



STUDY PROTOCOL

REVISED **A systematic review protocol for identifying the effectiveness of greenhouse gas mitigation interventions for health care systems in low- and middle-income countries [version 2; peer review: 2 approved, 3 approved with reservations]**

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Abstract

Background: Climate change is predicted to be our century's most significant health threat. In 2021, 46 countries committed to environmentally sustainable low carbon health care systems. Of those, 34 were from low- and middle-income countries (LMICs). Currently, health systems are responsible for 4.4% of global greenhouse gas (GHG) emissions, with health systems in high-income countries (HICs) contributing the largest proportion to the sector's GHG emissions. However, future increases are predicted in LMICs in the absence of robust GHG mitigation. This systematic review aims to identify evidence-based GHG mitigation interventions to guide the transformation of health care systems towards net zero, specifically in LMICs. Additionally, potential synergies between interventions that aid adaption to climate change and mitigate GHG emissions will be investigated.

Methods: This protocol will follow the 'Preferred Reporting Items for Systematic review and Meta-Analysis Protocols (PRISMA-P) checklist of recommended items to address in a systematic review protocol'. A comprehensive search will be conducted on electronic databases

Open Peer Review

Approval Status ? ✓ ? ✓ ?

	1	2	3	4	5
version 2 (revision) 12 Jun 2023		✓ view	? view	✓ view	? view
		↑			
version 1 04 Aug 2022	? view	✓ view			

1. **Francis D. Pope**, University of Birmingham, Birmingham, UK
2. **Raanan Raz** , The Hebrew University of Jerusalem, Jerusalem, Israel
3. **Claudia Quitmann** , Heidelberg Institute of Global Health, Heidelberg, Germany

identified as relevant. Search terms were identified to capture all relevant peer-reviewed, primary research published between 1990 and 2022. The risk of bias will be assessed, and the quality of evidence graded. The eventual narrative synthesis will feed into a theory of change framework on GHG mitigation of health care systems in LMICs.

Discussion: This systematic review will synthesise the existing evidence around GHG mitigation interventions across all scopes of emissions, including scope 1 (health care operations), scope 2 (energy), and scope 3 (supply chains). It can be used to inform recommendations on how health care systems in LMICs can reduce emissions while prioritising which actions to take to gain the most significant reductions in GHG emissions, considering ease of implementation, scope and cost. Finally, this can catalyse further research in this area which is urgently needed.

Keywords

climate change, planetary health, health systems, sustainability, resilience, mitigation, adaptation

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Any reports and responses or comments on the article can be found at the end of the article.

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Author roles: **Blom IM:** Conceptualization, Funding Acquisition, Methodology, Writing – Original Draft Preparation, Writing – Review & Editing; **Asfura JS:** Methodology, Writing – Review & Editing; **Eissa M:** Methodology, Writing – Review & Editing; **Mattijssen JC:** Methodology, Writing – Review & Editing; **Sana H:** Methodology, Writing – Review & Editing; **Haines A:** Conceptualization, Funding Acquisition, Methodology, Writing – Original Draft Preparation, Writing – Review & Editing; **Whitmee S:** Conceptualization, Funding Acquisition, Methodology, Writing – Original Draft Preparation, Writing – Review & Editing

Competing interests: No competing interests were disclosed.

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REVISED Amendments from Version 1

Following the reviewers' valuable feedback, several amendments have been made to our manuscript to enhance its clarity and methodology. Firstly, the critical appraisal tool intended for individual articles was revised. Originally, we planned to use the Joanna Briggs Institute (JBI) Critical Appraisal Tools, but given the non-clinical, diverse, and policy-focused nature of the interventions in the included articles, these tools were deemed inappropriate. In response, and in consultation with experts, we developed a custom appraisal tool better suited for our specific research needs. Secondly, we revised the introduction section to clarify a particular sentence and enhance its understanding. Thirdly, to ensure a comprehensive review, we have adjusted the timeline of our study to include articles published up until March 2023. Lastly, we've elaborated on the rationale behind our selection of the ten databases, providing an explanation for each and detailing their individual contributions to our study.

Any further responses from the reviewers can be found at the end of the article

Introduction

Without action to reduce global greenhouse gas (GHG) emissions, climate change is predicted to be the biggest threat to global public health in the 21st century due to many direct and indirect health effects, including extreme weather, the spread of vector-borne diseases, lack of access to clean water and mental health impacts¹. Although health care systems will have to deal with the health impacts of this looming public health crisis, they are also responsible for 4.4% of GHG emissions globally, thereby contributing to it². At the United Nations Framework Convention on Climate Change 26th Conference of Parties (UNFCCC COP26) in November 2021, 46 countries committed to a transition to sustainable, low carbon health systems defined by the WHO as systems that improve, maintain or restore health while minimising negative impacts on the environment and leveraging opportunities to restore and improve it, for the benefit of the health and well-being of current and future generations^{3,4}. Furthermore, 14 countries committed to achieving net-zero health systems between 2030 and 2050⁴. Among the countries pledging, many were low- and middle-income countries (LMICs), namely 34 and 11, respectively⁴. Even though health care systems in LMICs have lower GHG emissions than high-income countries (HICs), as health care systems in many LMICs advance, an increase in these emissions is expected unless action is taken to identify, quantify and reduce them. In addition, LMICs are expected to experience the negative impacts on health from climate change both earlier and most severely due to geographical location and exposure, whilst being the least equipped to deal with them because of lack of resources to cope and recover⁵. It is vital to ensure that any adaptation actions undertaken by health care systems do not also exacerbate the sector's GHG emissions, locking them into higher-emission trajectories. However, there is a current gap in knowledge on transforming health care systems in LMICs to adapt to climate change while transitioning to low carbon. Therefore, to bring the COP26 commitments to reality, evidence-based GHG mitigation interventions towards more

sustainable health care systems in LMICs must be identified across all scopes of emissions including scope 1 (health care operations), scope 2 (energy), and scope 3 (supply chains). This article will describe a systematic review protocol towards this aim following the Preferred Reporting Items for Systematic review and Meta-Analysis Protocols (PRISMA-P) checklist of recommended items to address in a systematic review protocol⁶.

Aims, objectives and research questions

This systematic review aims to identify practical and theoretical GHG mitigation interventions for health care in LMICs. The following research questions guide this study and summarise its objectives:

- 1) What practical or theoretical GHG mitigation interventions across health care operations, energy, and supply chains can be identified that decrease greenhouse gas emissions in the context of low- and middle-income countries?
- 2) What are the implementation processes to reach the desired outcomes, including goal setting, determining roles and responsibilities, delegating tasks, execution and monitoring of tasks, and the evaluation; and what are enablers of and barriers to implementation?
- 3) How do the GHG mitigation interventions interact with actions to promote adaptation and resilience, including possible synergies, co-benefits, conflicts or trade-offs?
- 4) How do these interventions vary contextually, and what aspects are applicable across different contexts? Contextual variables include the economic context (*e.g.* economic growth, unemployment rate), the socio-cultural context (*e.g.* social values, religion), and the political-legal context (political stability, legal framework).

Methods

A systematic review will be undertaken to collate, critically appraise and synthesise existing evidence on practical or theoretical GHG mitigation interventions across health care operations, energy and supply chains in the context of LMICs. Various aspects will be explored, including the implementation process. Furthermore, the relation of these interventions with adaptation will be analysed where reported. Within the following paragraphs, different aspects of the methodology will be discussed.

Eligibility criteria

Table 1 shows the areas considered in screening the articles and the related inclusion and exclusion criteria.

Information sources

This systematic review will make use of electronic databases as information sources. The electronic databases that have been evaluated to be relevant and intended to be searched for the systematic review are [Ovid MEDLINE](#), [Ovid EMBASE](#), [Global Health](#), [SCOPUS](#), [Web of Science](#), [AfricaPortal](#), [Africa-Wide Information](#), [LILACS](#), [Global Index Medicus](#), [GreenFILE](#) and [ELDIS](#). The first five databases provide access to health-care and global health-related literature across different

Table 1. Inclusion and exclusion criteria of the systematic review.

Area	Criteria
Publication type	Only peer-reviewed primary research will be included, including analytical cross-sectional studies, case-control studies, case reports, cohort studies, diagnostic test accuracy studies, and randomised controlled trials. Any other articles, such as protocols, guidelines, (systematic) reviews, perspectives, commentaries, or editorials, will be excluded. However, relevant reviews will be screened for primary references.
Language	Articles written in English, Spanish, Italian, Portuguese, French and Arabic will be included for screening. All other languages will be excluded.
Context	Only articles will be included from which the context of the research is in LMICs. It will be excluded if the research context is in HICs, or general and not specific to a country, group of countries or region.
Topic	Only articles will be included that mention any theoretical or practical GHG mitigation intervention across health care operations, energy and supply chains towards a decrease of GHG emissions. Articles that do not report such a mitigation intervention will be excluded.
Metrics	Only articles that report a quantified change in GHG emissions from the intervention as mentioned above will be included. If a measurable outcome is not reported, the article will be excluded.
Timeline	Only articles published between 1990 and 17 March 2023, will be included. 1990 is chosen as a starting point for the inclusion of articles since it is the start of a significant research movement supporting the climate change and health connection ⁸ . Articles that were written before 1990 are excluded.

indices and the latter five specialize in LMIC-specific literature across different regions.

Search strategy

A broad and sensitive search strategy has been designed, which will be repeated across the identified relevant databases. [Table 2](#) includes a specific example of the search strategy that has been drafted for the electronic database Ovid MEDLINE.

Study records

Data management. The references of the articles identified through the search strategies on the relevant electronic databases will be uploaded to the software Rayyan QCRI which allows simultaneous collaboration between all screeners. The inclusion and exclusion criteria will be applied in every step of the screening process as outlined below. Citation, abstracts and full articles will be uploaded to be used at the different, relevant screening steps. Every screener unfamiliar with the software will receive a training session from the first author to gain familiarity with its use.

Selection process. After removing duplicates, papers will be initially screened by title, following Mateen *et al.*'s recommendations to improve the screening process's efficiency⁷. Then, articles will be screened by abstract and shortlisted articles will be screened through full-text analysis against eligibility criteria using the software Rayyan QCRI. At least two reviewers will perform each screening step, and any disagreements regarding inclusion will be discussed. If there is no consensus between two screeners, a third author will be consulted until an agreement is reached.

Data collection process. Data from eligible articles will be collated independently using a tailored data collection form

with a detailed instruction manual trialled before use. As part of the pilot phase, four reviewers will extract data from the same five articles, after which the form will be discussed and adjusted based on experience and feedback. This will also contribute to improved consistency of data collection between different reviewers.

Data items. [Table 3](#) shows an overview of the data items for which data will be sought.

Outcomes and prioritisation

The primary outcome is the identification of GHG mitigation interventions undertaken with the aim of reducing GHG emissions within health care systems in the context of LMICs and the quantified emission reductions associated with each mitigation action. The main objective of the research is to identify these interventions as there is a lack of overview of evidence-based interventions towards environmental sustainability in this context.

Secondary outcomes include identifying links with climate change adaptation actions, including climate resilience, the emission scope of the intervention, and the implementation process, including the timeline and enablers or barriers faced. The collection of other secondary outcomes is pertinent to inform policy recommendations regarding which interventions will be easiest to implement and in which context, and where actions can be scaled or translated between different contexts.

Risk of bias in individual studies

For each included article, the risk of bias will be assessed using specifically designed questions applicable across different study types using a simple judgement of low risk, high risk of unclear risk on different axes as endorsed by

Table 2. Search strategy of the systematic review drafted for the electronic database Ovid MEDLINE.

Search line	Content of search
1	(netzero or net zero).mp.
2	Carbon Footprint/
3	Greenhouse Effect/
4	exp Climate Change/
5	(carbon or CO2 or methane or CH4 or nitrous oxide or nitrus oxide or N2O or hydrofluorocarbon* or HFC* or perfluorocarbon* or PFC* or F-gas or fluorinated gas or sulfur hexafluoride or SF6 or nitrogen trifluoride or NF3 or emission* or greenhouse or GHG or climat* change* or global warming or footprint or eco-friendly or climate friendly or environment* friendly or eco-efficient or environment* responsible or environment* sound or energy-efficient or energy-saving or green initiative* or environmental impact or short-lived climate pollutant or black carbon).mp.
6	(environment* and sustainab*).mp.
7	1 or 2 or 3 or 4 or 5 or 6
8	exp "Delivery of Health Care"/
9	exp Health Facilities/
10	(health system* or health-care or health-care or health sector or health supply chain* or health service* or delivery of health or health delivery or health facilit* or health cent* or hospital or hospitals or clinic or clinics or emergency room* or operat* room* or operat* theat* or patient care or ward* or urgent care or primary care or secondary care or tertiary care or quaternary care or telemedicine or medical cent* or diagnostic care or rehabilitative care or preventative care or palliative care or home care).mp.
11	8 or 9 or 10
12	7 and 11
304	or/13-303 [ALL LOW AND MIDDLE-INCOME COUNTRIES (expert search)]
305	12 and 304
306	limit 305 to yr="1990 - 2022"

Table 3. List of variables for which data will be sought as part of the systematic review. GHG: Greenhouse gas.

Data item	Definition
Article identifiers	Basic identifiers of the article will be extracted, including name, authors, date, journal, article type and article design.
Methodology	The methodology used in the article will be identified and extracted.
Geographical scale	The geographical scale, namely if it was conducted at the local, regional, national or international level.
Location	The article's location will be extracted by identifying the relevant town/city, region, country and/or countries where the research was conducted.
Emission scope	If a particular emission scope was researched, this will be extracted, and it will be identified whether the research interacts with scope 1 (health care operations), scope 2 (energy), scope 3 (supply chains) or multiple scopes.
Part of the health care system	If a particular aspect of the health care system was researched, this will be extracted, (e.g. a primary health care clinic, a rural hospital).
GHG mitigation intervention(s)	The GHG mitigation intervention(s) are the interventions that lead towards a decrease in GHG emissions, including its details.
Measurable impact of the GHG mitigation intervention(s)	The quantified impact of the identified intervention(s) of the research on mitigation, including a specification of GHG or GHG equivalent and whether it is a practical or theoretical impact.

Data item	Definition
Implementation process	The implementation process will be extracted, including enablers and barriers that were faced and how these were or will be approached.
Implementation timeline	The timeline around the implementation will be extracted in terms of length around the implementation process.
Economic analysis	If included, the economic aspects such as cost effectiveness, cost benefit or cost consequences will be extracted.
Linkage with adaptation or resilience	If the intervention is directed at both mitigation and adaptation or specifically resilience is described, this will be extracted. These interactions can be synergies, co-benefits, conflicts, trade-offs or co-harms ⁹ .
Health impact	If the intervention has a measured impact on health outcomes or exposures, this will be extracted.
Funding source	The source of funding for the authors will be extracted to identify potential conflicts of interest.
Conflicts of interest	Further potential conflicts of interest will be extracted, including relationships with relevant parties other than financial relationships.
Summary	Each article will be summarised in under 100 words on the extraction sheet.

the Cochrane Collaboration. These questions span different areas including reporting bias, and clarity in the definitions, methods, results and discussion. An assessment will be 'unclear' if relevant information is missing from the assessed article. The assessments will be made independently by at least two authors, after which they will be compared. Any disagreements will be discussed, and a third author will be consulted if no consensus is found. The risk of bias in each included article will be reported in the eventual manuscript of the systematic review¹⁰.

Data synthesis

It is unlikely that extracted data from included articles in this systematic review will be appropriate for quantitative synthesis because of the diversity of contexts, types and scale of intervention and possible outcomes. A narrative synthesis will present the identified data of the included articles. A table will be provided to summarise the included articles and their findings to facilitate this synthesis. Findings will be grouped by type of intervention where possible. Through narrative analysis, these findings will be further explored and compared between articles. Furthermore, the identified data will feed into a theory of change theoretical framework on GHG mitigation interventions for health care systems in LMICs.

Meta-bias(es)

Reporting bias will be investigated by recording whether included articles are preceded by a protocol published before the article's publication. If selective reporting of the results is identified while comparing the protocol to the eventual article, this will be reported.

Confidence in cumulative evidence

To assess the overall strength of the body of evidence created from the synthesis of the included articles, the evidence will be graded using the approach developed by the Grading of Recommendations Assessment, Development and Evaluation (GRADE) Working Group. This tool includes the domains 'Risk

of Bias', 'Imprecision', 'Inconsistency', 'Indirectness', and 'Publication Bias'. The eventual evidence will be graded using four different categories. As described by Siemieniuk *et al.*, these categories are that the certainty of the evidence is 1) very low (the true effect is probably very different from the estimated effect), 2) low (the true effect might be very different from the estimated effect), 3) moderate (the authors believe that the true effect is probably close to the estimated effect) or 4) high (the authors are confident that the true effect is similar to the estimated effect)¹¹.

Dissemination of information

The findings and outcomes of this study will be published in peer-reviewed scientific journals and presented at conferences and meetings related to planetary health, climate change and health, and health systems. The findings will also be disseminated to the broader public using a social media dissemination strategy.

Amendments

This protocol is the first publication. In case of important protocol amendments following review, they will be tracked, dated and published as such on Wellcome Open Research.

Discussion

Climate change is expected to have a major impact on health¹. While health care systems need to become prepared to deal with these health effects, they must also move to sustainable practice to halt their contribution to this health emergency. Most countries committed to sustainable health care systems at COP26 are LMICs, yet there is a lack of structured evidence to inform policy⁴. Furthermore, health system research rarely considers the interaction between these GHG mitigation interventions and adaptation, which is especially important in vulnerable locations. To respond to this emergency, this protocol describes the approach to a systematic review which will provide an overview of the current existing peer-reviewed evidence on interventions towards GHG mitigation of health

care systems in LMICs. To the authors' knowledge, this will be the first attempt to create this overview. Given the urgency around climate change and its impact on health, it is also a timely one. It will provide the first step in the direction of evidence-based guidance toward GHG mitigation of health care systems in LMICs.

Several potential sources for biases for this review, common to this methodology, could impact the quality of the evidence presented in the eventual synthesis. First, the risk of publication bias must be considered for three reasons. The first reason is that GHG mitigation research is a recent area of research that is rapidly developing and expanding, considering the topic's urgency. It could be regarded as likely that not all successful mitigation interventions are indeed published in peer-reviewed journals due to the perceived lengthy publication process. The second reason is that interventions with a measured impact are more likely to be published than those with lesser or no significant impact on decreasing GHG emissions. The final reason that might contribute to publication bias is that certain areas of mitigation, such as those that produce scope 1 and 2 emissions, might receive more research funding than emissions from scope 3. The publication bias will be assessed as part of the synthesis during the systematic review.

A second potential bias to consider is the reviewer bias which can be caused by varied interpretations of inclusion criteria by different reviewers. To reduce this risk of bias, all reviewers will be trained and familiarized with the program before starting. Furthermore, each article will be screened by at least two reviewers during every step of article screening. Any disputes will be discussed, and a third reviewer will be involved if no consensus can be reached.

Finally, a third potential bias to be aware of during the process of this systematic review is the existence of inconsistent terms and definitions. In the relatively young area of research into GHG mitigation, terms are used interchangeably and

often not clearly defined. To reduce this risk of bias, the search strategy is broad and includes a wide range of terms that can be relevant to the research topic.

As outlined above, the search strategy aims to be comprehensive. Therefore, a challenge during the synthesis might be that heterogeneity of reporting styles is observed between the selected articles: for example, using various metrics and units across contexts. The authors will aim to translate heterogeneous results to allow for quantitative synthesis and interpretation, where possible.

In conclusion, this protocol describes a systematic review methodology that aims to provide an urgently needed overview of interventions toward GHG mitigation in health care systems. Furthermore, any connections with climate change adaptation by health care systems will also be synthesised. Through that, the review will have the opportunity to contribute to ongoing GHG mitigation and adaptation efforts. Furthermore, doing so will also contribute to identifying areas where more research is needed to guide future efforts in an evidence-based manner.

Data availability

Underlying data

No data are associated with this article.

Reporting guidelines

Medicine: PRISMA-P Checklist for 'A Systematic Review Protocol for Identifying the Effectiveness of Greenhouse Gas Mitigation Interventions for Health Care Systems in Low- and Middle-Income Countries', <https://doi.org/10.17037/DATA.00002988>

Data are available under the terms of the [Creative Commons Zero "No rights reserved" data waiver](#) (CC0 1.0 Public domain dedication).

References

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Open Peer Review

Current Peer Review Status: ? ✓ ? ✓ ?

Version 2

Reviewer Report 11 April 2024

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Zerina Lokmic Tomkins

Monash University, Melbourne, Victoria, Australia

Thank you for the opportunity to review this work. There are only few comments for authors to consider:

Abstract:

It is not clear in the abstract if the review is using qualitative, quantitative or mixed methods approach -please consider clarifying this.

Methodology:

How will the effectiveness of interventions be evaluated - is it only going to be described or will it also be assessed on what has worked/not worked - consider if using template for intervention description and replication (TiDiER) checklist might be more appropriate to report the findings as a complement to your own tool. Although mostly used to report clinical interventions, the tool is adaptable to other settings. Using TiDiER might help reduce some of the biases described in this project proposal.

I was also curious to understand how will you clarify between mitigation and adaptation/resilience variables (Table 3) - are specific indicators used to distinguish between the two.

References

1. Hoffmann TC, Glasziou PP, Boutron I, Milne R, et al.: Better reporting of interventions: template for intervention description and replication (TiDiER) checklist and guide. *BMJ*. 2014; **348**: g1687 [PubMed Abstract](#) | [Publisher Full Text](#)

Is the rationale for, and objectives of, the study clearly described?

Yes

Is the study design appropriate for the research question?

Yes

Are sufficient details of the methods provided to allow replication by others?

Partly

Are the datasets clearly presented in a useable and accessible format?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Environmental health, climate change adaptation (maternal and child health) digital health

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

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Caleb Dresser

Beth Israel Deaconess Medical Center / Harvard Medical School, Boston, USA

This systematic review protocol appears well-designed and the team appears to be prepared to execute on this plan effectively.

The authors plan to conduct a systematic review of the published literature on GHG emissions reduction in low and middle income country healthcare systems. Their inclusion of both medically focused databases (their first five) and LMIC-focused databases (their second five) is laudable; while this will present a substantial screening challenge given the volume of articles that may be produced on initial searches, this will also provide the most comprehensive possible list of articles for consideration for inclusion.

I agree with the author's assessment of the current state of the literature in this field, and agree that a narrative synthesis is likely to be the most effective (and most feasible) approach for interpreting the literature that is identified. Uneven use of terminology in this evolving field will present a challenge, and it is highly unlikely that the articles identified in this search will be sufficiently congruent in terms of methods or reported outcomes to be suitable for formal meta-analysis.

The protocol appears well-designed, and will contribute useful new information to this field.

Is the rationale for, and objectives of, the study clearly described?

Yes

Is the study design appropriate for the research question?

Yes

Are sufficient details of the methods provided to allow replication by others?

Yes

Are the datasets clearly presented in a useable and accessible format?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: My work focuses on climate change and health, with a focus on health systems and the implications of climate change for healthcare. While the majority of my work focuses on healthcare-based adaptation to climate change, I also serve on our hospital's sustainability committee, teach a course at Harvard's school of public health that covers healthcare sustainability in the context of climate change, and have designed and conducted multiple systematic reviews in the field of climate change and health.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 09 April 2024

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**Claudia Quitmann**

University Hospital Heidelberg and Medical Faculty of Heidelberg University, Heidelberg Institute of Global Health, Heidelberg, Germany

Thank you for giving me the opportunity to review the revised version of: "A systematic review protocol for identifying the effectiveness of greenhouse gas mitigation interventions for health care systems in low- and middle-income countries".

Some minor comments:

Abstract:

- In 2021, 46 countries committed to environmentally sustainable low carbon health care systems. Please refer to a more recent year.
- Mention number of databases in the abstract
- scope 1 (health care operations) health care operation sounds a bit misleading and scope 1 emissions can also be energy-related; I suggest rephrasing the words in the brackets to more closely follow the GHG Protocol.

- Search terms were identified to capture all relevant peer-reviewed, primary research published between 1990 and 2022. The amendment states that articles are included until March 2023 - please correct abstract.

Introduction:

- 1) What practical or theoretical GHG mitigation interventions across health care operations, energy, and supply chains can be identified that decrease greenhouse gas emissions in the context of low- and middle-income countries? I suggest to use the terms scope 1-3.
- Is it planned to analyze objective 2-4 by intervention? I assume that the results differ quite a lot depending on the intervention (e.g., building insulation vs. plant-based menus vs. abolishing desflurane).

Methods:

- Only peer-reviewed primary research will be included. I assume that grey literature would be a very valuable source, please state briefly why it was decided to exclude it.

I wish the authors all the best for their scoping review!

Is the rationale for, and objectives of, the study clearly described?

Yes

Is the study design appropriate for the research question?

Yes

Are sufficient details of the methods provided to allow replication by others?

Yes

Are the datasets clearly presented in a useable and accessible format?

Not applicable

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Planetary Health

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 19 June 2023

<https://doi.org/10.21956/wellcomeopenres.21670.r59939>

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Raanan Raz 

Braun School of Public Health and Community Medicine, The Hebrew University of Jerusalem, Jerusalem, Israel

I approve this article for indexing

Is the rationale for, and objectives of, the study clearly described?

Not applicable

Is the study design appropriate for the research question?

Not applicable

Are sufficient details of the methods provided to allow replication by others?

Not applicable

Are the datasets clearly presented in a useable and accessible format?

Not applicable

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Version 1

Reviewer Report 11 April 2023

<https://doi.org/10.21956/wellcomeopenres.19964.r55482>

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Raanan Raz 

Braun School of Public Health and Community Medicine, The Hebrew University of Jerusalem, Jerusalem, Israel

This vital study is aimed to systematically evaluate methods of GHG emission reduction in the health sector in LMIC countries. With this, it reflects a real need to examine which of the efforts in this area is thriving and efficient, the various enablers and barriers for implementation, the scope and magnitude of the research in this field, and many other issues that have yet to be systematically addressed. The researchers strictly adopt a systematic review approach using the PRISMA-P checklist, avoiding and assessing biases as much as possible. This is an excellent protocol for this task, and this timely research can certainly help direct precious efforts toward the most efficient approaches.

With this, I have one major comment for the researchers to consider. The described protocol considers only peer-reviewed articles, as often when systematically reviewing a scientific health issue. However, many implementations of GHG emission reduction in the health sector, particularly in LMIC countries, are not necessarily accompanied by peer-reviewed articles. This is because some of these projects may lack substantial research aspects and implement relatively simple and obvious interventions. Such projects are not documented in peer-reviewed articles; instead, they may be published in various ways by national and international organizations, such as GGHH (<https://greenhospitals.org/>) and others. Therefore, I encourage the research team to broaden their search to include other sources of information about relevant projects in LMIC.

Is the rationale for, and objectives of, the study clearly described?

Yes

Is the study design appropriate for the research question?

Yes

Are sufficient details of the methods provided to allow replication by others?

Yes

Are the datasets clearly presented in a useable and accessible format?

Not applicable

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Environmental Epidemiology

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Author Response 07 Jun 2023

Iris Blom

Dear Reviewer, Thank you for taking the time to review our manuscript and for your valuable comments. We are delighted to learn that you perceive our study's relevance and potential impact. Regarding your major comment about considering non-peer-reviewed articles and grey literature, we wholeheartedly agree with your insights. Many successful GHG emission reduction projects in the health sector, especially in LMIC countries, may not be documented in peer-reviewed articles, but rather, they might be published through national and international organizations. Your suggestion to broaden our search criteria to include these additional sources of information is both valid and valuable. While the current scope of our review is to provide a comprehensive overview of what is known within peer-reviewed literature, we understand that this may present a limitation in the study. To address this, we will ensure to clearly outline this limitation in our manuscript and emphasize the need for including an understanding of the grey literature as a significant recommendation for future research. This will be noted as a crucial next step in further research, with the hope to eventually capture a broader and more realistic range of GHG

emission reduction strategies in the health sector across LMICs. We are grateful for your constructive feedback, which will greatly enhance our work. With kind regards, Dr Iris Martine Blom

Competing Interests: No competing interests were disclosed.

Reviewer Report 10 March 2023

<https://doi.org/10.21956/wellcomeopenres.19964.r54136>

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Francis D. Pope

School of Geography, Earth and Environmental Sciences, University of Birmingham, Birmingham, UK

The protocol details a systematic review for identifying the effectiveness of GHG mitigation interventions for health care systems within LMICs. The subject area is timely, with the health care sector responsible for almost 5% of global GHG emissions.

Overall, the protocol is sensible looking at relevant articles between 1990 and 2022. The review will be a narrative review because of the lack of similar studies with which to get quantitative comparison out of. The protocol should be indexed once the following comments have been responded to.

Within the introduction, feedback loops between GHG emissions and the health care sector are discussed. It is not clear how these feedback loops will be set up.

The review will look at scope 1, scope 2 and scope 3 emissions. Scope 3 is respect to supply chains. There is a huge literature with respect to vehicle emissions most of which will not mention the health care sector. How will you ensure you capture the relevant information from the wide range of literatures that will need to be read?

Similarly, with the respect to "...promote adaptation and resilience, including possible synergies, co-benefits, conflicts and trade offs." Much of this literature will come from outside the healthcare literature. A plan to capture this information will be required.

The information sources discussed in the search strategy should be justified. Detail what each database will bring and how it is distinct from the others.

The language of the papers that will be reviewed is wide, and this is to be commended. Does the team have the required language skills to review all these languages? If not, how will this be dealt with.

Timeline – all articles within 2022 should now be possible to review, not just those up to 30 Jan 2022.

Is the rationale for, and objectives of, the study clearly described?

Yes

Is the study design appropriate for the research question?

Yes

Are sufficient details of the methods provided to allow replication by others?

Yes

Are the datasets clearly presented in a useable and accessible format?

Not applicable

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Climate change and green house gas emissions.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 07 Jun 2023

Iris Blom

Dear Reviewer, Thank you for the time and effort you have dedicated to reviewing our manuscript. Your comments and insights are greatly appreciated, and we believe they significantly contribute to the improvement and clarification of our work. We have carefully considered your feedback and addressed each of your comments as detailed below: Regarding the lack of clarity on feedback loops between GHG emissions and the healthcare sector, we appreciate your concern. In light of your comment, we have revised the wording in this section to better express our intended meaning. Specifically, we mean to convey that if adaptation measures that increase greenhouse gases are implemented, they could negatively impact mitigation efforts. Your point about the challenges associated with capturing relevant information from the vast literature on vehicle emissions, especially those not explicitly referencing the healthcare sector, is indeed crucial. We agree that the healthcare system transformation requires learning extensively from efforts across all sectors due to its interconnected nature, especially concerning scope 3 emissions. Our primary goal for this systematic review is to provide a comprehensive overview of research conducted specifically within the healthcare context. We understand the potential limitations of this focus and will ensure they are clearly stated in our study. As for the concern about capturing literature from outside the healthcare sector related to promoting adaptation and resilience, our approach will be akin to the one mentioned above. While we strive to create a thorough understanding of what is known within the healthcare systems

context, we will be explicit about the limitations of this approach in our study. We appreciate your suggestion about justifying the information sources discussed in our search strategy. We have now included explanations for the selection the databases in the methodology, outlining their unique contributions to our study. Thank you for acknowledging the range of languages in which we aim to review papers. We can confirm that our team has the necessary skills to review papers in all the languages listed. Lastly, in response to your note on the timeline, we have revised the manuscript to include all articles up till March this year, thus extending beyond the initially proposed date of 30th January 2022. We hope that our revisions and responses adequately address your comments and concerns. We look forward to hearing from you regarding the next steps in the review process. Thank you again for your careful reading and valuable feedback. With kind regards, Dr Iris Martine Blom

Competing Interests: No competing interests were disclosed.
