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Climate Actions in Hospital: A Scoping Review Protocol

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Keywords:	climate action, hospital, Health promoting hospital, scoping review, climate smart healthcare

TTITLE-

Climate Actions in Hospital: A Scoping Review Protocol

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ABSTRACT

Introduction: Health and climate change are inexorably linked through the exacerbation of health risks and contribution of the health sector to greenhouse gas emissions. Climate action in healthcare settings is critical to address climate change with a smarter use of energy, minimising waste, and by enhancing disaster preparedness. Globally, hospital climate action is growing, but there is potential to go further. The scientific literature on this topic lacks synthesis poses challenges for hospital leadership to track climate action performance and spur even higher climate target and implementation. This scoping review will reflect the current knowledge about hospital climate action and existing tools to measure progress in this area.

Methods and analysis: We will conduct a scoping review applying the six-stage protocol proposed by Asksey and O'Malley. Our study includes peer-reviewed literature of how hospitals have addressed climate change (mitigation and adaptation) since 1992 (Kyoto Protocol). All identified studies indexed in Medline, Scopus and Embase will be examined. Quantitative and thematic analysis will be used to evaluate and categorise the study results.

Implications and dissemination: This research is part of the climate-smart hospital initiative to improve the implementation of hospital climate action. This scoping review will provide a valuable synthesis understanding of hospitals climate actions, and tools used to measure its implementation. This scoping review will support mobilising and accelerate hospital climate action; recognising and showcasing existing actions; sharing and creating knowledge on high-potential solutions. The findings will be disseminated with all members of the International Health Promoting Hospital and Health Services (HPH) and the Global Green and Healthy Hospital (GGHH) network. Dissemination will occur through peer-reviewed publications and to the HPH and membership through annual conference and newsletter.

Keywords: Climate action, hospital, climate-smart healthcare, health-promoting hospital, scoping review

Strengths and limitations of this study

- This systematic scoping review will provide a pertinent synthesis and systematic examination of scientific literature regarding mitigation and adaptation in hospitals.
- This review will study multidisciplinary databases covering public health, medicine, engineering, architecture, social science, policy and the environment to provide a comprehensive evaluation of the literature.
- There will be no restrictions applied to healthcare facility type, study design or location, which are published in English, Chinese and Indonesian.
- Our purpose of synthesising different aspects of hospitals and climate change, identified studies will not be excluded based on quality assessment. However, the type of literature and the value of available evidence will be charted in the review.

INTRODUCTION

Climate change threatens the lives and health of countless people, coastal cities and local economies. Researchers have warned that climate change is more likely to intensify and increase the severity of various climate-sensitive extreme events and their associated health risks [1–4]. More than 9,000 cities representing approximately 15% of the global population has made commitments to cut down emissions in achieving the Paris Agreement. However, making commitments is only the first step towards the transformations necessary to achieve domestic climate targets and the Paris Agreement goals [5]. Collective tracking of impacts from individual commitments is challenging because of inadequate and often uneven information on targets and greenhouse gas emissions. Moreover, the effort to align methodologies and concepts applied by the diverse range of stakeholders engaged in climate action is still being advanced.

Delays in action increase the risk of missing the Paris goals and exposing the world to more significant impacts from climate change. The recent International Panel on Climate Change '1.5 Degree Report' highlighted the dire consequences of climate change if we keep releasing emissions at our current rate [6]. Global warming and climate-related disasters, such as floods and emerging infectious disease outbreaks, present severe health security threats on a global scale [7]. As climate change and climate-induced disaster risks confronting our health are increasing, effective adaptation and mitigation action is urgently needed. These efforts are particularly important for hospitals as they play a critical role in reducing climate change impacts not only by treating illnesses and injuries but also by being prepared for climate-induced disasters and leading community efforts to adapt climate change.

Healthcare is among the 'heavy-emitting' sectors, with a carbon footprint of approximately 26.6 million tonnes of carbon dioxide equivalent (MtCO2e) in 2015. The carbon footprint of the health sector accounts for 39% of public sector emissions in England, 7% of Australia's total emissions [8] and 10% of United States [9]) national CO_2e emissions. Healthcare facilities, by the way, their function is structured, are often significant consumers of energy and producers of waste [10]. Several organisations and alliances in North America, Europe and Asia have surfaced over the past decade with a remit to address the ecological and carbon footprint of hospitals [10–13].

Healthcare facilities must be encouraged to uphold their mitigation efforts, which reduce speed, stabilise or reverse climate change by cutting down greenhouse gas emissions [14]. On a daily basis, hospitals generate enormous energy and greenhouse gas emissions, which contribute to climate change. There are mitigation measures hospitals can take to slow, halt or perhaps even reverse the warming trend. Low-carbon health services including hospital design which allow natural lighting, prioritise renewable energy transition, employing energy efficiency measures, rainwater harvesting, provision of facilities for cycling or walking and minimising

healthcare waste management and refusing single-use plastics with green procurement policy. However, at this critical time, mitigating emissions is no longer optional to allow adaptation possible for climate–health threats.

The health care sector cannot turn away from climate change and must be ready to lead the way with carbon reduction initiatives that also improve the standard of healthcare [15]. The health sector has the responsibility to act on health threats and manage future demand on the health service. The *Lancet* Climate and Health Countdown 2018 report highlighted accelerated adaptation action as crucial to address the health risks of climate change [16]. According to the report, only one in five of hospitals in high-income countries has developed a plan to address future health-care service delivery needs resulting from climate change. There are noteworthy good practice examples of mitigation and adaptation efforts, but most health infrastructures are still ill-prepared. The recent deadly torrential rains in western Japan and the earthquake that caused a complete blackout in Hokkaido in 2018, found that some of the hospitals went without power for over 40 hours. More than 100 designated as disaster response medical centres' power generator fuel reserve is not enough to maintain their operations for three days [17].

Healthcare facilities need to incorporate both mitigation and adaptation measures, which include projections and preparedness for the impacts of climate change, to lessen health burden [18]. Focusing efforts to enhance the adaptive capacity in specific areas, promoting institutional improvement, embracing adaptive management, and developing tools to support these processes are important priorities and can build the resilience of local public health systems to climate change [19-20]. However, it is unclear what progress, hospitals across the world are acting to reduce emissions and adapt to climate change. Therefore, this scoping review will reflect what the current knowledge about hospitals climate action and existing tools to measure progress in this area is. As converging crises of climate change, we require much more radical

climate action. This scoping review will support mobilising and accelerating climate action and help to reap the benefits in efficiency and effectiveness among different actors.

RESEARCH OBJECTIVES

This scoping review will analyse the development of hospitals incorporating climate change adaptation and mitigation practices to address climate change. This study will provide a comprehensive understanding of the current knowledge of hospital climate actions and tools used to measure its implementation. This scoping review will support mobilising and accelerating hospital climate action; recognising and showcasing existing actions; sharing and creating knowledge on high-potential solutions.

METHODOLOGY

Patient and public involvement

This scoping review study will have no patient or public involvement.

Protocol design

This scoping review will be conducted as per Arksey and O'Malley and further developed by Levac *et al*. [21,22] These methods include six-stage procedures including (1) identifying the research question, (2) identifying relevant studies, (3) study selection, (4) charting the data, (5) collating, summarising and reporting the result and (6) external consultation with relevant stakeholders.

1) Identifying the research question

The specific research questions are:

- Which areas have been studied regarding the hospital impacts of climate change?
- What is the geographical origin, journal and study types of the publications?
    - Geographical origin: Africa, the Americas, South-East Asia, Europe, Eastern Mediterranean, Western Pacific.

- Journal: Multidisciplinary
- Study types: original research, review, commentary, letter, protocol, case study.

- To what extent do hospitals address climate change?
  - Mitigation (sustainable policy, improve energy efficiency, shifting to renewable energy, minimising waste, green procurement)
  - Adaptation (disaster risk reduction, health professionals' and community climate awareness and preparedness, vulnerability evaluation, early warning system)
- What measures and tools in the scientific literature on climate change mitigation and adaptation in hospitals?

2) *Information sources and search strategy*

Eligible studies will be identified through Medline, Scopus and Embase. The search terms cover all areas of climate action and hospital, including Medical Subject Headings (MeSH) terms, subject headings and keywords. A Griffith University health librarian will review the search strategy in the proposed databases based on the keywords demonstrated in Table 1, and search syntaxes outlined in Table 2. To capture all eligible studies, we will follow the search strategy, which allows both MeSH terms and free text.

Table 1. Search terms for the scoping review on 'Hospital and climate action.'

Hospital-related
Healthcare provider/industry/sector, hospital, medical facility/institution/centre/ acute care unit, intensive care unit, ward, clinic, infirmary, emergency department, trauma centre, nursing station, operating theatre, dialysis centre
Climate-related

Climate change, global warming, extreme weather, climate variability, greenhouse gas emission, greenhouse effect, high temperature, heat wave, drought, flood, climate-induced, climate-related disaster
Climate Action-related
Mitigation, reduction, adaptation, cease, tackle, address, combat, fight, strategy, procedure, process, implementation, action, effort, attempt, policy, framework, plan, law, approach, response

Table 2. Search strategy syntax for Medline, Scopus, Embase

Database	Search strategy syntax
Medline	(“Healthcare provider*” OR “health care provider*” OR “healthcare industr*” OR “health care industr*” OR “healthcare sector*” OR “health care sector*” OR hospital* OR “medical facilit*” OR hospital* OR "health facilit*" OR "Medical facilit*" OR "health institution*" OR "Medical institution*" OR "health care cent*" OR "healthcare cent*" OR "acute care unit*" OR "healthcare institution*" OR "health care institution*" OR "intensive care unit*" OR ward* OR clinic* OR infirmar* OR "emergency department*" OR "trauma cent*" OR "nursing station*" OR "operating theat*" OR “dialysis centre*” OR “dialysis center*” OR hemodialysis) AND ("climate change" OR "climate variabil*" OR "global warming" OR "greenhouse effect*" OR "greenhouse gas emission*" OR GHGE OR "heat wave*" OR heatwave* OR "high temperature*" OR drought* OR flood* OR "climate induced" OR "climate related disaster*") AND (Mitigation OR reduction OR adaptation* OR cease OR tackl* OR address OR combat OR fight OR Strateg* OR procedure* OR process* OR implementation* OR action* OR effort* OR attempt* OR polic* OR framework OR plan* OR law OR approach* OR response*)
Scopus	TITLE-ABS-KEY ("Healthcare provider*" OR "health care provider*" OR "healthcare industr*" OR "health care industr*" OR "healthcare sector*" OR "health care sector*" OR hospital* OR "medical facilit*" OR hospital* OR "health facilit*" OR "Medical facilit*" OR "health institution*" OR "Medical institution*" OR "health care cent*" OR "healthcare cent*" OR "acute care unit*" OR "healthcare institution*" OR "health care institution*" OR "intensive care unit*" OR ward* OR clinic* OR infirmar* OR "emergency department*" OR "trauma cent*" OR "nursing station*" OR "operating theat*" OR "dialysis centre*" OR "dialysis center*" OR hemodialysis) AND TITLE-ABS-KEY ("climate change" OR "climate variabil*" OR "global warming" OR "greenhouse effect*" OR "greenhouse gas emission*" OR ghge OR "heat wave*" OR heatwave* OR "high temperature*" OR drought* OR flood* OR "climate induced" OR "climate related

	disaster*") AND TITLE-ABS-KEY (mitigation OR reduction OR adaptation* OR cease OR tackl* OR address OR combat OR fight OR strateg* OR procedure* OR process* OR implementation* OR action* OR effort* OR attempt* OR polic* OR framework OR plan* OR law OR approach* OR response*)
Embase	('healthcare provider*':ti,ab,kw OR 'health care provider*':ti,ab,kw OR 'healthcare industr*':ti,ab,kw OR 'health care industr*':ti,ab,kw OR 'healthcare sector*':ti,ab,kw OR 'health care sector*':ti,ab,kw OR hospital*:ti,ab,kw OR 'health facilit*':ti,ab,kw OR 'medical facilit*':ti,ab,kw OR 'health institution*':ti,ab,kw OR 'medical institution*':ti,ab,kw OR 'health care cent*':ti,ab,kw OR 'healthcare cent*':ti,ab,kw OR 'acute care unit*':ti,ab,kw OR 'healthcare institution*':ti,ab,kw OR 'health care institution*':ti,ab,kw OR 'intensive care unit*':ti,ab,kw OR ward*:ti,ab,kw OR clinic*:ti,ab,kw OR infirmar*:ti,ab,kw OR 'emergency department*':ti,ab,kw OR 'trauma cent*':ti,ab,kw OR 'nursing station*':ti,ab,kw OR 'operating theat*':ti,ab,kw OR 'dialysis centre*':ti,ab,kw OR hemodialysis:ti,ab,kw) AND ('climate change':ti,ab,kw OR 'global warming':ti,ab,kw OR 'extreme weather':ti,ab,kw OR 'climate variability*':ti,ab,kw OR 'carbon footprint':ti,ab,kw) AND (mitigation:ti,ab,kw OR reduction:ti,ab,kw OR adaptation*:ti,ab,kw OR cease:ti,ab,kw OR tackl*:ti,ab,kw OR address:ti,ab,kw OR combat:ti,ab,kw OR fight:ti,ab,kw OR strateg*:ti,ab,kw OR procedure*:ti,ab,kw OR process*:ti,ab,kw OR implementation*:ti,ab,kw OR action*:ti,ab,kw OR effort*:ti,ab,kw OR attempt*:ti,ab,kw OR polic*:ti,ab,kw OR framework:ti,ab,kw OR plan*:ti,ab,kw OR law:ti,ab,kw OR approach*:ti,ab,kw OR response*:ti,ab,kw)

3) Study selection process

The research team will first use Zotero software to remove duplicates of references; and then screen titles and abstract in English, Chinese and Indonesian. Two independent reviewers will be involved in this step. Title and abstract screening will base on the inclusion and exclusion criteria outlined in Table 3. Those that meet all eligibility criteria will include in the analysis. All screening and data abstraction process will be conducted by two reviewers, independently. The two primary reviewers will resolve the inconsistency in study eligibility through discussion, before involving a third reviewer in the study selection stage. For study replicability and transparency, authors will use Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram to record the selection process, including exclusion reasons.

Table 3. Selection of articles Based on Inclusion and Exclusion Criteria

Inclusion criteria	Exclusion criteria
Peer-reviewed articles with all types of methods	conference proceedings, dissertations
Publication types (original, reviews, commentaries, editorials, case studies)	The language used not in English, Chinese and Indonesian.
Indexed in MEDLINE, Scopus and Embase	
Published since 1992*	
No restriction to geographical origin or population	

*Date of publication: The *Kyoto Protocol,* an international agreement established since the year 1992 which linked to the United Nations Framework Convention on Climate Change (UNFCCC), which commits its Parties by setting internationally binding emission reduction targets.

4) Data items and data abstraction process

The scoping review will explore the implemented mitigation and adaptation actions in hospitals and tools are being used to track progress. Data extraction including author, publication date, journal, study characteristic, intervention characteristic, tools used to measure intervention, intervention results (e.g., barriers, success factors, outcomes) and any facilitating factors reported associated with hospital climate action. Examples of facilitating factors include, but are not limited to, law and policy, electricity cost, advocates (e.g. Environmentalist), characteristic of the hospital (e.g. Pro-environment, faith-based organisations), vulnerability to climate change (e.g. higher risk of flood, past disasters experience). The research team will discuss before reviewing to ensure standardisation and comprehensiveness.

5) Synthesis of Result

We will conduct a mix-methods with quantitative and qualitative analyses. Thematic analysis will be used to explore and examine study results, disciplines associated with hospitals climate action and tools used to measure its implementation. The result is presented using tabulated data, and new themes will be included as required.

6) External consultation with relevant stakeholders.

In this review process, we will consult experts and health practitioners from the University of Sydney, Health Care Without Harm, Global Green and Healthy Hospital, the International Health Promoting Hospitals and Health Services Network. These institutions and hospital networks have extensive research experience in the field of greening the healthcare and hospital development. We will analyse and incorporate their inputs into this review.

DISCUSSION

Implication

The climate-smart hospital working group will use the result from this scoping review to strategically work with hospitals and our partners to improve their implementations of hospital mitigation and adaptation. Findings will support stakeholders to make evidence-based decisions, as well as research directions.

Moreover, this scoping review will serve as an essential synthesis of scientific knowledge on adaptation and mitigation action in hospitals. As such, it will contribute to the *Lancet* climate and health countdown (Panel 3 Health system climate change risk assessment, preparedness and resilience); and other global processes on the Sendai Framework global target D (reduce critical infrastructure disruption by 2030) and associated indicators. There has not been, to the best of our knowledge; no systematic scoping review exists.

Dissemination

This project is part of the climate-smart hospital initiative to enhance hospital climate preparedness. Task Force on HPH and Environment of The International Health Promoting Hospital and Health Services also informs this work, which comprised health practitioners across regions to provide strategic advice to the HPH members on various environment-related matters that impact health promotion-based practice in hospital settings.

We will share the review findings with all members of the International HPH and Global Green and Healthy Hospital (GGHH) network. Results may be of interest to hospitals globally who are seeking to improve their understanding of hospitals adaptation and implementation strategy internationally. Dissemination will occur through peer-reviewed scientific publications and to the HPH and membership through annual conference and newsletter.

CONTRIBUTORS

Gan prepared the first draft and initiated the project. Pascual, Banwell and Dwirahmadi advised on the rationale and data collection methods. Chu and Wang provided inputs on study methodology and revised the draft. All authors approved the final version of this paper.

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COMPETING INTEREST

None declared.

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ETHICS APPROVAL

This literature-based study does not require ethical approval.

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Hospital Climate Actions and Assessment Tools: A Scoping Review Protocol

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ABSTRACT

Introduction: Health and climate change are inexorably linked through the exacerbation of health risks and the contribution of the health sector to greenhouse gas emissions. Climate action in healthcare settings is critical to address climate change with a smarter use of energy, minimising waste and by enhancing disaster preparedness. Globally, hospital climate action is growing, but there is the potential to go further. The scientific literature on this topic lacks synthesis and poses challenges for hospital leadership to track climate action performance and spur even higher climate target and implementation. This scoping review will reflect the current knowledge about hospital climate action and existing tools to measure progress in this area.

Methods and analysis: We will conduct a scoping review applying the six-stage protocol proposed by Asksey and O'Malley. Our study includes peer-reviewed literature of how hospitals have addressed climate change (mitigation and adaptation) since Kyoto Protocol was signed in 1997. All identified studies indexed in Medline, Scopus, Embase and CINAHL will be examined. Quantitative and thematic analysis will be used to evaluate and categorise the study results.

Ethics and dissemination: This research is part of the climate-smart hospital initiative to improve the implementation of hospital climate action. This scoping review will provide a valuable synthesis to aid understanding of hospitals' climate actions, and tools used to measure its implementation. This scoping review will support the mobilising and acceleratation of hospital climate action, recognise and showcase existing actions and share and create knowledge on high-potential solutions. The findings will be disseminated with all members of the International Health Promoting Hospital and Health Services (HPH) and the Global Green and Healthy Hospital (GGHH) network. Dissemination will occur through peer-reviewed publications and with the HPH and membership through its annual conference and newsletter.

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- This review will study multidisciplinary databases covering public health, medicine, engineering, architecture, social science, policy and the environment to provide a comprehensive evaluation of the literature.
- There will be no restrictions applied to healthcare facility type, study design or location, which are published in English, Chinese and Indonesian.
- The study aims to synthesise different aspects of hospital climate actions, identified studies will not be excluded based on quality assessment. However, the type of literature and the value of available evidence will be charted in the review.
- While there is limited to no incentive for hospital to publish actions taken on adaptation and mitigation, data source are restricted only to those that were publicly available. However, relevant stakeholders' insights will be incorporated in this review process.

INTRODUCTION

Climate change threatens the lives and health of countless people, coastal cities and local economies. Researchers have warned that climate change is more likely to intensify and increase the severity of various climate-sensitive extreme events and their associated health risks [1–4]. More than 6,000 subnational actors, including cities and regions have made have made quantifiable commitments to cut down emissions in achieving the Paris Agreement [5]. However, making commitments is only the first step towards the transformations necessary to achieve domestic climate targets and the Paris Agreement goals. Collective tracking of impacts from individual commitments is challenging because of inadequate and often uneven information on targets and greenhouse gas emissions. Moreover, the effort to align methodologies and concepts applied by the diverse range of stakeholders engaged in climate action is still being advanced.

Delays in action increase the risk of missing the Paris goals and exposing the world to more significant impacts from climate change [6-7]. The recent International Panel on Climate Change '1.5 Degree Report' highlighted the potential consequences of climate change if we keep releasing emissions at our current rate [8]. Global warming and climate-related disasters, such as floods and emerging infectious disease outbreaks, present severe health security threats on a global scale. Hospitals as they play a critical role in reducing climate impacts not only by treating illnesses and injuries but also by being prepared for climate-induced disasters and leading community efforts to adapt climate change [9].

Healthcare is among the 'heavy-emitting' sectors; the global health sector had a climate footprint of 2.0GtCO_2e in 2014, equivalent to 4.4% of global net emissions [10]. The National Health Service carbon footprint in England is 22.8 million tonnes of carbon dioxide equivalents (MtCO_2e) in 2015 [11]. Healthcare sector accounts for 7% of Australia's total emissions [12] and 10% of the United States [13] national CO_2e emissions. Healthcare facilities are often significant consumers of energy and producers of waste [14]. Several organisations and alliances in North America, Europe and Asia have surfaced over the past decade with a remit to address the ecological and carbon footprint of hospitals [15–18].

Healthcare facilities must be encouraged to uphold their mitigation efforts, which reduce the speed, stabilise or mitigate climate change by cutting down greenhouse gas emissions [19]. On a daily basis, hospitals generate enormous energy and greenhouse gas emissions, which contribute to climate change. There are mitigation measures hospitals can take to slow the warming trend. Low-carbon health services including hospital design which allow natural lighting, prioritises renewable energy transition, employs energy efficiency measures [20], rainwater harvesting, provision of facilities for cycling or walking and minimise healthcare waste management [21] and refusing single-use plastics with green procurement policy [22]. However, at this critical time, mitigating emissions is no longer optional to allow adaptation possible for climate–health threats.

The health care sector cannot turn away from climate change and must be ready to lead the way with carbon reduction initiatives that also improve the standard of healthcare [23]. The health sector has the responsibility to act on health threats and manage future demands on the health service. Healthcare facilities need to incorporate both mitigation and adaptation measures, which include projections and preparedness for the impacts of climate change, to lessen health burden. Focusing efforts to enhance the adaptive capacity in specific areas, promoting institutional improvement, embracing adaptive management, and developing tools to support these processes are important priorities and can build the resilience of local public health systems to climate change [24-25]. However, it is unclear how hospitals across worldwide are acting to reduce emissions and adapt to climate change.

Therefore, this scoping review will reflect the current knowledge about hospital climate action and the existing tools to measure progress in this area. As converging crises of climate change,

we require much more radical climate action. This scoping review will support mobilising and accelerating climate action and help to reap the benefits in efficiency and effectiveness among different actors.

RESEARCH OBJECTIVES

The purpose of this scoping review is to gain understanding on the development of hospitals incorporating climate change adaptation and mitigation practices to address climate change. The findings from this scoping review will provide a comprehensive understanding of the current knowledge of hospital climate actions and tools used to measure its implementation. This review will be used to support mobilising and accelerating hospital climate action, showcasing existing actions and sharing and creating knowledge on high-potential solutions.

METHODOLOGY

Patient and public involvement

This scoping review study will have no patient or public involvement in the design or planning of this study.

Protocol design

This scoping review will be conducted as per Arksey and O'Malley [26] and further developed by Levac et al [27]. These methods include six-stage procedures including: (1) identifying the research question, (2) identifying relevant studies, (3) study selection, (4) charting the data, (5) collating, summarising and reporting the result and (6) external consultation with relevant stakeholders.

1) Identifying the research question

- To what extent do hospitals address climate change?
  - Mitigation (sustainable policy, improve energy efficiency, shifting to renewable energy, minimising waste, green procurement)
  - Adaptation (disaster risk reduction, health professionals' and community climate awareness and preparedness, vulnerability evaluation, early warning system)

- What measures and tools exist in the scientific literature regarding climate change mitigation and adaptation in hospitals?

2) *Information sources and search strategy*

Eligible studies will be identified through Medline, Scopus, Embase and CINAHL. The search terms cover all areas of climate action and hospital, including Medical Subject Headings (MeSH) terms, subject headings and keywords. The search strategy in the proposed databases based on the keywords is demonstrated in Table 1, and search syntaxes outlined in Table 2. To capture all eligible studies, we will follow the search strategy, which allows both MeSH terms and free text.

Table 1. Search terms for the scoping review on 'Hospital and climate action.'

Hospital-related
Healthcare provider/industry/sector, hospital, medical facility/institution/centre/ acute care unit, intensive care unit, ward, clinic, infirmary, emergency department, trauma centre, nursing station, operating theatre, dialysis centre, operating room, surgical services
Climate-related
Climate change, global warming, extreme weather, climate variability, greenhouse gas emission, greenhouse effect, high temperature, heat wave, drought, flood, climate-induced, climate-related disaster, storm, typhoon, hurricanes, cyclone, sea level rise
Climate Action-related
Mitigation, reduction, adaptation, cease, tackle, address, combat, fight, strategy, procedure, process, implementation, action, effort, attempt, policy, framework, plan, law, approach, response, system thinking, integrated model.

Table 2. Search strategy syntax for Medline, Scopus, Embase, and CINAKL

Database	Search strategy syntax
Medline	("Healthcare provider*" OR "health care provider*" OR "healthcare industr*" OR "health care industr*" OR "healthcare sector*" OR "health care sector*" OR hospital* OR "medical facilit*" OR hospital* OR "health facilit*" OR "Medical facilit*" OR "health institution*" OR "Medical institution*" OR "health care cent*" OR "healthcare cent*" OR "acute care unit*" OR "healthcare institution*" OR "health care institution*" OR "intensive care unit*" OR ward* OR clinic* OR infirmar* OR "emergency department*" OR "trauma cent*" OR "nursing station*" OR "operating theat*" OR "dialysis centre*" OR "dialysis center*" OR hemodialysis OR

	“operating room*” OR “surgical service*”) AND ("climate change" OR "climate variabil*" OR "global warming" OR "greenhouse effect*" OR "greenhouse gas emission*" OR GHGE OR "heat wave*" OR heatwave* OR "high temperature*" OR drought* OR flood* OR "climate induced" OR "climate related disaster*" OR “storm*” OR “typhoo*” OR “hurricance*” OR “cyclone*” OR “sea level rise*”) AND (Mitigation OR reduction OR adaptation* OR cease OR tackl* OR address OR combat OR fight OR Strateg* OR procedure* OR process* OR implementation* OR action* OR effort* OR attempt* OR polic* OR framework OR plan* OR law OR approach* OR response* OR system thinking OR integrated model)
Scopus	TITLE-ABS-KEY ("Healthcare provider*" OR "health care provider*" OR "healthcare industr*" OR "health care industr*" OR "healthcare sector*" OR "health care sector*" OR hospital* OR "medical facilit*" OR hospital* OR "health facilit*" OR "Medical facilit*" OR "health institution*" OR "Medical institution*" OR "health care cent*" OR "healthcare cent*" OR "acute care unit*" OR "healthcare institution*" OR "health care institution*" OR "intensive care unit*" OR ward* OR clinic* OR infirmar* OR "emergency department*" OR "trauma cent*" OR "nursing station*" OR "operating theat*" OR "dialysis centre*" OR "dialysis center*" OR hemodialysis OR ““operating room*” OR “surgical service*”) AND TITLE-ABS-KEY ("climate change" OR "climate variabil*" OR "global warming" OR "greenhouse effect*" OR "greenhouse gas emission*" OR ghge OR "heat wave*" OR heatwave* OR "high temperature*" OR drought* OR flood* OR "climate induced" OR "climate related disaster*" OR storm* OR typhoo* OR hurricance* OR cyclone* OR sea level rise*) AND TITLE-ABS-KEY (mitigation OR reduction OR adaptation* OR cease OR tackl* OR address OR combat OR fight OR strateg* OR procedure* OR process* OR implementation* OR action* OR effort* OR attempt* OR polic* OR framework OR plan* OR law OR approach* OR response* OR system thinking OR integrated model*)
Embase	('healthcare provider*':ti,ab,kw OR 'health care provider*':ti,ab,kw OR 'healthcare industr*':ti,ab,kw OR 'health care industr*':ti,ab,kw OR 'healthcare sector*':ti,ab,kw OR 'health care sector*':ti,ab,kw OR hospital*:ti,ab,kw OR 'health facilit*':ti,ab,kw OR 'medical facilit*':ti,ab,kw OR 'health institution*':ti,ab,kw OR 'medical institution*':ti,ab,kw OR 'health care cent*':ti,ab,kw OR 'healthcare cent*':ti,ab,kw OR 'acute care unit*':ti,ab,kw OR 'healthcare institution*':ti,ab,kw OR 'health care institution*':ti,ab,kw OR 'intensive care unit*':ti,ab,kw OR ward*:ti,ab,kw OR clinic*:ti,ab,kw OR infirmar*:ti,ab,kw OR 'emergency department*':ti,ab,kw OR 'trauma cent*':ti,ab,kw OR 'nursing station*':ti,ab,kw OR 'operating theat*':ti,ab,kw OR 'dialysis centre*':ti,ab,kw OR hemodialysis:ti,ab,kw) AND ('climate change':ti,ab,kw OR 'global warming':ti,ab,kw OR 'extreme weather':ti,ab,kw OR 'climate variability*':ti,ab,kw OR 'carbon footprint':ti,ab,kw) AND (mitigation:ti,ab,kw OR reduction:ti,ab,kw OR adaptation*:ti,ab,kw OR cease:ti,ab,kw OR tackl*:ti,ab,kw OR address:ti,ab,kw OR combat:ti,ab,kw OR fight:ti,ab,kw OR strateg*:ti,ab,kw OR

	procedure*:ti,ab,kw OR process*:ti,ab,kw OR implementation*:ti,ab,kw OR action*:ti,ab,kw OR effort*:ti,ab,kw OR attempt*:ti,ab,kw OR polic*:ti,ab,kw OR framework:ti,ab,kw OR plan*:ti,ab,kw OR law:ti,ab,kw OR approach*:ti,ab,kw OR response*:ti,ab,kw OR system thinking*:ti,ab,kw OR integrated model*:ti,ab,kw)
CINAKL	(“Healthcare provider*” OR “health care provider*” OR “healthcare industr*” OR “health care industr*” OR “healthcare sector*” OR “health care sector*” OR hospital* OR “medical facilit*” OR hospital* OR "health facilit*" OR "Medical facilit*" OR "health institution*" OR "Medical institution*" OR "health care cent*" OR "healthcare cent*" OR "acute care unit*" OR "healthcare institution*" OR "health care institution*" OR "intensive care unit*" OR ward* OR clinic* OR infirmar* OR "emergency department*" OR "trauma cent*" OR "nursing station*" OR "operating theat*" OR “dialysis centre*” OR “dialysis center*” OR hemodialysis OR “operating room*” OR “surgical service*”) AND ("climate change" OR "climate variabil*" OR "global warming" OR "greenhouse effect*" OR "greenhouse gas emission*" OR GHGE OR "heat wave*" OR heatwave* OR "high temperature*" OR drought* OR flood* OR "climate induced" OR "climate related disaster*" OR “storm*” OR “typhoo*” OR “hurricance*” OR “cyclone*” OR “sea level rise*”) AND (Mitigation OR reduction OR adaptation* OR cease OR tackl* OR address OR combat OR fight OR Strateg* OR procedure* OR process* OR implementation* OR action* OR effort* OR attempt* OR polic* OR framework OR plan* OR law OR approach* OR response* OR system thinking OR integrated model*)

3) Study selection process

The research team will first use Zotero software to remove duplicates of references; and then screen titles and abstracts in English, Chinese and Indonesian. Two independent reviewers who have proficiencies in English, Chinese and Indonesian will be involved in this step. Title and abstract screening will be based on the inclusion and exclusion criteria outlined in Table 3. Those that meet all eligibility criteria will be include in the analysis. All screening and data abstraction process will be conducted by two independent reviewers. The two primary reviewers will resolve the inconsistency in study eligibility through discussion, before involving a third reviewer in the study selection stage.

Table 3. Selection of articles Based on Inclusion and Exclusion Criteria

Inclusion criteria	Exclusion criteria
Peer-reviewed articles with all types of methods	conference proceedings, dissertations

Publication types (original, reviews, commentaries, editorials, case studies, grey literatures)	The language used not in English, Chinese and Indonesian.
Indexed in MEDLINE, Scopus and Embase	
Published since 1997*	
No restriction to geographical origin or population	

*Date of publication: The *Kyoto Protocol,* an international agreement signed in 1997 (UN Doc FCCC/CP/1997/7/Add.1, Dec. 10, 1997; 37 ILM 22 (1998) which linked to the United Nations Framework Convention on Climate Change (UNFCCC), which commits its Parties by setting internationally binding emission reduction targets.

4) Data items and data abstraction process

The scoping review will explore the implemented mitigation and adaptation actions in hospitals and the tools which are being used to track progress. Data extraction including author, publication date, journal, study characteristic, intervention characteristic, tools used to measure intervention, intervention results (e.g., barriers, success factors, outcomes) and drivers reported associated with hospital climate action. Examples of facilitating factors include, but are not limited to, law and policy, electricity cost, advocates (e.g. Environmentalist), characteristic of the hospital (e.g. faith-based organisations), vulnerability to climate change (e.g. higher risk of flood, past disasters experience). The research team will discuss these factors before reviewing to ensure standardisation and comprehensiveness.

5) Synthesis of Result

The primary researcher will conduct a thematic analysis to explore and examine study results, disciplines associated with hospitals climate action and tools used to measure its implementation. The result is presented using tabulated data, and new themes will be included as required.

6) External consultation with relevant stakeholders.

A 1-day scoping study consultation meeting will be held to present a preliminary summary of the state of evidence related to hospital climate actions and tools used to measure its implementation. Experts, health practitioners and relevant stakeholders in the field of greening

healthcare will be encouraged to express their ideas as they pertain to the results during the meeting discussion.

Sessions will include a combination of structured presentations from experts, small and large group discussion sessions to facilitate knowledge exchange of insights for establishing a common consensus and identifying key considerations for promoting climate actions in hospital settings.

The authors will use Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for scoping review (PRISMA-ScR) checklist [28] on the reporting of this scoping review.

DISCUSSION

Implication

The climate-smart hospital working group will use the results of this scoping review to strategically work with hospitals and our partners to improve their implementation of hospital mitigation and adaptation. Findings will support stakeholders to make evidence-based decisions, as well as research directions. Moreover, this scoping review will serve as an essential synthesis of scientific knowledge on adaptation and mitigation action in hospitals. There has not been, to the best of our knowledge, a systematic scoping review undertaken.

Dissemination

This project is part of the climate-smart hospital initiative to enhance hospital climate preparedness. Task Force on HPH and Environment of The International Health Promoting Hospital and Health Services (HPH) also informs this work, which comprises health practitioners across regions to provide strategic advice to the HPH members on various environment-related matters that impact health promotion-based practice in hospital settings.

We will share the review findings with all members of the International HPH and Global Green and Healthy Hospital (GGHH) network. Results may be of interest to Ministries of Health, policymakers, national climate change and health teams, hospital managers, healthcare practitioners globally who are seeking to improve their understanding of hospital adaptation and implementation strategy internationally. Dissemination will occur through peer-reviewed

scientific publications and to the HPH and membership through their annual conference and newsletter.

CONTRIBUTORS

Gan prepared the first draft and initiated the project. Pascual, Banwell and Dwirahmadi advised on the rationale and data collection methods. Chu and Wang provided inputs on study methodology and revised the draft. All authors approved the final version of this paper.

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COMPETING INTEREST

None declared.

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ETHICS APPROVAL

This literature-based study does not require ethical approval.

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Hospital Climate Actions and Assessment Tools: A Scoping Review Protocol

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TITLE-

Hospital Climate Actions and Assessment Tools: A Scoping Review Protocol

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ABSTRACT

Introduction: Health and climate change are inexorably linked through the exacerbation of health risks and the contribution of the health sector to greenhouse gas emissions. Climate action in healthcare settings is critical to reduce risks and impacts of climate change through the smarter use of energy, minimising waste and enhancing disaster preparedness. Globally, hospital climate action is growing; however, the potential for further progress and impacts remains. The literature on this topic lacks synthesis, and this poses challenges for hospital leadership in tracking the impact of climate action. This scoping review will summarise the current knowledge about hospital climate action and existing tools to measure progress in this area.

Methods and analysis: This scoping review will be conducted applying the six-stage protocol proposed by Asksey and O'Malley. The study includes literature of how hospitals have addressed climate change (mitigation and adaptation) since the Kyoto Protocol was signed in 1997. All identified studies indexed in Medline, Scopus, Embase and CINAHL will be examined. The search strategy will also include Google Scholar to capture relevant grey literature. Quantitative and thematic analysis will be used to evaluate and categorise the study results.

Ethics and dissemination: This scoping review is part of the climate-smart hospital initiative which will provide a valuable synthesis to aid understanding of hospitals' climate actions, and tools used to measure its implementation. As such it will contribute to mobilising and accelerating the implementation of climate action in hospitals.

The findings will be disseminated with all members of the International Health Promoting Hospital and Health Services (HPH) and the Global Green and Healthy Hospital (GGHH) network. Dissemination will occur through peer-reviewed publications and with the HPH and membership through its annual conference and newsletter.

Keywords: Climate action, hospital, climate-smart healthcare, health-promoting hospital, scoping review

Strengths and limitations of this study

- This systematic scoping review will provide a pertinent synthesis and systematic examination of scientific and grey literature regarding mitigation and adaptation in hospitals.
- This review will study multidisciplinary databases covering public health, medicine, engineering, architecture, social science, policy and the environment to provide a comprehensive evaluation of the literature.
- There will be no restrictions applied to healthcare facility type, study design or location, which are published in English, Chinese and Indonesian.
- The study aims to synthesise different aspects of hospital climate actions; identified studies will not be excluded based on quality assessment. However, the type of literature and the value of available evidence will be charted in the review.
- While there is limited to no incentive for hospital to publish actions taken on adaptation and mitigation, data sources are restricted only to those that were publicly available. However, relevant stakeholders' insights will be incorporated into this review process.

INTRODUCTION

Climate change threatens the lives and health of countless people, coastal cities and local economies. Researchers have warned that climate change will intensify and increase the severity of various climate-sensitive extreme events and their associated health risks [1–4]. More than 6,000 subnational actors, including cities and regions, have made quantifiable commitments to reducing emissions to achieve the Paris Agreement [5]. However, making commitments is only the first step towards the transformations necessary to achieve nationally determined contributions (NDCs). Collective tracking of contributions from individual commitments is challenging because of inadequate and often incomplete information on targets and greenhouse gas emissions. Moreover, there are ongoing efforts to align methodologies and concepts applied by the diverse range of stakeholders engaged in climate action.

Delays in action increase the risk of missing global mitigation targets and exposing the world to more significant impacts from climate change [6-7]. The recent Intergovernmental Panel on Climate Change '1.5 Degree Report' highlighted the

potential consequences of climate change if current emission rates continue [8]. Global warming and climate-related disasters, such as floods and infectious disease outbreaks present severe health threats on a global scale [9]. Hospitals play a critical role in reducing health impacts by 1) treating illnesses and injuries, 2) being prepared for climate-induced disasters, 3) effectively engage the community on adaptation activities and 4) stepping up to minimise healthcare carbon emissions [10,11].

Healthcare is among the 'heavy-emitting' sectors; the global healthcare sector had a climate footprint of 2.0GtCO_2e in 2014, equivalent to 4.4% of global net emissions [11]. The National Health Service carbon footprint in England is 22.8 million tonnes of carbon dioxide equivalents (MtCO_2e) in 2015 [12]. The Australian healthcare sector accounts for 7% of total national emissions [13] and 10% of the United States [14] national CO_2e emissions. As hospitals are often significant consumers of energy and producers of waste [15], several organisations and alliances in North America, Europe and Asia have surfaced over the past decade with commitments addressing these issues [16–19].

Hospitals must be encouraged to uphold their mitigation efforts, and there are mitigation measures which hospitals can take to slow the warming trend. Low-carbon health services including hospital design which allow natural lighting, policies that prioritise renewable energy transition, employs energy efficiency measures [20], rainwater harvesting, provision of facilities for cycling or walking and minimise healthcare waste management [21] and refusing single-use plastics with green procurement policy [22]. The healthcare sector cannot turn away from climate change and must act on this responsibility through accelerated concrete implementation of carbon reduction initiatives that also improve the standard of healthcare [23]. However, at this critical time, mitigating emissions is no longer optional; furthermore, specific adaptation actions are necessary to face climate–health threats.

The healthcare sector has the responsibility to act on health threats and manage future demands on the health service. Healthcare facilities need to incorporate both mitigation and adaptation measures, which include projections and preparedness for the impacts of climate change to lessen health burden. By focusing their efforts to enhance the adaptive capacity in specific areas, promoting institutional improvement,

embracing adaptive management, and developing tools [24] to support these processes are important priorities and can build the resilience of local health systems to climate change [25,26]. However, it is unclear how hospitals worldwide are acting to reduce emissions and adapt to climate change.

As the converging crises of health and climate change, we require much more radical climate action. Therefore, this scoping review will synthesise the current knowledge about hospital climate action and the existing tools to measure progress in this area. As such it will contribute to mobilising and accelerating hospitals to implement climate action.

RESEARCH OBJECTIVES

The purpose of this scoping review is to synthesise knowledge on how hospitals incorporate adaptation and mitigation practices to address climate change. The findings from this scoping review will provide a comprehensive understanding of the current knowledge of hospital climate actions and tools used to measure their implementation. This review will showcase existing actions and share knowledge on solutions with high potential for success.

METHODOLOGY

Patient and public involvement

This scoping review study will have no patient or public involvement in the design or planning of this study.

Protocol design

This scoping review will be conducted based on the methodology as per Arksey and O'Malley [27] and further developed by Levac et al. [28]. These methods include six-stage procedures including 1) identifying the research question, 2) information sources and search strategy, 3) study selection, 4) data extraction, 5) collating, summarising and reporting the result and 6) external consultation with relevant stakeholders.

1) Identifying the research question

- To what extent do hospitals address climate change?

- Mitigation (sustainable policy, improve energy efficiency, shifting to renewable energy, minimising waste, green procurement)
- Adaptation (disaster risk reduction, health professionals' and community climate awareness and preparedness, vulnerability evaluation, early warning system)

- What measures and tools exist in the scientific literature regarding climate change mitigation and adaptation in hospitals?

2) Information sources and search strategy

Eligible studies will be identified through Medline, Scopus, Embase and CINAHL. The search terms cover all areas of climate action and hospital, including Medical Subject Headings (MeSH) terms, subject headings and keywords. To truly capture grey literature, search strategy will include Google Scholar, and searches of targeted organisations, file types and websites. The keywords for the search strategy are outlined in Table 1, and the corresponding search syntaxes for each database are outlined in Table 2. To capture all eligible studies, we will follow the search strategy, which allows both MeSH terms and free text.

Table 1. Search terms for the scoping review on 'Hospital and climate action'

Hospital-related
Healthcare provider/industry/sector, hospital, medical facility/institution/centre/ acute care unit, intensive care unit, ward, clinic, infirmary, emergency department, trauma centre, nursing station, operating theatre, dialysis centre, operating room, surgical services
Climate-related
Climate change, global warming, extreme weather, climate variability, greenhouse gas emission, greenhouse effect, high temperature, heatwave, drought, flood, climate-induced, climate-related disaster, storm, typhoon, hurricanes, cyclone, sea-level rise
Climate Action-related
Mitigation, reduction, adaptation, cease, tackle, address, combat, fight, strategy, procedure, process, implementation, action, effort, attempt, policy, framework, plan, law, approach, response, system thinking, integrated model.

Table 2. Search strategy syntax for Medline, Scopus, Embase, and CINAKL

Database	Search strategy syntax
Medline	(“Healthcare provider*” OR “health care provider*” OR “healthcare industr*” OR “health care industr*” OR “healthcare sector*” OR “health care sector*” OR hospital* OR “medical facilit*” OR hospital* OR "health facilit*" OR "Medical facilit*" OR "health institution*" OR "Medical institution*" OR "health care cent*" OR "healthcare cent*" OR "acute care unit*" OR "healthcare institution*" OR "health care institution*" OR "intensive care unit*" OR ward* OR clinic* OR infirmar* OR "emergency department*" OR "trauma cent*" OR "nursing station*" OR "operating theat*" OR “dialysis centre*” OR “dialysis center*” OR hemodialysis OR “operating room*” OR “surgical service*”) AND ("climate change" OR "climate variabil*" OR "global warming" OR "greenhouse effect*" OR "greenhouse gas emission*" OR GHGE OR "heat wave*" OR heatwave* OR "high temperature*" OR drought* OR flood* OR "climate induced" OR "climate related disaster*" OR “storm*” OR “typhoo*” OR “hurricance*” OR “cyclone*” OR “sea level rise*”) AND (Mitigation OR reduction OR adaptation* OR cease OR tackl* OR address OR combat OR fight OR Strateg* OR procedure* OR process* OR implementation* OR action* OR effort* OR attempt* OR polic* OR framework OR plan* OR law OR approach* OR response* OR “system thinking” OR integrated model)
Scopus	TITLE-ABS-KEY ("Healthcare provider*" OR "health care provider*" OR "healthcare industr*" OR "health care industr*" OR "healthcare sector*" OR "health care sector*" OR hospital* OR "medical facilit*" OR hospital* OR "health facilit*" OR "Medical facilit*" OR "health institution*" OR "Medical institution*" OR "health care cent*" OR "healthcare cent*" OR "acute care unit*" OR "healthcare institution*" OR "health care institution*" OR "intensive care unit*" OR ward* OR clinic* OR infirmar* OR "emergency department*" OR "trauma cent*" OR "nursing station*" OR "operating theat*" OR "dialysis centre*" OR "dialysis center*" OR hemodialysis OR ““operating room*” OR “surgical service*”) AND TITLE-ABS-KEY ("climate change" OR "climate variabil*" OR "global warming" OR "greenhouse effect*" OR "greenhouse gas emission*" OR ghge OR "heat wave*" OR heatwave* OR "high temperature*" OR drought* OR flood* OR "climate induced" OR "climate related disaster*" OR storm* OR typhoo* OR hurricance* OR cyclone* OR sea level rise*) AND TITLE-ABS-KEY (mitigation OR reduction OR adaptation* OR cease OR tackl* OR address OR combat OR fight OR strateg* OR procedure* OR process* OR implementation* OR action* OR effort* OR attempt* OR polic* OR framework OR plan

	* OR law OR approach* OR response* OR “system thinking” OR integrated model*)
Embase	('healthcare provider*':ti,ab,kw OR 'health care provider*':ti,ab,kw OR 'healthcare industr*':ti,ab,kw OR 'health care industr*':ti,ab,kw OR 'healthcare sector*':ti,ab,kw OR 'health care sector*':ti,ab,kw OR hospital*:ti,ab,kw OR 'health facilit*':ti,ab,kw OR 'medical facilit*':ti,ab,kw OR 'health institution*':ti,ab,kw OR 'medical institution*':ti,ab,kw OR 'health care cent*':ti,ab,kw OR 'healthcare cent*':ti,ab,kw OR 'acute care unit*':ti,ab,kw OR 'healthcare institution*':ti,ab,kw OR 'health care institution*':ti,ab,kw OR 'intensive care unit*':ti,ab,kw OR ward*:ti,ab,kw OR clinic*:ti,ab,kw OR infirmar*:ti,ab,kw OR 'emergency department*':ti,ab,kw OR 'trauma cent*':ti,ab,kw OR 'nursing station*':ti,ab,kw OR 'operating theat*':ti,ab,kw OR 'dialysis centre*':ti,ab,kw OR hemodialysis:ti,ab,kw) AND ('climate change':ti,ab,kw OR 'global warming':ti,ab,kw OR 'extreme weather':ti,ab,kw OR 'climate variability*':ti,ab,kw OR 'carbon footprint':ti,ab,kw) AND (mitigation:ti,ab,kw OR reduction:ti,ab,kw OR adaptation*:ti,ab,kw OR cease:ti,ab,kw OR tackl*:ti,ab,kw OR address:ti,ab,kw OR combat:ti,ab,kw OR fight:ti,ab,kw OR strateg*:ti,ab,kw OR procedure*:ti,ab,kw OR process*:ti,ab,kw OR implementation*:ti,ab,kw OR action*:ti,ab,kw OR effort*:ti,ab,kw OR attempt*:ti,ab,kw OR polic*:ti,ab,kw OR framework:ti,ab,kw OR plan*:ti,ab,kw OR law:ti,ab,kw OR approach*:ti,ab,kw OR response*:ti,ab,kw OR system thinking*:ti,ab,kw OR integrated model*:ti,ab,kw)
CINAKL	(“Healthcare provider*” OR “health care provider*” OR “healthcare industr*” OR “health care industr*” OR “healthcare sector*” OR “health care sector*” OR hospital* OR “medical facilit*” OR hospital* OR "health facilit*" OR "Medical facilit*" OR "health institution*" OR "Medical institution*" OR "health care cent*" OR "healthcare cent*" OR "acute care unit*" OR "healthcare institution*" OR "health care institution*" OR "intensive care unit*" OR ward* OR clinic* OR infirmar* OR "emergency department*" OR "trauma cent*" OR "nursing station*" OR "operating theat*" OR “dialysis centre*” OR “dialysis center*” OR hemodialysis OR “operating room*” OR “surgical service*”) AND ("climate change" OR "climate variabil*" OR "global warming" OR "greenhouse effect*" OR "greenhouse gas emission*" OR GHGE OR "heat wave*" OR heatwave* OR "high temperature*" OR drought* OR flood* OR "climate induced" OR "climate related disaster*" OR “storm*” OR “typhoo*” OR “hurricance*” OR “cyclone*” OR “sea level rise*”) AND (Mitigation OR reduction OR adaptation* OR cease OR tackl* OR address OR combat OR fight OR Strateg* OR procedure* OR process* OR implementation* OR action* OR effort* OR attempt* OR polic* OR framework OR plan* OR law OR approach* OR response* OR “system thinking” OR integrated model*)
Google Scholar	File type (pdf. / .doc), site: .gov, site: .org, and “topic” theses: site .edu

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3) Study selection

The research team will first use Zotero software to remove duplicates of references; and then screen titles and abstracts in English, Chinese and Indonesian. Two independent reviewers who have proficiencies in English, Chinese and Indonesian will be involved in this step. Title and abstract screening will be based on the inclusion and exclusion criteria outlined in Table 3. Those that meet all eligibility criteria will be included in the analysis. All screening and data extraction process will be conducted by two independent reviewers. The two primary reviewers will resolve any inconsistencies in study eligibility through discussion, before involving a third reviewer in the study selection stage.

Table 3. Selection of articles Based on Inclusion and Exclusion Criteria

Inclusion criteria	**Exclusion criteria**
Peer-reviewed articles with all types of methods	conference proceedings, dissertations
Publication types (original research article; reviews; commentaries; editorials; case studies; and grey literature including conference papers, corporate sustainability reports, theses, and technical guidance documents)	The language used does not include English, Chinese or Indonesian.
Indexed in MEDLINE, Scopus and Embase	
Published since 1997*	
No restriction to geographical origin or population	

*Date of publication: The *Kyoto Protocol,* an international agreement signed in 1997 (UN Doc FCCC/CP/1997/7/Add.1, Dec. 10, 1997; 37 ILM 22 (1998) which linked to the United Nations Framework Convention on Climate Change (UNFCCC), which commits its Parties by setting internationally binding emission reduction targets.

4) Data extraction process

The scoping review will explore the implemented mitigation and adaptation actions in hospitals and the tools which are being used to track progress. Data extraction will include: author, publication date, journal, study characteristic, intervention

characteristic, tools used to measure intervention, intervention results (e.g., barriers, success factors, and outcomes) and drivers reported associated with hospital climate action. Examples of facilitating factors include, but are not limited to, law and policy, available funding, electricity cost, advocates (e.g. Environmentalist), characteristic of the hospital (e.g. faith-based organisations), vulnerability to climate change (e.g. higher risk of flood, past disasters experience). The research team will discuss these factors before reviewing to ensure standardisation and comprehensiveness.

5) Collating, summarising and reporting the result

The primary researcher will conduct a thematic analysis to explore and examine study results, disciplines associated with hospitals climate action and tools used to measure its implementation. The result is presented using tabulated data, and new themes will be included as required.

6) External consultation with relevant stakeholders.

A one-day consultation meeting will be held to present a preliminary summary of the state of evidence related to hospital climate actions and tools used to measure its implementation. Experts, health practitioners and relevant stakeholders in the field of greening healthcare will be encouraged to express their ideas as they pertain to the results during the meeting discussion. The meeting will include a combination of structured presentations from experts, small and large group discussion sessions to facilitate knowledge exchange of insights for establishing a common consensus and identifying critical considerations for promoting climate actions in hospital settings.

The authors will use the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for scoping review (PRISMA-ScR) checklist [29] on the reporting of this scoping review.

Ethics and Dissemination

This project is literature-based research, thus does not require ethical approval. This research is part of the climate-smart hospital initiative to enhance hospital climate preparedness. The Task Force on HPH and Environment of The International Health Promoting Hospital and Health Services (HPH) provides valuable guidance to inform this work. The taskforce consists of health practitioners across regions who provide

strategic advice to HPH members on various environment-related matters that impact health promotion-based practice in hospital settings.

We will share the review findings with all members of the International HPH and Global Green and Healthy Hospital (GGHH) network. Results may be of interest to Ministries of Health, policymakers, national climate change and health teams, hospital managers, healthcare practitioners globally who are seeking to improve their understanding of hospital adaptation and implementation strategy internationally. Dissemination will occur through peer-reviewed scientific publications and to the HPH and membership through their annual conference and newsletter.

CONTRIBUTORS

Gan prepared the first draft, initiated the project and revised the manuscript. Banwell and San Pascual advised on the rationale and search strategy. Chu and Wang provided inputs on study methodology.

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COMPETING INTEREST

None declared.

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