at PGIMER, Chandigarh, India.	The research highlights the need for policies promoting digital sobriety to mitigate the environmental impact of virtual continuing medical education (CME) events. It emphasizes that while virtual CMEs significantly reduce carbon emissions compared to physical events, awareness and knowledge about digital sobriety among participants remain low. The study suggests that policies should focus on educating public health professionals about the carbon footprint of digital activities and encourage practices that minimize emissions during virtual events. This could include guidelines for efficient use of technology and promoting hybrid models that balance in-person and virtual participation.

Arefeh Mousavi, 2020	The intervention involves developing strategies and action plans derived from the Paris Agreement on climate change, tailored specifically for the health system of Iran. Actions are set out comprehensively and categorized into mitigation, adaptation, research and development, reporting and sharing information, and public education. Mitigation efforts focus on reducing greenhouse gas emissions and improving energy efficiency in health facilities. Adaptation includes enhancing healthcare infrastructure, increasing access to safe water, and developing guidelines for climate-sensitive jobs. Research and development aim to understand	The Delphi process involved multiple rounds of questionnaires, where experts provided feedback and reached consensus on health-related components. The final components were classified into nine categories, focusing on strategies for mitigation and adaptation to climate change impacts on public health. The Ministry of Health and Medical Education (MoHME) was responsible for integrating these strategies into the health system framework.	The implementation of the intervention involved a diverse group of stakeholders, including the Ministry of Health and Medical Education (MoHME) in Iran, which is responsible for public health services and enhancing health standards through education. Collaboration with educational institutions, such as the Ministry of Science, Research, and Technology, was also emphasized to strengthen knowledge transfer related to health and climate change.	Government.	Iran	National	Study focused on national level and understanding the plan formulation.	The policy context is centered around the implementation of the Paris Agreement on climate change, which highlights the importance of public health in addressing climate-related health risks in Iran. The Ministry of Health and Medical Education (MoHME) is responsible for creating comprehensive frameworks to mitigate health impacts from climate change, emphasizing the need for intersectoral collaboration and increased stakeholder awareness. The study aims to provide an evidence-based framework for health policy-making that focuses on reducing greenhouse gas emissions and adapting to the health effects caused by climate change.
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	<p>climate impacts on health and develop adaptation technologies. Reporting involves sharing information and experiences across organizations, while public education raises awareness about climate change's health effects through media, schools, and public conferences.</p>							
Bethuel Ngcamu, 2024.	<p>The intervention involves the solarization of the vaccine cold chain system and Primary Health Care Centers (PHCCs) in Lebanon. This initiative aims to create a sustainable, environmentally viable, and reliable immunization system. It is designed to transition from traditional gas or kerosene-powered refrigerators to</p>	<p>The intervention involved a multi-phase methodology, starting with an inventory assessment of existing cold chain equipment across health facilities, including Primary Health Care Centers (PHCCs) and dispensaries. Over 1,000 solar direct-drive (SDD) refrigerators were procured and installed in more than 800 health facilities, along with solarization of 14 district vaccine</p>	<p>The implementation of the solarization intervention in Lebanon involved UNICEF Lebanon, the Ministry of Public Health (MoPH), and various developmental partners. UNICEF played a crucial role in the procurement and installation of over 1,000 solar direct-drive (SDD) refrigerators across more than 800 health facilities, including 150 Primary Health Care Centers (PHCCs).</p>	NA	Lebanon	Sub-national	<p>The interventions were delivered in various healthcare settings across Lebanon, specifically in 800 health facilities, which include 275 Primary Health Care Centers (PHCCs) and 500 Dispensaries. The solarization efforts targeted both district vaccine stores and central and regional cold rooms,</p>	<p>The policy context surrounding the solarization of the vaccine cold chain system in Lebanon is influenced by the country's severe economic and energy crises, which have significantly impacted healthcare services, particularly vaccine storage. The Ministry of Public Health (MoPH) and UNICEF have adopted a two-level approach to address these challenges, focusing on the solarization of cold chain equipment</p>

	solar direct-drive (SDD) refrigerators, ensuring reliable vaccine storage and reducing vaccine wastage.	stores and central cold rooms. Remote Temperature Monitoring Devices were also installed for real-time monitoring of the vaccine supply chain.					enhancing the entire PHCC network. The study focused on settings where vaccine storage and immunization services were critical, particularly in areas facing challenges due to economic and energy crises.	and Primary Health Care Centers (PHCCs). This initiative aims to enhance the reliability of vaccine storage, reduce operational costs, and build public trust in immunization systems, while also contributing to environmental sustainability.
Bilal Ahmed Khan, 2019.	Solid waste management in urban clinics, which includes composting, material recovery, and incineration of hazardous waste. This integrated design aims to reduce greenhouse gas emissions and is considered practicable for a resource-constrained economy.	Limited further details.	Not reported.	Facility funding.	Pakistan	Sub-national	The interventions studied were delivered in small clinics (n=371) situated in densely populated urban areas of Hyderabad, Pakistan. The study focused on private clinics that primarily provide outpatient services. The clinics included in the study were selected based on their solid waste management	The study emphasizes the need for sound management policies for healthcare waste, particularly in developing countries, to protect the environment and public health. It highlights that small clinics, which contribute significantly to healthcare waste, often lack secure waste management systems compared to larger hospitals, posing environmental threats.

							practices and their contribution to healthcare waste generation.	
Binaya Sapkota, 2014.	The intervention involved the formation of a healthcare waste management committee (HCWMC) at the Government of Nepal Civil Service Hospital, which was responsible for overseeing waste management activities.	The intervention was implemented by forming a Healthcare Waste Management Committee (HCWMC) under the hospital's executive director, responsible for overseeing activities and budget allocation for waste management. Training programs were conducted for health professionals, including doctors, nurses, and waste handlers, focusing on safe healthcare waste management practices, segregation, collection, handling, transportation, treatment, and disposal of waste. The committee developed a waste management policy and standard operating procedures (SOP)	The committee comprised representatives from various departments and units responsible for waste generation within the hospital. Health professionals, including doctors, nurses, and waste handlers, were actively involved in the training programs focused on safe healthcare waste management practices.	Health facility.	Nepal	Facility level.	The interventions were studied in a tertiary care governmental hospital setting, specifically at the Government of Nepal Civil Service Hospital in Kathmandu. The evaluation of waste management practices was conducted in various wards, including gynaecology, obstetrics, paediatrics, medicine, and orthopaedics.	The healthcare waste management (HCWM) policy and standard operating procedures (SOP) were developed and endorsed by the committee, ensuring consistency with national laws and regulations, including the Solid Waste Management Act 2011 and Environmental Protection Act 1997.

		<p>consistent with national and international regulations, and a color-coded system for waste segregation was introduced. Regular monitoring and evaluation were conducted to ensure compliance and sustainability of the improvements.</p>						
<p>Cassandra Thiel, 2017.</p>	<p>The intervention involves a surgical model for cataract surgery that emphasizes resource efficiency, aiming to achieve quality outcomes while minimizing costs and environmental impacts. This model is designed by the Aravind Eye Care System, which focuses on using reusable instruments and materials to reduce waste and emissions associated with cataract surgery. The approach is based on extensive training</p>	<p>The intervention was implemented through a hybrid environmental lifecycle assessment framework that included manual waste audits, purchasing data, and interviews with Aravind staff to quantify environmental emissions associated with cataract surgery. Aravind Eye Care System focused on resource efficiency by using reusable surgical instruments and minimizing the use of single-use materials, which significantly reduced</p>	<p>Midlevel ophthalmic personnel, who were crucial in the assembly-line model of surgery, enhancing efficiency and patient throughput. Overall, the collaborative efforts of healthcare professionals at Aravind were essential for the successful execution of the intervention.</p>	<p>The research was supported by a Fulbright-Nehru Academic and Professional Excellence Award through the United States India Educational Foundation, New Delhi, India. It is unclear if the intervention was supported through the same funding.</p>	<p>India</p>	<p>Facility level.</p>	<p>The interventions were studied in two tertiary care centers of the Aravind Eye Care System located in southern India.</p>	<p>Focus on identifying policy changes which support efficiency such as the use of multiuse ophthalmic pharmaceuticals, which are already practiced by Aravind. The study emphasizes the need for collaboration among healthcare professionals, waste management, and medical device manufacturing industries to promote recycling and reduce waste in ophthalmic surgical supplies.</p>

	of staff and rigid sterilization protocols to ensure short surgical durations and quick turnaround times, thereby decreasing electricity use and associated costs.	environmental impacts. The surgical model emphasized short surgical durations and quick turnaround times, allowing for more surgeries per day while maintaining quality outcomes. Additionally, the implementation of decentralized wastewater treatment systems and solar photovoltaic panels contributed to sustainability efforts.						
Christopher Jack, 2024.	The intervention involves the establishment of an early warning system (EWS) for heat-related health risks in the cities of Abidjan and Johannesburg. This system aims to provide timely alerts for heatwaves and mitigate heat-related morbidity and mortality.	The intervention involved a structured four-step process to establish an early warning system (EWS) for heat-related health risks. Step 1 focused on defining vulnerability and heat hazards, which included quantifying social determinants of health and developing geospatial heat hazard maps. Step 2 integrated various data	The implementation of the intervention involved a collaborative effort from stakeholders locally.	The intervention was developed and supported by the Fogarty International Center, the National Institute of Environmental Health Sciences (NIEHS), and the Office of Strategic Coordination (OSC) of the National Institutes of Health under Award Number	Côte d'Ivoire (specifically in Abidjan) and South Africa (specifically in Johannesburg).	Sub-national .	The interventions were studied in urban settings, specifically in the cities of Abidjan, Cote d'Ivoire, and Johannesburg, South Africa. These cities were selected due to their rapid urbanization and the challenges they face related to heat-related health impacts.	The study aims to inform policy interventions and resource allocation through the creation of a unified 'heat risk index' that consolidates multiple vulnerability factors into a single actionable metric. The research emphasizes the importance of integrating diverse datasets to develop comprehensive health strategies that address the unique challenges faced by urban

		sources to define a heat-health hazard model, combining biomedical data, vulnerability, and heat hazard data from clinical trials. Step 3 involved app co-design with stakeholders to select risk temperature thresholds, while Step 4 tested the EWS by monitoring app performance through metrics like downloads and user feedback.		U54 TW 012083.				populations in African cities.
Cordelia Kwon, 2024.	The intervention is the transition from a paper-based medical record system to an electronic medical record (EMR) system at Aravind Eye Care Systems. This intervention was designed to improve healthcare delivery and reduce environmental emissions associated with medical record-keeping. The design of the EMR system is based on the	The intervention involved the transition from a paper-based medical record system to an electronic medical record (EMR) system at Aravind's Pondicherry location, which was enacted in 2018. The implementation of the EMR system is also informed by life cycle assessment (LCA) methodologies to estimate the environmental impacts of both record-keeping systems. The	The transition to EMRs required immense institutional support, including policy making and cultural change, indicating involvement from various stakeholders within the healthcare system. Additionally, staff members were reassigned to critical tasks after the EMR implementation, highlighting the involvement of hospital personnel in the transition process.	Not reported.	India	Facility level.	The interventions were studied in a high-volume eye care facility located in southern India, specifically at Aravind-Pondicherry. This facility is part of the Aravind Eye Care System, which is the largest conglomerate eye care provider in India, handling over 4 million outpatient visits annually.	Authors note a move towards efficiency, but describe the transition to electronic medical records (EMRs) necessitates significant institutional support, including policy-making and cultural change, particularly in low and middle-income countries (LMICs) where implementation is slower due to high costs. Understanding the environmental implications of EMR systems is crucial for sustainable

	<p>need for efficient data management, enhanced care coordination, and the reduction of clinical errors.</p>	<p>implementation included the purchase of capital equipment such as computers, routers, and other necessary infrastructure, which required careful allocation of production and disposal impacts across their life spans. Staff training was conducted to enhance comfort levels with the EMR system, and processes were developed to ensure efficient use of the technology. The study also noted that some residual practices from the paper system persisted during the initial implementation phase.</p>						<p>healthcare goals, as measures to reduce carbon emissions in LMICs' health systems can combat climate change and provide long-term savings. The study emphasizes the importance of decarbonizing electric grids to reduce the environmental impact of EMRs, highlighting the need for proper sourcing of renewable energy technologies.</p>
<p>Emilia Raila, 2017</p>	<p>The intervention involves mainstreaming the use of cardboard sharps healthcare waste containers instead of plastic sharps healthcare waste containers to reduce black carbon emissions</p>	<p>The intervention involved the use of cardboard sharps healthcare waste (HCW) containers instead of plastic ones during incineration to reduce black carbon (BC) emissions. Researchers</p>	<p>The implementation of the intervention involved researchers who conducted an observational study at the United Nations Mission in Haiti (MINUSTAH) in 2014. The lead researcher had prior experience, having</p>	<p>Not reported.</p>	<p>Haiti</p>	<p>Facility level.</p>	<p>The interventions were studied in a healthcare setting, specifically at the United Nations Mission base in Haiti. The research focused on the incineration of</p>	<p>The research highlights the urgent need for policy formulation to address black carbon (BC) emissions from healthcare waste incineration, particularly emphasizing the transition from</p>

	<p>from healthcare waste incineration. This intervention is based on observational research findings from a study conducted at the UN Peacekeeping Operations (MINUSTAH) in Haiti in 2014.</p>	<p>conducted an observational study at the UN Peacekeeping Operations (MINUSTAH) in Haiti, observing 20 incineration cycles, each lasting 30 minutes, with weights of containers ranging from 3 to 14.6 kg. Independent samples t-tests were utilized to compare smoke emissions, revealing significantly lower emissions from cardboard containers (<math>6.81 \pm 4.79\%</math> smoke) compared to plastic containers (<math>17.77 \pm 8.38\%</math> smoke), indicating the effectiveness of the intervention in reducing harmful emissions.</p>	<p>served for six years at MINUSTAH, which facilitated the handling of technical aspects of hazardous waste. Data collection was performed by two trained smoke readers and the team leader, who was a certified visible emissions reader. The research team also included support from the management of MINUSTAH, particularly the Chief Property Management Section and Property Disposal Team.</p>				<p>healthcare waste, particularly plastic and cardboard sharps containers.</p>	<p>plastic to cardboard sharps containers. This shift is crucial for reducing smoke emissions, which have significant health and climate change implications. The study provides quantitative evidence that can inform policymakers about the detrimental effects of plastic container incineration and the benefits of adopting non-incineration disposal technologies. It underscores the necessity for global healthcare stakeholders to implement better policies to mitigate vulnerabilities associated with BC emissions.</p>
<p>Gabriel Gulis, 2013</p>	<p>The intervention focuses on the development of a clinical waste management policy for Cameroon, which was evaluated through a Health Impact</p>	<p>The intervention involved conducting a Health Impact Assessment (HIA) to evaluate the development of a clinical waste management policy in Cameroon, initiated in May</p>	<p>The implementation of the intervention involved fifteen stakeholders from various portfolios within the health sector in Cameroon. These stakeholders included healthcare providers, administrators,</p>	<p>The funding for the intervention related to the health impact assessment and evaluation of a clinical waste management policy for</p>	<p>Cameroon</p>	<p>Sub-national</p>	<p>The interventions were conducted in the Northwest region of Cameroon, involving healthcare facilities but not limited explicitly</p>	<p>The policy context for clinical waste management in Cameroon is characterized by the absence of a comprehensive clinical waste management policy, which has led to ineffective waste</p>

	Assessment (HIA).	2008. The HIA process identified key risk factors associated with poor clinical waste management, such as cross-contamination and environmental pollution. Recommendations were developed based on stakeholder input and international guidelines, emphasizing the need for strong economic and political support for effective policy implementation. The process aimed to enhance stakeholder awareness and participation in clinical waste management.	infection control professionals, and representatives from non-governmental organizations (NGOs). Their participation was crucial in identifying risk factors associated with poor clinical waste management and in developing recommendations for a clinical waste management policy. The stakeholders expressed a lack of awareness regarding the health impact assessment (HIA) process, highlighting the need for further education and engagement in future initiatives. Overall, their involvement was essential for the success of the HIA process and the proposed policy development.	Cameroon was supported by a travel grant from the Institute of Public Health, University of Southern Denmark.			to hospitals and clinics. The study engaged 15 stakeholders from public and private sectors, including regional health officials, members of local hospital management committees, and NGO representatives involved in waste management.	management practices. Stakeholders emphasized the need for strong economic and political capital to develop and implement a robust clinical waste management policy. The government is urged to engage in consultations with all stakeholders involved in the clinical waste management process to facilitate effective policy development. The integration of Health Impact Assessment (HIA) into policy-making is crucial, as it can address potential health risks associated with clinical waste management. The existing Environmental Impact Assessment (EIA) framework in Cameroon could support the incorporation of HIA into policy processes.
Georgina Morrow, 2014	The intervention focuses on strategies for addressing the	The intervention was implemented through a policy analysis framework	The implementation of the intervention involved a diverse range of actors,	Deutsche Gesellschaft für Internationale	Fiji	Nationa l	Not reported.	The Fiji National Climate Change Policy (NCCP) was endorsed by the

	<p>health impacts of climate change, specifically emphasizing the need for explicit inclusion of health considerations in the Fiji National Climate Change Policy (NCCP) and the National Climate Change Adaptation Strategy (NCCAS). It advocates for a cross-sectoral approach, informed by the Health in All Policies (HiAP) framework, to ensure that health aspects are integrated into climate change and sectoral policies.</p>	<p>that involved analyzing the content, context, and processes surrounding the development of the Fiji National Climate Change Policy (NCCP) and the National Climate Change Adaptation Strategy (NCCAS). This process included extensive stakeholder consultations involving government officials, NGOs, and community representatives to ensure diverse input. Implementation monitored through quarterly progress reports and annual reviews. Recommendations highlighted the necessity for the explicit inclusion of health impacts—specifically dengue fever, diarrheal disease, and malnutrition—in future iterations of these policies to strengthen public health responses.</p>	<p>including representatives from various government ministries, non-governmental organizations (NGOs), development partners, regional agencies, and UN agencies. The Climate Change Unit (CCU) led the policy development and was responsible for monitoring the implementation of the National Climate Change Policy (NCCP). The National Climate Change Country Team (NCCCT) included these representatives and played a crucial role in the policy's approval and oversight. Enhanced coordination among these actors is essential for aligning climate change activities across different sectors and organizations.</p>	<p>Zusammenarbeit (GIZ), which co-funded the development of the National Climate Change Policy (NCCP). Secretariat of the Pacific Community (SPC), which also co-funded the NCCP. The World Bank Asian Development Bank Australian Agency for International Development European Union United Nations Development Programme United States Agency for International Development</p>				<p>cabinet in 2007, providing a framework that outlines the government's position on climate change and directs stakeholder responsibilities. The NCCP was developed through an extensive consultative process involving various stakeholders, including government, NGOs, and community representatives, and it was reviewed in 2011. The policy analysis revealed that health impacts of climate change, such as dengue fever, diarrheal disease, and malnutrition, were mentioned only indirectly in the NCCP and related sectoral policies. Ethnic diversity and historical tensions, which may challenge policy implementation, were mentioned.</p>
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<p>Graça Carvalho, 2023.</p>	<p>The intervention is a free, live-virtual, evidence and competency-based climate and health course targeted toward health risks in the Caribbean. It aims to increase communication about climate and health, equip health professionals with relevant knowledge and skills, and engage them with climate and health initiatives within their communities. The course was designed by a team of authors and is based on the need to address the lack of health workforce capacity to implement climate mitigation and adaptation measures in the Caribbean, as climate change poses significant health risks in the region.</p>	<p>The intervention was implemented through a free, live-virtual, evidence and competency-based climate and health course conducted from March to May, targeting health risks in the Caribbean. The course aimed to enhance communication about climate and health, equip health professionals with relevant knowledge and skills, and engage them with local initiatives. It included a pre-course survey to assess participants' confidence and a post-course survey to evaluate changes in their communication and engagement regarding climate and health. The course was structured into weekly lectures and interactive sessions, utilizing the GCCHE core competencies as its foundation.</p>	<p>Health professionals, including physicians, nurses, public health workers, hospital administrators, health system leaders, health educators, policymakers, environmental health professionals, and government officials. Outreach for participation was conducted through email and social media, targeting both individuals and groups representing these professions. The initiative received support from regional health organizations such as the Caribbean Public Health Agency (CARPHA) and the Healthy Caribbean Coalition (HCC), as well as global organizations focused on health. Course faculty included experts from within the region, ensuring deep engagement and relevant content delivery.</p>	<p>The provided contexts do not contain any information regarding the funding for the intervention.</p>	<p>Caribbean region</p>	<p>Regional</p>	<p>The interventions were delivered in a live-virtual format, utilizing the Zoom platform, which allowed for active participation from health professionals. Participants came from diverse settings, including governmental agencies, academic institutions, hospitals, private practices, and community-based organizations (CBOs). The course targeted health professionals from various health-related fields across the Caribbean region.</p>	<p>The policy context emphasizes the need for health professionals to engage in climate mitigation and adaptation efforts, as their expertise is currently under-utilized in addressing climate change impacts on health. The initiative aligns with national health adaptation plans (H-NAPS) and the United Nations Framework Convention on Climate Change, suggesting that national support is crucial for building capacity within health sectors to effectively respond to climate-related health challenges.</p>
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<p>Helena Wright, 2019.</p>	<p>The intervention refers to the various measures and strategies implemented to address the impacts of climate change in Bangladesh, particularly in sectors such as agriculture, health, and disaster management. These interventions are designed based on the recognition of the vulnerabilities faced by the population due to climate change, including increased temperature, unpredictable rainfall patterns, and the frequency of extreme weather events. Specific interventions include the construction of polders, changes in cropping patterns, early warning systems, and community-based disaster</p>	<p>The intervention in Bangladesh was implemented through the establishment of various policy frameworks and funding entities aimed at addressing climate change. The Bangladesh Climate Change Strategy and Action Plan (BCCSAP) was unveiled in 2008, followed by the creation of the Bangladesh Climate Change Trust Fund (BCCTF) in 2009 and the Bangladesh Climate Change Resilience Fund (BCCRF) in 2010, which provided financial resources for climate adaptation projects. Additionally, the government recognized the role of media in disaster risk communication, as seen in the National Broadcasting Policy of 2014, which facilitated the dissemination of</p>	<p>Various stakeholders were involved, including the Government of Bangladesh, which has established several policy provisions and funding entities since the signing of the Kyoto Protocol. The Bangladesh Climate Change Trust Fund (BCCTF) and the Bangladesh Climate Change Resilience Fund (BCCRF) were created to support these initiatives. Additionally, the International Centre for Climate Change and Development (ICCCAD) and the Gobeshona initiative played significant roles in coordinating research and knowledge sharing among national and international communities. Local communities and traditional knowledge systems were also integrated into media interventions to enhance resilience.</p>	<p>The Infrastructure Development Company Ltd. (IDCOL) plays a significant role in funding interventions for renewable energy development in Bangladesh, particularly through the Solar Home Systems (SHS) program. IDCOL utilizes donor funding from both domestic and international sources to offer various financial measures, including grants, subsidies, concessional loans, and technical services for SHS. The Government of Bangladesh is also involved in funding climate adaptation initiatives, as</p>	<p>Bangladesh</p>	<p>Sub-national</p>	<p>The interventions studied were delivered in various settings, including agricultural sectors, coastal zones, and water management systems in Bangladesh. The settings also encompassed urban areas, particularly in response to flooding challenges in cities like Dhaka. Additionally, the interventions were aimed at addressing the vulnerabilities of specific populations, including women and children, who are disproportionately affected by climate change.</p>	<p>The policy context in Bangladesh regarding climate change has evolved significantly, particularly after the signing of the Kyoto Protocol, which shifted focus from relief-based responses to climate and disaster risk reduction. Key policy documents include the National Adaptation Programme of Action (NAPA) developed in 2005 and revised in 2009, and the Bangladesh Climate Change Strategy and Action Plan (BCCSAP) introduced in 2008. These frameworks emphasize integrated approaches across sectors such as agriculture, forestry, and water resources, aiming to enhance resilience and adaptation to climate impacts. The government has also established various funding mechanisms to support climate initiatives, including</p>
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	management initiatives.	emergency weather bulletins and climate change awareness programs.		evidenced by its financial support for the National Adaptation Plan (NAP) roadmap and various climate finance projects. Additional funding sources include the Bangladesh Climate Change Trust Fund (BCCTF), the Bangladesh Climate Change Resilience Fund (BCCRF), and the Pilot Programme for Climate Resilience (PPCR), which have been established to support climate resilience efforts.				the Bangladesh Climate Change Trust Fund and the Bangladesh Climate Change Resilience Fund.
Idoteyin Ezirim, 2018	The intervention refers to the implementation of the 2013 national healthcare waste management policy in Nigeria,	The intervention for healthcare waste management in Nigeria was implemented through the development of a	The implementation of the intervention was conducted by the Partnership Coordination Department of the National Agency for	The funding for healthcare waste management interventions in Nigeria has been	Nigeria	Sub-national	The interventions studied were delivered in various health facilities across Nigeria,	The policy context of the study revolves around the development and implementation of a national healthcare waste management

	<p>which aimed to establish good waste management practices across health facilities. The intervention is based on the need to improve healthcare waste management practices in Nigeria, particularly in response to the increasing generation of healthcare waste due to enhanced health services.</p>	<p>national healthcare waste management policy and strategic plan in 2013, addressing the previous lack of a framework. An environmental safeguard audit was conducted in 2015 to assess the implementation of this policy across 1,921 health facilities, utilizing a checklist adapted from World Bank guidelines. Over 10,000 health workers trained, the article also mentions training 112 master trainers and distributing health care waste management materials. Compliance was monitored not only through the environmental safeguard audit but also through regular World Bank monitoring visits and facility waste management planning.</p>	<p>the Control of AIDS (NACA) in Nigeria, with technical and financial support from the World Bank. This policy was designed by the Federal Ministry of Health and the Federal Ministry of Environment, in collaboration with the Making Medical Injections Safe (MMIS) project and other partners.</p>	<p>supported by various organizations, including the World Bank, USAID, and the AIDSFree Project. USAID PEPFAR spent over 2 million dollars in eight states through the AIDSFree Project from 2015 to 2016 to address weaknesses in healthcare waste management. The World Bank second HIVAIDS Program Development Project (HPDP2) conducted routine visits to monitor and supervise waste management processes in all 36 states in Nigeria. The Federal Government of Nigeria also provided high-temperature</p>			<p>specifically in tertiary, secondary, and primary health facilities. The study included a total of 1,921 health facilities, which were selected using a probability proportional to size sampling method. The health facilities were spread across the six geopolitical zones of Nigeria.</p>	<p>policy in Nigeria, which was established in 2013 to address the lack of an enabling environment for managing healthcare waste. This policy aims to improve waste segregation, collection, treatment, and disposal practices in health facilities across the country. The study assessed the level of implementation of this policy in 1921 health facilities, revealing significant improvements in waste management practices since its introduction. However, the quality of implementation varied across different states and health facilities, indicating the need for further training and resources.</p>
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				incinerators at tertiary health facilities as part of the intervention.				
Jamiu Oladigbolu, 2021	Hybrid energy system (HES) designed to electrify a rural healthcare facility in Nigeria. This system combines solar PV, wind, diesel generator, and battery storage to provide a reliable power supply.	The intervention was implemented through a techno-economic viability assessment of a hybrid energy system (HES) designed to power a rural healthcare facility in Nigeria. The HES comprised solar PV, wind, diesel generator, and battery components, with the HOMER software utilized for simulation and analysis. Five different system configurations were simulated to evaluate their performance based on parameters such as Net Present Cost (NPC) and Cost of Energy (COE). The optimal configuration identified was a PV/DG/battery system, which demonstrated the lowest NPC of \$16,457 and COE	Not reported.	Not reported.	Nigeria	Facility level.	The interventions studied were delivered in a rural healthcare facility located in Kudu village, Mokwa district of Northern Nigeria. The healthcare center is a government-owned clinic that caters to pregnant women and children, featuring various medical rooms and equipment. The setting is characterized by a lack of reliable electricity, leading to the use of a diesel-powered generator for urgent needs.	The research paper focuses on the techno-economic assessment of hybrid energy systems (HES) for electrifying rural healthcare facilities in Nigeria. It highlights the need for effective policies to support the integration of renewable energy technologies in rural areas, which can enhance healthcare delivery. The study emphasizes that poor component selection has led to high electricity costs in previous assessments, indicating a need for policy frameworks that guide optimal system configurations. Furthermore, the findings suggest that decentralized HES can significantly improve energy access and sustainability, aligning with broader goals of

		of \$0.259/kWh, while also being environmentally friendly with reduced carbon emissions.						rural electrification and public health improvement in Nigeria.
Jelena Božić, 2019.	The intervention discussed in the research paper focuses on assessing and improving indoor air quality (IAQ) in hospitals, particularly through the evaluation of heating, ventilating, and air conditioning (HVAC) systems. It is designed to identify and mitigate the risks of microbiological pathogens in the indoor hospital environment, thereby enhancing the safety and comfort of patients and medical staff. The intervention is based on the understanding that airborne transmission is a significant route for microbial pathogens in indoor	The intervention for improving indoor air quality (IAQ) in hospitals involved several key strategies. These included the removal or modification of pollutant sources and the maintenance of heating, ventilating, and air conditioning (HVAC) systems through periodic cleaning and filter replacement. Additionally, increasing the ventilation rates of HVAC systems was emphasized to meet local building code standards. The study highlighted the importance of consistently implemented control strategies to reduce the risk of bacterial and fungal infections among healthcare workers and immunocompromis	The implementation of the intervention involved healthcare professionals and engineers who are responsible for the design and function of hospitals. Epidemiologists and infection-control professionals played a crucial role, utilizing specialized equipment and techniques to maintain hospital buildings. The study aimed to provide useful information for these professionals to minimize the risk of microbiological pathogens in the indoor hospital environment. Regular air-control measures were emphasized as essential for reducing the dissemination of airborne biological particles in hospitals, highlighting the collaborative effort required for effective	The provided contexts do not contain any information regarding funding for interventions. Therefore, the answer cannot be generated based on the available information.	Bosnia and Herzegovina	Sub-national	The interventions were studied in various clinical settings, including the Clinic of Cardiovascular Diseases, Clinic of Gynaecology and Obstetrics, Pulmonary Clinic, Clinic for Skin and Venereal Diseases, Paediatric Clinic, Neurosurgery Clinic, and the Infectious Diseases Clinic.	The research emphasizes the importance of maintaining indoor air quality (IAQ) in healthcare settings to mitigate the risks of airborne infections, particularly for immunocompromised individuals. Effective control strategies, such as regular maintenance of HVAC systems, including cleaning and filter replacement, are crucial for reducing bacterial and fungal contamination. Additionally, increasing ventilation rates in HVAC systems should comply with local building codes to enhance air quality. The study highlights that environmental parameters, particularly relative humidity, play a significant role in the survival of airborne

	environments, and that regular air-control measures are crucial for reducing airborne biological particles.	ed patients, as airborne microorganisms pose significant health risks in indoor environments.	indoor air quality management.					infectious organisms, underscoring the need for policies that prioritize IAQ management in healthcare facilities.
La De, 2023.	The intervention involves the implementation of two different energy system scenarios aimed at enhancing the resilience of the electric power system during outages. The first scenario utilizes a diesel generator (DG) in conjunction with a utility electric grid (UEG) and local electric load (ELL) to provide energy to key loads during grid disruptions. The second scenario consists of a grid-connected ad hoc microgrid (MG) that incorporates a photovoltaic (PV) system and a battery energy storage (BES) system to supply electricity to key loads during outages. The	The intervention was implemented through the simulation of two distinct energy system scenarios aimed at enhancing the resilience of a local hospital during power outages. The first scenario utilized a diesel generator alongside a utility electric grid and local electric loads to provide energy during disruptions. The second scenario involved a grid-connected ad hoc microgrid that incorporated a photovoltaic (PV) system and a battery energy storage (BES) system to supply electricity to critical loads during outages. The HOMER Grid software was employed to simulate a 3-day	Not described local stakeholders in the hospital.	Not reported.	Indonesia	Facility level.	The interventions studied were delivered in the setting of a local hospital located in Mandalika, Lombok Island, Indonesia. The focus was on providing power to critical loads, specifically the hospital's emergency room, heating, cooling, and lighting systems during power outages.	Not reported.

	design of the intervention is based on the need to strengthen the electrical power system's resilience during extreme weather conditions and natural disasters.	outage, allowing for a comparative analysis of both systems in terms of technology, economics, and environmental impact.						
Leandro Gobbo Braz, 2017	The intervention in the study is the implementation of a scavenging system in operating rooms to reduce the concentrations of waste anesthetic gases, specifically isoflurane and sevoflurane. The scavenging system is designed to minimize occupational exposure to anesthetic gases and environmental contamination in operating rooms. The study is based on the comparison of trace concentrations of inhalational anesthetics in operating rooms with and without a	The intervention involved measuring waste concentrations of isoflurane and sevoflurane in operating rooms (ORs) with and without a central scavenging system. Measurements were taken at three specific locations: near the anesthesiologist, the nursing assistant, and the anesthesia workstation. Data collection occurred at two time points: 30 minutes and 120 minutes after the start of surgery. The study utilized a portable anesthetic gas analyzer to detect real-time concentrations of the anesthetics.	The implementation of the intervention involved a team of researchers and medical professionals.	Not reported.	Brazil	Facility level.	The interventions were studied in a hospital setting with a theater comprising 13 operating rooms (ORs). Out of these, seven ORs did not have a scavenging system, while six had a partial scavenging system. The study was conducted in a public university hospital.	The study highlights the importance of implementing effective anesthetic gas scavenging systems in operating rooms (ORs) to minimize occupational exposure to inhalational anesthetics, which can lead to adverse health effects. It emphasizes that current international guidelines recommend a limit of 2 parts per million (ppm) for exposure to halogenated anesthetics, which is frequently exceeded in ORs without scavenging systems. The findings suggest that frequent monitoring and proper installation of scavenging systems

	central scavenging system.							are essential for compliance with safety standards and to protect healthcare professionals from harmful exposure.
Mustafa Ali, 2016	The intervention refers to the integrated hospital waste management plan that was developed based on the life cycle assessment (LCA) approach to evaluate different waste disposal scenarios. This plan aims to minimize greenhouse gas emissions and promote environmentally friendly waste disposal technologies such as composting and material recovery.	Life cycle assessment conducted to inform the waste management plan. The design of the intervention is based on the findings from the study conducted at the District Head Quarter (DHQ) hospital in Gujranwala, Pakistan, which highlighted the shortcomings in current hospital waste practices and the potential benefits of effective waste segregation.	Hospital personnel.	Not reported.	Pakistan	Facility level.	The interventions studied were delivered in a hospital setting, specifically at the largest hospital in a major city of Pakistan. The study involved a survey conducted from November 2014 to January 2015, focusing on the hospital's waste management practices. The hospital under study had 449 beds and provided treatment to over 4 million people across the district.	The study emphasizes the need for policymakers to formulate an integrated hospital waste management plan, highlighting the importance of waste minimization, segregation, and recycling to reduce greenhouse gas emissions. It identifies serious shortcomings in current hospital waste practices, such as high transportation costs and emissions due to waste being incinerated in another city. The findings can guide behavioral changes among hospital staff and management, promoting safe waste management practices. The research also suggests that effective waste segregation can lead to

								environmentally friendly disposal technologies, contributing to pollution prevention.
Nesli Ciplak,2015.	Diverse scenarios for health care waste management options in the West Black Sea Region discussed and evaluated via an MCDA tool to identify best option.	Scenario 1 (SC1): Incineration-only healthcare waste (HCW) is incinerated at a proposed off-site Zonguldak incinerator, while HCW suitable for alternative treatment (HCW SAT) is treated at the existing Zonguldak Autoclave Unit. Scenario 2 (SC2): All HCW is treated at a proposed central Zonguldak incinerator without internal segregation for incineration-only waste. Scenario 3 (SC3): HCW SAT is treated in situ by autoclave at hospitals or sent to the nearest hospital's on-site autoclave unit, while incineration-only HCW is treated at a region-based incineration unit in Zonguldak.	Not reported.	Facility funding.	Turkey	Sub-national	The interventions studied were delivered in the West Black Sea Region of Turkey, specifically covering three provinces: Zonguldak, Karabuk, and Bartin. The region has an estimated population of 1.5 million and is recognized as a 'Priority Development Area' by the Turkish Ministry of Development.	The policy context emphasizes the need for effective planning and integrated assessment of health care waste (HCW) management technologies in Turkey, particularly in the West Black Sea Region, where significant investments for infrastructure improvement are anticipated. It highlights the importance of incorporating social aspects and public involvement in decision-making processes, as models from both developed and developing countries should consider these factors.

<p>Panin Asirifua Obeng, 2020</p>	<p>The intervention was implemented through the development and enforcement of a comprehensive Water Safety Plan (WSP) by the Community Water and Sanitation Agency (CWSA) in Ghana, aimed at ensuring compliance among small-scale water supply systems. The CWSA intensified regulatory activities to address the high levels of faecal contamination reported in improved water sources. The emphasis was placed on educating community members about the importance of WSPs to enhance accountability and participation in monitoring water quality.</p>	<p>The implementation of the intervention involved several key stakeholders. The Community Water and Sanitation Agency (CWSA) played a crucial role by intensifying regulatory activities to ensure compliance with water safety frameworks. Additionally, the Assemblies collaborated with the CWSA to build the capacity of technical staff at the District Municipal Assemblies for effective water safety planning. Consultants were also expected to assist District Assemblies in preparing formal Water Safety Plans (WSPs) for rural water supply projects. This collaborative effort aimed to enhance the management of small-scale water supply systems and safeguard public health.</p>	<p>The research paper does not provide specific information regarding the duration of any intervention implemented in the Assin Fosu Small Town Water Supply System. It primarily focuses on the assessment of the water safety planning and the quality of water delivered to consumers, along with the methodologies used for sampling and analysis. The study was conducted in 2014, and it mentions the need for ongoing efforts and interventions to improve water safety planning practices, but it does not detail the length or specifics of any interventions that were implemented.</p>	<p>The intervention aims to ensure that small-scale water supply systems in Ghana are managed with comprehensive water safety plans (WSPs) to prevent microbial contamination, which poses significant health risks to consumers. It targets the improvement of water quality management practices to meet relevant quality standards as outlined by the World Health Organization (WHO) and the Ghana Standards Authority (GSA). The expected outcome is to enhance the safety and quality of drinking water delivered to</p>	<p>Ghana</p>	<p>Sub-national</p>	<p>The study involved a sample size of 10 public standpipes, 3 boreholes, and 2 filtration units, which were randomly selected from the Assin Fosu Small Town Water Supply System in Ghana. For each sampling point, 3 samples were taken at monthly intervals, resulting in a total of 30 samples collected over 3 months. Additionally, a fourth round of samples was taken from the standpipes specifically to assess the level of residual chlorine in the distribution network after detecting bacteriological contamination.</p>	<p>The study emphasizes the importance of developing and implementing comprehensive Water Safety Plans (WSPs) to ensure the delivery of safe drinking water in Ghana's small-scale water supply systems. It highlights that existing management practices often fail to comply with recommended schedules for water quality control and monitoring activities, which is critical for public health. The Community Water and Sanitation Agency (CWSA) has intensified regulatory activities to ensure compliance with the Water Safety Framework (WSF) in response to high levels of faecal contamination in water sources. The findings aim to inform current interventions and improve water safety planning.</p>
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		through improved water quality management.		consumers, thereby safeguarding public health and contributing to the achievement of Sustainable Development Goal (SDG) 6.				practices across communities.
Putri Nilam Sari, 2019.	The intervention assessed include the presence of adaptation and presence of early warning systems by Public Health Centers (PHCs).	The study retrospectively assessed the extent to which implementation had taken place; in ideal scenarios this would have involved presence of warning systems at facility levels and ability of staff to respond to climate events.	The local government played a crucial role by conducting health risk assessments and notifying PHCs about potential climate hazards. However additional capacity is needed for the PHCs; collaboration with universities and institutions focused on climate change is essential for analyzing health impacts and training human resources to provide community information.	Government.	Indonesia	Facility level.	Primary care settings in Padang.	Indonesia has established a regulation regarding the Health Sector Adaptation Strategy on the Impact of Climate Change, which mandates the implementation of adaptation measures to mitigate adverse health effects. The Sustainable Development Goals advocate for strengthening adaptive capacity and improving management capacity to address climate change threats effectively.
Rebekka Schnitter, 2018.	The intervention refers to the adaptation measures identified to reduce health risks associated with climate change in	The intervention in Dominica involved a comprehensive climate change and health vulnerability and adaptation assessment, which was led by the Ministry of Health	The implementation of the climate change and health vulnerability and adaptation assessment in Dominica involved various stakeholders,	Government.	Dominica	National	The contexts provided do not specify the types of settings in which the interventions were studied or delivered.	The assessment of climate change and health vulnerability in Dominica highlights the need for a national adaptation plan (HNAP) to address health risks

	<p>Dominica. These measures include actions to enhance existing risk management activities and additional measures for each priority risk area. The adaptation measures were designed based on the findings from the climate change and health vulnerability and adaptation assessment conducted in Dominica.</p>	<p>and Environment with support from various organizations, including PAHO and WHO. Key activities included stakeholder engagement, data collection, and analysis to identify health risks and vulnerable populations. The assessment resulted in the development of adaptation options aimed at enhancing resilience to climate change impacts on health, focusing on vector-borne, foodborne, and waterborne diseases. Programs were implemented to improve public health surveillance, water quality monitoring, and community awareness regarding safe practices.</p>	<p>including officials from different government ministries, environmental health officers, community leaders, and public health officials. The assessment was led by the Dominica Ministry of Health and Environment, with support from international organizations such as the Pan American Health Organization (PAHO), World Health Organization (WHO), World Meteorological Organization (WMO), and Health Canada (HC). An advisory committee, comprising members from the Ministry of Health and Environment and international experts, provided guidance throughout the assessment process.</p>					<p>associated with climate change. The plan was directly informed</p>
<p>Saber Azami-Aghdash, 2023</p>	<p>The intervention consists of 11 designed actions aimed at improving hospital waste management at</p>	<p>The intervention was implemented through a structured action research approach, utilizing the Simmons model,</p>	<p>The implementation of the intervention involved hospital officials and workers from various departments at the Farabi Hospital in</p>	<p>The study is supported by the Tabriz University of Medical Sciences.</p>	<p>Iran</p>	<p>Facility level.</p>	<p>The interventions were delivered in a hospital setting, specifically at the Farabi</p>	<p>Limited reflection on national policy or contextual issues; reinforced importance of waste management.</p>

	<p>the Farabi Hospital in Malekan. Key interventions included staff training, procurement of waste management equipment, and the establishment of waste segregation protocols.</p>	<p>which consists of six major steps. Initially, significant issues in hospital waste management were identified through a checklist and brainstorming sessions with hospital officials and staff. Eleven targeted interventions were designed based on these findings and prioritized using a matrix that considered acceptance, effectiveness, cost, and time. The implementation phase lasted six months, followed by a re-evaluation of waste management performance.</p>	<p>Malekan, Iran. A total of eleven officials and workers participated in the problem-solving brainstorming session, which was crucial for identifying issues and designing interventions. The participants were selected based on their history of responsibility in hospital waste management and their willingness to engage in the study.</p>				<p>Hospital in Malekan City, Iran.</p> <p>The study involved hospital administrators, management, and staff, indicating a focus on the healthcare environment.</p> <p>The action research approach utilized in the study was aimed at addressing waste management issues within the hospital.</p>	
<p>Santosh Singh, 2020</p>	<p>The intervention is the design of a stand-alone hybrid photovoltaic (PV) energy system tailored to meet the daily electrical load demand of a remote healthcare centre located in Madhya Pradesh, India. It is based on an optimal design and sizing</p>	<p>Limited further details.</p>	<p>Hospital personnel.</p>	<p>Unclear hospital assumed.</p>	<p>India</p>	<p>Facility level.</p>	<p>The interventions studied were delivered in a remote healthcare centre located in Bijalpur village, near Indore city of Madhya Pradesh, India.</p>	<p>The research highlights the growing interest in solar photovoltaic (PV) energy systems in remote areas, driven by high solar radiation levels and the increasing competitiveness of PV compared to conventional energy sources. Supportive policies and rapid</p>

	of the hybrid PV energy system, which includes a PV generator, battery, inverter, and diesel generator, according to the load demand							cost reductions have encouraged the adoption of PV systems for various applications, including healthcare. The economic analysis indicates that hybrid PV-diesel-battery systems are more cost-effective and environmentally friendly than traditional diesel systems, suggesting a favorable policy context for renewable energy investments in rural healthcare settings. This aligns with global trends towards sustainable energy solutions in underserved regions.
Stella Hartinger,2024.	The intervention focuses on promoting health-centered climate-resilient development in Latin America, addressing vulnerabilities to climate change while improving health outcomes. It is designed based on scientific evidence and	The implementation of interventions in Latin America involved developing health strategies that incorporate climate and health perspectives, as seen in countries like Argentina, Colombia, Costa Rica, El Salvador, Nicaragua, and Peru, which	The implementation of the intervention involved various stakeholders, including inter-programmatic working groups created within provincial Ministries of Health in Argentina. Public consultations were also a crucial part of the process, allowing participation from different	The Green Climate Fund (GCF) is one of the largest multilateral funding mechanisms under the UNFCCC, providing funding for climate change adaptation projects in Latin America.	Latin America	Cross-country	The contexts provided do not specify the types of settings in which the interventions were studied or delivered.	The policy context emphasizes the urgent need for health-centered climate-resilient development in Latin America, particularly in light of the disparities and vulnerabilities exposed by recent climate events. Engagement with health and climate change by key societal actors is

	<p>collaboration among scientists, policymakers, and citizens to inform responses to health and climate change. The intervention emphasizes the need for decarbonizing energy systems and enhancing climate services for health to effectively prepare for and respond to climate challenges. It aims to facilitate intersectoral collaboration and integrate meteorological information into health services to improve decision-making and resource allocation. The intervention is also based on the recognition of the dual challenge of mitigating greenhouse gas emissions while addressing health risks from climate change.</p>	<p>reported having plans under development. Argentina approved a National Health and Climate Change Strategy in 2023, demonstrating a commitment to integrating health and climate policies. The cooperation between meteorological, climate, and health services was emphasized to enhance decision-making and resource allocation within health sectors. Intersectoral collaboration was identified as crucial for effective implementation, requiring engagement across various sectors such as finance, transport, and agriculture.</p>	<p>groups, sectors, and governmental areas. The initiative was supported by the Green Climate Fund, which financed the Readiness proposal that facilitated the development of action plans on health and climate change. This collaborative approach highlights the importance of political will and financial schemes in advancing health and climate initiatives.</p>	<p>In 2022, the GCF approved approximately US\$486 million for such projects in the region. The GCF's budget for projects aimed at climate change adaptation in Latin America decreased by 16% compared to 2021, with 11.6% of the total approved funding directed towards projects with potential health benefits. Strong and stable climate finance schemes are essential for successful energy transition and climate-resilient development, which can contribute to better health outcomes and societal</p>				<p>essential to drive effective climate action, with many countries incorporating health-related topics in their Nationally Determined Contributions (NDCs). However, adaptation policies remain weak, with only a few countries having developed Health National Adaptation Plans (HNAPs), highlighting the need for robust vulnerability assessments and intersectoral collaboration.</p>
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				prosperity. The funding sources for these interventions must include permanent fiscal commitments and support from multilateral development banks to ensure effective climate-resilient development pathways.				
Tamal Chowdhury, 2021.	The intervention is the design of a stand-alone energy hybrid system for a temporary health care center located in Saint Martin Island, Bangladesh. This system aims to optimize increasing energy demand in response to the pressures faced by health care sectors due to COVID-19.	The intervention involved designing a stand-alone hybrid energy system for a temporary health care center in Saint Martin Island, Bangladesh, utilizing renewable energy sources. The system configuration included photovoltaic (PV) panels, wind turbines, batteries, and a generator, aimed at optimizing energy demand and reducing emissions. Homer Pro	Not reported.	NA	Bangladesh	Facility level.	The interventions studied were delivered in a makeshift health care center located on Saint Martin Island, Bangladesh. This setting was chosen due to the massive pressure on health care sectors caused by the emergence of COVID-19, leading to the establishment of temporary	The research highlights the urgent need for sustainable energy solutions in the healthcare sector, particularly in temporary health care centers established due to the COVID-19 pandemic. It emphasizes the importance of implementing renewable energy-based hybrid systems to meet rising energy demands while minimizing environmental impact. The study suggests

		software was employed to model the system, which demonstrated a Levelized Cost of Energy (LCOE) of \$0.4688, significantly lower than traditional solar home systems.					health care centers. The island has a population of almost six thousand people, primarily engaged in fishing, and has abundant wind and solar resources.	that policymakers should consider the economic and environmental benefits of such systems, as they can significantly reduce CO2 emissions compared to traditional diesel generators. The findings advocate for integrating renewable energy technologies into health care policies to enhance energy access and sustainability in rural areas.
Tanya Zakrison, 2017	The intervention refers to Cuba's disaster response strategy, which is grounded on more than half a century of iterative disaster planning and management. It is designed based on lessons learned from past disaster events, integrating healthcare and public health professionals into the frontline response, and actively engaging	Intervention in Cuba's response to Hurricane Irma was implemented through a well-structured disaster management system developed over decades. This included the integration of healthcare and public health professionals into frontline disaster response, ensuring that medical personnel were available during emergencies. The government	Healthcare professionals, including physicians and allied healthcare personnel, played a central role in the frontline response, ensuring the healthcare system remained functional throughout the disaster. Specialized medical-surgical brigades were activated, with many preemptively dispatched to remote areas to provide medical care. The Cuban population was also actively	Government.	Cuba	National	The study is set in Cuba, which was significantly impacted by Hurricane Irma in 2017, affecting twelve of its fifteen provinces and 90 percent of the population.	The policy context surrounding Cuba's response to Hurricane Irma is rooted in over five decades of disaster planning and management strategies, which emphasize self-sufficiency and resilience. The establishment of the Risk Reduction Management Center (RRMC) in 2005, in collaboration with the UNDP, exemplifies Cuba's commitment to scientific evidence-

	<p>the public in disaster preparedness. The intervention incorporates technology into disaster risk reduction and infuses scientific approaches into risk planning.</p>	<p>engaged citizens in disaster preparedness training, focusing on family-level readiness and community participation in local mitigation committees. Technological advancements were incorporated, such as the installation of micro-generators and emergency backup systems to maintain power for critical infrastructure. Additionally, systematic strategies for risk mapping and community drills were established to enhance resilience.</p>	<p>engaged in disaster preparedness and response, sharing responsibilities across the community.</p>					<p>based risk management and community preparedness. Cuba's national initiative, 'The Life Task to Face Climate Change,' prioritizes climate change adaptation and disaster risk reduction, reflecting the urgency of addressing increasing storm intensity. The Cuban Civil Defense System plays a crucial role in disaster preparedness, ensuring healthcare professionals are integrated into emergency response efforts.</p>
<p>Wesam H. Beitelmal, 2022</p>	<p>The intervention involves the implementation of hybrid energy systems to address the energy needs of the Murzuq health clinic during the COVID-19 pandemic. Renewable energy sources, including photovoltaic (PV)</p>	<p>The intervention was implemented through a techno-economic assessment of three different hybrid energy systems, specifically PV/Battery, PV/Generator/Battery, and Generator-only configurations. The study measured</p>	<p>Research led.</p>	<p>Unclear hospital assumed.</p>	<p>Libya</p>	<p>Facility level.</p>	<p>The interventions were implemented in a health clinic located in Murzuq, a rural area in southern Libya.</p> <p>The study focused on resolving energy challenges in</p>	<p>Libya faces chronic power shortages, particularly in rural areas like Murzuq, due to prolonged conflict and damaged infrastructure, necessitating alternative energy solutions.</p> <p>The COVID-19 pandemic increased the operational</p>

	<p>and battery-based hybrid systems are the subject of study. The intervention aims to mitigate the increased energy demand caused by extended clinic hours and the need for additional medical equipment during the pandemic, ensuring a sustainable and stable electricity supply for the clinic.</p>	<p>the clinic's electricity demand before and during the COVID-19 pandemic to capture the increased energy needs. Through the simulation, the photovoltaic/battery hybrid energy system was identified as the most viable option, providing a sustainable and cost-effective energy supply with reduced carbon emissions.</p>					<p>the clinic, exacerbated during the COVID-19 pandemic.</p> <p>The clinic's operations expanded due to increased working hours and patient volume, resulting in higher energy demands.</p> <p>Murzuq's location was identified as advantageous for utilizing renewable energy, given its high solar energy potential.</p>	<p>demands of health clinics, leading to extended working hours and a greater need for reliable electricity.</p> <p>Policymakers are urged to invest in renewable energy systems to replace unreliable fossil fuel-based generators, promoting energy access, sustainability, and economic feasibility in underserved communities.</p>
<p>Yizhao Sun. 2017.</p>	<p>The intervention refers to the design strategies for the lobby of outpatient departments in hospital buildings, aimed at improving the healthcare environment while reducing energy consumption.</p>	<p>The intervention was implemented through a two-stage methodology focusing on both space-design and facade-design of hospital lobbies. In the first stage, simulations were conducted to analyze how different positions, orientations, and heights of the lobby affect energy</p>	<p>Research led.</p>	<p>Research led.</p>	<p>China</p>	<p>Facility level.</p>	<p>The interventions studied were delivered in the context of outpatient department lobby designs within hospital buildings. The specific setting for the study was in cold climate regions of China, with</p>	<p>Not reported.</p>

		consumption and daylight availability. In the second stage, the impact of varying window-wall and skylight ratios on energy consumption and daylight performance was examined. The simulations utilized climatic data from Tianjin, China, and aimed to identify effective design strategies that enhance the healthcare environment while minimizing energy consumption. This comprehensive approach ensured a thorough investigation of design factors.					Tianjin being the example used for investigation. The focus was on the thermal and daylighting environment of current hospitals in Tianjin.	
Shuang Zhong, 2014.	The intervention refers to the framework for evaluating hospital disaster resilience, which was developed based on existing literature and through a three-round Modified-Delphi consultation with key experts in China.	Assessment implementation is the intervention.	Research led.	Research led.	China	Sub-national	The study was conducted in Shandong Province, China, focusing on tertiary hospitals, which are classified into Grade A, B, and C based on their service levels, size, medical technology, and quality of care. A total of 50	The study highlights the importance of integrating local, provincial, and national systems to enhance disaster resilience in hospitals, particularly in the context of China, which faces various types of disasters. It emphasizes that health systems, including tertiary

							<p>tertiary hospitals were selected using stratified random sampling, comprising 28 Grade A, 20 Grade B, and 2 Grade C hospitals. The survey was carried out between January 2013 and June 2013, with questionnaires sent to hospitals accompanied by an official letter from the provincial health department.</p>	<p>hospitals, must be included in disaster planning at all levels to improve emergency response capabilities. The findings suggest that a cohesive approach among hospitals is necessary for effective disaster management, indicating a need for policy development that fosters collaboration and resource sharing among healthcare facilities. The research also points out the variability in disaster resilience arrangements, which can inform health authorities and hospital managers in policy formulation.</p>
Saurabh Gupta, 2006	Biomedical waste management practices in the hospital, including treatment of solids.	Assessment implementation is the intervention.	Research led.	Research led.	India	Facility level.	<p>The study is set in Balrampur Hospital, located in Lucknow, North India, which is one of the oldest and largest government healthcare</p>	<p>The policy context for biomedical waste management in India is primarily governed by the 'Biomedical Waste (Management and Handling) Rules, 1998', which mandates the segregation, collection, and</p>

							<p>establishments in the region. The hospital has a capacity of 656 beds, providing various medical facilities and treating a diverse population, including ministers and top bureaucrats. The research focuses on the hospital's biomedical waste management practices, highlighting significant issues such as the mixing of infectious and non-infectious waste and the lack of proper disposal methods.</p>	<p>proper disposal of biomedical waste into ten categories, each with designated treatment methods such as incineration and autoclaving. The enforcement of these regulations has been inadequate, with the State Pollution Control Board failing to hold healthcare establishments accountable for safe waste management practices. Recent developments include the adoption of the 'Biomedical Waste Management Rules, 2000' in Uttar Pradesh, aimed at addressing the lack of treatment facilities for biomedical waste.</p>
Philip Koka,2018.	Disaster preparedness and response in Tanzanian regional hospitals.	Assessment implementation is the intervention.	Research led.	Research led.	Tanzania	Sub-national	<p>Tanzania was classified as a low-income country with a population of approximately 45 million, where over 80% of the population resided in rural</p>	<p>The policy context for disaster management in Tanzania is governed by the Disaster Relief Coordination Act and the National Guideline and Policy for disasters, which are overseen by the</p>

							<p>areas. The regional hospitals are expected to provide a broader range of care and specialty services compared to district facilities, serving as referral hospitals for their respective regions.</p>	<p>disaster management department in the Prime Minister's office. The health system in Tanzania operates on a referral basis, starting from dispensaries to regional hospitals and tertiary referral hospitals, highlighting the structured approach to healthcare delivery.</p>
Malcolm Araos, 2015	<p>The intervention refers to public health adaptation initiatives that address the health risks posed by climate change in urban areas, which include direct changes in management or behavior.</p>	<p>The study employed systematic data collection methods to analyze health adaptation planning in urban municipalities larger than 1 million people. Climate change planning documents from municipalities were utilized as the data source for identifying and characterizing adaptation initiatives. A systematic classification method was designed to quantitatively</p>	<p>The study indicates that researchers from McGill University, alongside stakeholders in urban public health, were involved in assessing the public health adaptation initiatives. The research focused on the systematic analysis of municipal climate change adaptation planning documents without detailing specific individuals or groups implementing the interventions.</p>	Research led.	Cross-country	Cross-country	<p>The study assessed public health adaptation initiatives delivered in urban settings, specifically focusing on municipalities defined by the United Nations as having populations larger than 1 million people. The research focused on 401 urban areas globally, indicating a diverse range of urban environments.</p>	<p>The policy context surrounding public health adaptation to climate change in urban areas reveals significant gaps in planning and implementation. Only 10% of the 401 urban areas studied reported any public health adaptation initiatives, primarily focusing on management and behavior changes rather than long-term infrastructure investments.</p> <p>There is a notable absence of monitoring, reporting, and</p>

		retrieve data related to health adaptation initiatives from planning documents, focusing on variables such as health risk targeted and adaptation type.						<p>evaluation (MRE) of adaptation efforts, which are essential for assessing effectiveness and ensuring accountability.</p> <p>Furthermore, adaptation initiatives are frequently underreported, especially in the Global South, indicating lower prioritization and limited capacity for adaptation.</p>
Manar Aslan, 2019	Waste management systems utilised in hospitals and their efficacy.	Assessment implementation is the intervention.	Research led.	Research led.	Turkey	Sub-national	The interventions studied were delivered in public hospitals located in Konya, Turkey.	<p>The research emphasizes the need for government leaders to prioritize health care as a strategic obligation in hospital construction and operation. It suggests that regulations should be implemented to mitigate the negative environmental impacts of hospitals, from design to construction and during operation. The World Health Organization (WHO) has identified essential elements</p>

								for climate-friendly hospitals, including energy efficiency, green building design, alternative energy production, sustainable food sourcing, waste management, and water conservation. The study advocates for hospital management to adopt environmentally friendly strategies to enhance sustainability and reduce costs while improving health care services.
Manzurul Hassan, 2008.	The intervention involves training relevant personnel of different Health Care Establishments (HCE) for increasing awareness and proper in-house management of medical wastes. This initiative is based on the need for public awareness campaigns to ensure proper management of medical waste,	The intervention was implemented by PRISM Bangladesh, which focused on training personnel from various Health Care Establishments (HCE) to enhance awareness and improve in-house management of medical wastes. A public awareness campaign was initiated to promote proper medical waste management practices, particularly	PRISM Bangladesh	Research led.	Bangladesh	Sub-national	The study was conducted in Dhaka City, Bangladesh, specifically focusing on two municipal administrative wards, namely Ward 49 (Dhanmondi) and Ward 56. Dhanmondi was chosen due to its high concentration of health care establishments (HCE), which have been increasing	There is currently no national policy on medical waste management in Bangladesh, which hampers effective handling of medical waste. Existing laws are outdated, characterized by low or nonexistent penalties for offenders, necessitating the formulation of new, stricter regulations. A recently proposed law aims to address medical waste management, but it

	particularly regarding the reuse of contaminated syringes and needles.	concerning the reuse of contaminated sharps.					steadily since the area was zoned for commercial establishments in 1972. The research involved a total of 60 out of 68 HCE in the study area, which included hospitals, clinics, and diagnostic centers.	requires prompt adoption and enforcement. The lack of awareness and appropriate policies contributes significantly to the improper management of medical waste in Dhaka City. Improved coordination between the Department of Environment and the Dhaka City Corporation is essential for effective waste management.
Jessica Farley, 2017	The intervention refers to the assessment of flood preparedness in healthcare facilities in Eastern Province, Sri Lanka. It was designed by JMF based on a topic suggestion from the WHO Regional and Country offices.	Assessment implementation is the intervention.	Research led.	Research led.	Sri Lanka	Sub-national	The study was conducted in the Trincomalee District, located in the Eastern Province of Sri Lanka, which is known for its vulnerability to floods and other hydro-meteorological disasters. It involved public healthcare facilities, including curative health facilities and	The health services in Sri Lanka operate under the Ministry of Health, Nutrition, and Indigenous Medicine, which is responsible for population health protection and promotion, policy guideline setting, and management of healthcare institutions. The National Climate Change Adaptation Strategy acknowledges the link between climate change and health, emphasizing the

							<p>Medical Offices of Health, to assess their functional preparedness for flood events and general disaster preparedness. The research included a total of 31 government healthcare facilities, which comprised two general hospitals, three base hospitals, eleven divisional hospitals, and fifteen primary care units. The study utilized a mixed methods approach, incorporating both structured questionnaires and in-depth interviews with healthcare professionals.</p>	<p>need for climate change adaptation across sectors. Despite existing policies, there is a gap in effective communication of climate change information to peripheral public healthcare levels, indicating a need for improved dissemination channels. Investments in workforce and disaster training are essential adaptation strategies to enhance disaster response and climate change mitigation.</p>
Hoang Van Minh, 2014	The intervention refers to the activities implemented for storm and flood-related health problems at local health facilities,	Assessment implementation is the intervention.	Research led.	Research led.	Vietnam.	Sub-national	<p>The study was conducted in PhuVang district, located in Thua Thien-Hue province, Vietnam, which is a rural area</p>	<p>National policies for addressing storm and flood-related health issues exist but require enhancement to effectively translate into local actions</p>

	<p>which include health promotion activities aimed at improving local knowledge about these issues. The design of the intervention is based on the need to address health risks associated with storms and floods, including prevention and first-aid solutions, water, sanitation, nutrition issues, and disinfectant techniques after hazardous events.</p>						<p>frequently affected by storms and floods. The district covers an area of 280 km<sup>2</sup> and had a population of 171,363 as of 2010. The primary healthcare system in this district includes a district hospital, a district health center, two inter-communal polyclinics, 20 commune health centers, and a network of village health workers.</p>	<p>within rural communities. District emergency plans primarily emphasize disaster response rather than preventive measures, lacking clarity on the role of primary healthcare and coordination among sectors. The legal framework supporting the primary healthcare system's response to climate change and disaster-related health issues is deemed inadequate by a significant portion of respondents. Key documents guiding disaster risk reduction include the Ordinance on Prevention and Control of Floods and Storms and the National Strategy for Natural Disaster Prevention.</p>
Amal Brown, 2016.	<p>The intervention focuses on building the resilience of the health system in Ethiopia to withstand and recover from external shocks, such as drought,</p>	<p>Assessment implementation is the intervention.</p>	<p>UNICEF played a crucial role in procuring and distributing nutrition supplies, while the government facilitated their distribution to lower-level health tiers. A strong nutrition</p>	<p>Research led.</p>	<p>Ethiopia</p>	<p>Sub-national</p>	<p>The study is set in Ethiopia, specifically focusing on the impact of the El Niño drought that occurred in 2015 and 2016.</p>	<p>The policy context emphasizes the integration of nutrition interventions into emergency responses, particularly in Ethiopia, where malnutrition is</p>

	<p>particularly in the context of the El Niño phenomenon. It is based on strengthening the absorptive, adaptive, and transformative capacities of individuals, households, communities, and the health system as a whole. The intervention includes the integration of severe acute malnutrition (SAM) treatment into routine health services and the scale-up of the national Community Based Nutrition (CBN) programme. The design of the intervention is attributed to UNICEF, which has been actively involved in coordinating emergency nutrition responses and integrating nutrition commodities into</p>		<p>information system was established for risk-informed planning, enabling real-time monitoring and adaptive actions. Community-Based Nutrition (CBN) programs were integrated into health services, enhancing the identification and treatment of severe acute malnutrition (SAM) cases.</p>					<p>prevalent due to external shocks like drought. The Federal Ministry of Health (FMOH) has recognized the importance of strengthening the health system's resilience by incorporating community-based nutrition programs and severe acute malnutrition (SAM) management into routine health services. Additionally, the introduction of Infant and Young Child Feeding in Emergencies (IYCF-E) highlights the need for training health extension workers to support optimal feeding practices during crises. Overall, policies aim to enhance absorptive, adaptive, and transformative capacities within communities and the health system.</p>
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	the government supply chain.							
Natalia Bellan, 2012	The intervention focuses on the management of solid waste from medications and relevant environmental regulations.	The intervention aims to establish a medication waste disposal management program to ensure correct handling procedures and define responsibilities in various actions. This is intended to reduce possible sanitary risks to public health. It seeks to minimize the generation of medication waste through discussions involving various sectors of society, focusing on environmental education and public policies. The intervention also aims to promote technological research that lowers costs and environmental impact, ultimately improving the quality of life for the public. Additionally, it emphasizes the importance of participation from society, governmental	The implementation of the intervention involved various stakeholders, including governmental agencies, society, and the entire productive chain. The participation of these groups is fundamental as they act as protagonists in the context of medication waste management. The National Solid Waste Policy's Inter-ministerial Committee, established by Decree No. 7.404 of 2010, plays a crucial role in coordinating efforts for the implementation of Reverse Logistics Systems. Additionally, the National Sanitary Surveillance Agency (ANVISA) is responsible for overseeing the regulatory framework and ensuring compliance with health and safety standards related to medication disposal.	Research led.	Brazil	National	Not reported.	The policy context regarding medication waste disposal in Brazil is primarily governed by Law No. 12.305, instituted in 2010, which established the National Solid Waste Policy. This law was further regulated by Decree No. 7.404, creating an Inter-ministerial Committee for implementing Reverse Logistics Systems. However, there is no specific legislation addressing the final disposal of medications, leading to indirect management through the Ministry of Health and the Ministry of the Environment. The WHO has also provided guidelines for safe disposal of unwanted pharmaceuticals, emphasizing the need for organized policies.

		agencies, and the entire productive chain in achieving these outcomes.						
Christovam Barcellos, 2016	The intervention is the creation of a climate health observatory able to advise Brazil's climate and health initiatives.	The observatory is a platform designed to facilitate access to health indicators and climate-related data through a user-friendly interface. Users can interact with the platform via a map interface or by selecting the "Indicators" tab, which lists available health metrics. Additionally, the "Sentinel Sites" tab provides information on three initial monitoring locations. The platform allows users to execute complex queries across multiple geographically distributed sites without requiring technical expertise, and it generates semi-qualitative graphs and maps. This system supports research and development on climate and	Secretariat of Health Surveillance, Rede Clima network, CNPq Brazil	Research led.	Brazil	Sub-national	Not applicable	Observatories are noted as a potential tool to meet decision-makers needs for actionable climate and health data.

		<p>environmental changes and their health effects by providing data access.</p> <p>Furthermore, it encourages active participation from civil society and citizens in discussions about climate change and its impact on health and health systems.</p>						
Jerome Lock-Wah-Hoon, 2020	Vector borne disease surveillance systems in Beijing.	<p>Implementation of CBD surveillance system: surveillance feeds in messages to public health authorities; information can also come from other signals (e.g. legislation, workforce, etc.) - Public health authorities then decide on response, monitoring is then considered part of surveillance and feeds back to decision-making.</p>	<p>Stakeholders involved in the VBD range from national to provincial to district level; multiple responsibility areas are covered - e.g. infectious diseases, endemic diseases, hospital care, disease control, IPC, vector control.</p>	Explore VBD surveillance practice and system flexibility	Beijing, China	Sub-national	Beijing, China specifically and public health experts in VBD surveillance.	Beijing is at risk of becoming major epicentre for climate induced VBD outbreaks.
Lorena Pasquini, 2015.	The intervention refers to the actions taken by municipalities to address climate change adaptation and	Intervention was implemented through the establishment of a Flood and Storms Planning Task Team, which is a	Collaboration with third-party partners was essential for sourcing adaptation funding and conducting relevant research to inform	Government funding	South Africa	Sub-national	The study is set in the Western Cape Province of South Africa, focusing on two municipalities:	The policy context for climate change adaptation in municipalities emphasizes the need for local governments to

	<p>disaster risk reduction, which include implementing weather early-warning systems, flood risk reduction measures, and establishing disaster management plans. These interventions are designed based on the recognition of the costly impacts of climate change and the need for proactive measures to mitigate these effects. They are informed by the experiences and challenges faced by municipalities, particularly in the context of extreme weather events.</p>	<p>multi-disciplinary team formed to manage flood risk reduction and response measures, initiated in 2008. Regular maintenance and upgrading of storm-water drainage systems were also part of the intervention strategies to mitigate flood risks. Additionally, the municipalities engaged in awareness-raising campaigns among communities to promote adaptation measures.</p>	<p>local climate policies.</p>				<p>the City of Cape Town (CCT) and Hessequa.</p>	<p>integrate climate considerations into their planning and management practices. This integration is crucial as municipalities are often the most directly responsible for addressing climate impacts at the local level. Political stability and the presence of dedicated environmental champions within local government were noted as essential for effective policy implementation.</p>
<p>Rengaraj Venkatesh, 2015</p>	<p>The intervention discussed in the research paper is cataract surgery, specifically comparing different techniques such as manual small-incision cataract surgery (MSICS), phacoemulsificati</p>	<p>NA</p>	<p>NA</p>	<p>NR</p>	<p>NR</p>	<p>Cross-country</p>	<p>The research emphasizes the cost-effectiveness of these surgical methods in various settings, particularly contrasting resource-rich environments</p>	<p>Limited description of policy context, but study emphasizes that the generalizability of carbon footprint and cost data is limited due to variations in healthcare delivery across different regions.</p>

	on, and femtosecond laser-assisted cataract surgery. The design of the intervention is based on the need to improve visual outcomes while also considering the environmental impact and cost-effectiveness of the surgical techniques.						with resource-poor ones. The study also references a specific analysis conducted at the University Hospital of Wales, Cardiff, estimating the carbon footprint of cataract surgery.	
Sabiha-Javied,2008.	Management of medical waste in hospitals of Islamabad and Rawalpindi, Pakistan	NA	Hospital employees	Health facility.	Pakistan	Facility level	The study was conducted in hospitals located in Islamabad and Rawalpindi, Pakistan, focusing on the management of medical waste through incineration.	Noted lack of local legislative limits or standards concerning heavy metals in incinerated ash in Pakistan, indicating a significant gap in environmental policy.
Busisiwe Shezi, 2019.	The intervention primarily involves various climate change adaptation measures aimed at improving public health and community resilience.	Actions included scaling up the planting of trees for shade during heat waves, promoting vegetable gardening, instituting community-based early warning systems for adverse weather events, and raising standards for storm water drainage.	NA	Government funding	South Africa	Cross-country	The study was conducted at a conference for Environmental Health Practitioners (EHPs) hosted by the South African Institute of Environmental Health in Cape Town in January 2017.	The study highlights the importance of having a climate change and health policy or strategy within Environmental Health Practitioner (EHP) departments, with 41% of respondents indicating the existence of such policies in the context of the study.

		The intervention aims to enhance the role of Environmental Health Practitioners (EHPs) in helping communities adapt to the health impacts of climate change, particularly among vulnerable populations.						
Verena Rauchenwald,2020.	The intervention is a novel photochemical anesthetic waste gas destruction system designed to reduce the release of waste anesthetic gases into the atmosphere. It is based on a cylindrical, stainless steel gas-phase photochemical reactor that utilizes ultraviolet light to destroy halogenated anesthetic gases. The design was developed by a team of researchers from various institutions, including the University of Copenhagen and	The intervention involved the use of a cylindrical, stainless steel gas-phase photochemical reactor designed to destroy waste anesthetic gases. The reactor was equipped with a 240 W Amalgam Quartz Ultraviolet Lamp that emitted light at 254 and 185 nm, facilitating the breakdown of anesthetic agents. Nitrous oxide, sevoflurane, and desflurane were delivered to the reactor inlet using a clinical anesthesia machine, and the outlet was connected to a scavenging system for gas analysis. Inlet and outlet concentrations	NA	Research funding	NR	Facility level	The study was conducted in a clinical setting, specifically utilizing a clinical anesthesia machine to deliver nitrous oxide, sevoflurane, and desflurane to the reactor inlet.	Study uses references to global standards and HIC estimates. For example, the health care sector is a significant contributor to greenhouse gas emissions, accounting for nearly 10% of national emissions in the US, with anesthetic gases representing a notable portion of this impact. The UK National Health Service identified anesthetic gases as contributing 2.5% to England's carbon footprint, highlighting the need for effective emission reduction strategies. Study notes the Kyoto Protocol regulates nitrous oxide, one of

	the University of Utah.	were measured using infrared gas analyzers to evaluate the removal efficiencies of the anesthetic gases.						the main greenhouse gases, emphasizing the importance of reducing emissions from anesthetic practices.
E Weimann, 2017	The intervention involves various projects initiated by Groote Schuur Hospital (GSH) to reduce its carbon footprint, energy consumption, and hazardous waste, while promoting sustainability in a resource-constrained public healthcare setting. The intervention is designed based on the principles of the Global Green and Healthy Hospitals Initiative, which aims to lead the way towards low-carbon healthcare. It includes measures such as reducing the amount of general waste, increasing recycling, replacing polystyrene products with recyclable	The intervention at Groote Schuur Hospital (GSH) involved a series of projects aimed at reducing the hospital's carbon footprint and waste. This included the implementation of a polystyrene-free policy, where polystyrene cups and packaging were replaced with Forest Stewardship Council (FSC) recyclable paper products. Active change management processes were utilized to overcome resistance to these changes, involving meetings and presentations to explain the benefits of the new biodegradable materials. The hospital also engaged local farmers to collect food waste for pig	The intervention is supported by political leadership, government policies, and financial funding to effectively tackle the challenges posed by climate change on healthcare.	Facility and government funding	South Africa	Facility level	The study is set in Groote Schuur Hospital (GSH), located in Cape Town, South Africa, which is recognized as the leading academic hospital in Africa.	The policy context emphasizes the need for healthcare systems to adopt strategies that mitigate climate change impacts while enhancing public health outcomes. It highlights the importance of transitioning to low-carbon health systems, which can reduce greenhouse gas emissions and promote sustainable practices. The South African government has initiated analyses under the Long Term Adaptation Scenarios process to address climate change's effects on health.

	alternatives, and collaborating with local farmers to manage food waste.	feed, further promoting sustainability. Continuous monitoring of energy consumption and waste generation was established to track progress and encourage accountability.						
Michaela Ha,2019	The intervention is the reusable Respimat Soft Mist inhaler, which is designed to be more convenient for patients and to reduce environmental impact compared to traditional pressurised metered-dose inhalers (pMDIs). The design of the reusable Respimat is based on the performance and usability of the original disposable Respimat device, with updates aimed at enhancing patient-friendliness.	The intervention involved comparing the product carbon footprint (PCF) of the Respimat inhalers (both disposable and reusable) with that of pressurised metered-dose inhalers (pMDIs). The study assessed the PCFs of four inhalation products over their entire life cycle, focusing on their environmental impact, particularly in terms of global warming potential (GWP). The reusable Respimat was designed to be more convenient for patients while reducing environmental impact. Data were collected on usage patterns, with	NA	NR	NR	Unclear	Unclear	The study highlights the environmental impact of inhalers, particularly focusing on the need for low global warming potential (GWP) alternatives. The findings are applied to the UK specifically as exemplar but data seems to be applicable to other settings as per discussion in paper.

		specific actuations per day for each inhaler type, to accurately evaluate the PCF and identify life cycle hotspots.						
Nishant Kumar, 2014.	The intervention in the study focuses on anesthesia practices in Delhi; the research used a questionnaire designed to assess the awareness regarding global warming and the anesthesia practices contributing to it among qualified anesthesiologists in Delhi. The study seeks to identify actions and attitudes of these health professionals towards anesthesia practice in the city.	Anesthesia practice and gas use.	NA	Facility and government funding	India	Sub-national	The study was conducted in the city of Delhi, India, targeting qualified anesthesiologists, including consultants and senior residents.	The research highlights the need for improved awareness and resources among anesthesiologists regarding the environmental impact of their practices, particularly concerning greenhouse gases. While a significant majority of respondents were aware of the greenhouse effect, only a small percentage could identify all relevant greenhouse gases, indicating a gap in knowledge that could inform policy development. The study suggests that policies should focus on enhancing education about the environmental implications of anesthetic agents and promoting practices such as total intravenous

								anesthesia (TIVA) and low-flow techniques to mitigate pollution. This could lead to a more environmentally conscious approach within the medical community.
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## Appendix 4: Risk of bias assessments

**Table 1: Risk of bias assessment (quantitative studies)**

Study ID	Situating evidence	Clear question and hypothesis	Appropriate link to raw data	Risk of funding source influencing findings	Clarity of research design	Clarity of research method	Appropriateness of design and method	Situating findings in context	Overall ROB
Jamiu Oladigbolu, 2021	+	+	-	+	?	+	-	?	Moderate
Mustafa Ali, 2016	+	+	-	+	+	+	-	?	Moderate
La De, 2023.	+	+	+	+	-	+	-	?	Moderate
Bethuel Ngcamu, 2024.	+	+	-	+	+	+	-	+	Low
Yizhao Sun. 2017.	+	+	-	+	-	+	-	?	High
Helena Wright, 2019. (a book)	+	+	-	+	-	+	-	?	High
Tamal Chowdhury, 2021.	+	+	-	+	-	+	-	+	High
Santosh Singh,2020	+	?	-	+	-	+	-	-	High
Bilal Ahmed Khan, 2019.	+	+	-	+	-	+	-	+	High
Manar Aslan, 2019	+	+	-	+	+	+	-	+	Moderate
Nesli Ciplak,2015.	+	+	-	+	-	+	+	+	Moderate
Adel Zakaria, 2005.	+	+	-	+	-	+	-	?	High
Leandro Gobbo Braz, 2017	+	+	-	+	-	+	-	+	High
Wesam H. Beitelmal, 2022	+	+	-	+	+	+	+	+	Low
Aravind P. Gandhi, 2023	+	+	-	+	+	+	+	+	Low
Cordelia Kwon, 2024	+	+	?	+	+	+	+	-	Low
Graca Carvalho, 2023	+	+	+	?	+	+	?	?	Low
Christopher Jack, 2024	+	+	?	+	+	+	?	-	Moderate

Emilia Raila, 2017	+	+	?	+	+	+	?	?	Moderate
Jelena Bozic, 2019	+	+	?	+	+	+	+	-	Low
Casandra Thiel, 2017	+	+	?	+	+	+	+	+	Low
Philip Koka, 2018.	+	+	+	+	+	+	-	?	Low
Shuang Zhong, 2014.	+	+	-	+	+	+	-	?	Moderate
Binaya Sapkota, 2014.	+	+	-	+	+	+	-	?	Moderate
Gabriel Gulis, 2013	+	+	-	?	-	+	-	-	High
Malcolm Araos, 2015	+	+	-	+	+	+	-	-	High
Sabiha-Javied, 2008	+	+	-	?	+	+	-	-	High
Busisiwe Shezi, 2019	+	+	+	+	+	+	-	?	Low
Verena Rauchenwald, 2019	+	+	+	?	+	+	+	?	Low
Michaela Hansel, 2019	+	+	-	?	+	+	-	?	Moderate
Nishant Kumar, 2014	-	+	-	?	-	-	-	?	High

Key	Question
Situating evidence	Does the study acknowledge existing research and appropriately situate evidence produced in the overarching body of evidence?
Clear question and hypothesis	Does the study pose a clear research question or outline a hypothesis?
Appropriate link to raw data	Does the study present or link to the raw data it analyses?
Risk of funding source influencing findings	Is there a risk that sources of support/funding have influenced the study's conclusions?
Clarity of research design	Does the study identify a research design?
Clarity of research method	Does the study identify a research method?
Appropriateness of design and method	Does the study demonstrate why the chosen design and method are well suited to the research question?
Situating findings in context	Does the study explicitly consider any context-specific cultural factors that may bias the analysis/findings?
+	positive indication
-	negative indication
?	cannot tell based on text

**Table 2: Risk of bias assessment for mixed method studies**

Question	Situating evidence	Clear question and hypothesis	Appropriate link to raw data	Risk of funding source influencing findings	Clarity of research design	Clarity of research method	Mixed method rationale given	Situating findings in context	Effective integration of components	Effective interpretation of components	Divergences addressed	Component adherence to quality tradition	Overall RoB
Rebekka Schnitter, 2019.	+	+	-	+	+	+	+	+	+	?	?	?	Moderate
Anna Ibarra, 2019	+	+	?	+	+	+	+	-	+	?	+	?	Moderate
Panin Asirifua Obeng, 2020	+	+	-	?	+	+	+	+	+	+	+	+	Low
Putri Nilam Sari, 2019	+	+	-	?	+	+	+	+	+	+	+	+	Low
Idoteyin Ezirim, 2018	+	+	-	?	+	+	+	+	+	+	+	+	Low
Saber Azami-Aghdash, 2023	+	+	-	?	+	+	+	+	+	+	+	+	Low
Hoang Van Minh, 2014	+	+	-	?	+	+	+	?	+	+	+	+	Moderate
Jessica Farley, 2017	+	+	-	?	+	+	-	?	+	+	+	+	Moderate
Manzurul Hassan, 2008.	+	+	-	?	-	?	-	-	-	-	+	-	High
Saurabh Gupta, 2006	+	+	-	?	-	-	-	-	-	-	+	-	High
Hoang Van Minh, 2014	+	+	-	?	+	+	+	+	+	+	-	+	Moderate

Key	Question
Situating evidence	Does the study acknowledge existing research and appropriately situate evidence produced in the overarching body of evidence?
Clear question and hypothesis	Does the study pose a clear research question or outline a hypothesis?

Appropriate link to raw data	Does the study present or link to the raw data it analyses?
Risk of funding source influencing findings	Is there a risk that sources of support/funding have influenced the study's conclusions?
Clarity of research design	Does the study identify a research design?
Clarity of research method	Does the study identify a research method?
Mixed method rationale given	Is there an adequate rationale for using a mixed methods design to address the research question? (MMAT 5.1.)
Situating findings in context	Does the study explicitly consider any context-specific cultural factors that may bias the analysis/findings?
Effective integration of components	Are the different components of the study effectively integrated to answer the research question? (MMAT 5.2.)
Effective interpretation of components	Are the outputs of the integration of qualitative and quantitative components adequately interpreted? (MMAT 5.3.)
Divergences addressed	Are divergences and inconsistencies between quantitative and qualitative results adequately addressed? (MMAT 5.4.)
Component adherence to quality tradition	Do the different components of the study adhere to the quality criteria of each tradition of the methods involved? (MMAT 5.5.)
+	positive indication
-	negative indication
?	cannot tell based on text

**Table 3: Risk of bias assessment for qualitative studies**

Study ID	Situating evidence	Clear question and hypothesis	Appropriate link to raw data	Risk of funding source influencing findings	Clarity of research design	Clarity of research method	Appropriateness of approach	Appropriateness of methods	Findings derived appropriately	Interpretation substantiated	Coherence in overarching methods	Situating findings in context	Overall RoB
Arefeh Mousavi, 2020	+	+	-	?	+	+	+	+	+	+	+	+	Low
Georgina Morrow, 2014	+	+	-	?	+	+	+	+	+	+	+	+	Low
Angeli Rawat, 2022	+	+	-	?	+	+	+	+	+	+	+	+	Low
Adelaide Lusambili, 2023	+	+	+	+	+	+	?	?	+	?	+	+	Moderate
Anand Bhopal, 2021	+	-	+	+	+	+	?	-	+	-	?	-	High
Natalia Bellan, 2012	+	+	-	?	+	+	+	-	-	?	+	-	High
Jerome Lock-Wah-Hoon, 2020	+	+	-	?	+	+	+	+	+	+	+	?	Moderate
Lorena Pasquini, 2015	+	+	-	?	+	+	+	+	+	+	+	+	Low

Key	Question
Situating evidence	Does the study acknowledge existing research and appropriately situate evidence produced in the overarching body of evidence?
Clear question and hypothesis	Does the study pose a clear research question or outline a hypothesis?
Appropriate link to raw data	Does the study present or link to the raw data it analyses?
Risk of funding source influencing findings	Is there a risk that sources of support/funding have influenced the study's conclusions?
Clarity of research design	Does the study identify a research design?
Clarity of research method	Does the study identify a research method?

Appropriateness of approach	Is the qualitative approach appropriate to answer the research question? (MMAT 1.1.)
Appropriateness of methods	Are the qualitative data collection methods adequate to address the research question? (MMAT 1.2.)
Findings derived appropriately	Are the findings adequately derived from the data? (MMAT 1.3.)
Interpretation substantiated	Is the interpretation of results sufficiently substantiated by data? (MMAT 1.4.)
Coherence in overarching methods	Is there coherence between qualitative data sources, collection, analysis and interpretation? (MMAT 1.5.)
Situating findings in context	Does the study explicitly consider any context-specific cultural factors that may bias the analysis/findings?
+	positive indication
-	negative indication
?	cannot tell based on text