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Review

Climate change and primary health care in Africa: A scoping review

C.L. Lokotola[a,*], R. Mash[a], K. Naidoo[b], V. Mubangizi[c], N. Mofolo[d], P.N. Schwerdtle[e,f]

[a] Faculty of Medicine and Health Sciences, Department of Family and Emergency Medicine, Division of Family Medicine and Primary Care, Stellenbosch University, Cape Town, South Africa
[b] Faculty of Health Sciences, Department of Family Medicine, University of KwaZulu Natal, Durban, South Africa
[c] Mbarara University of Science and Technology, Mbarara, Uganda
[d] Sefako Makgatho Health Sciences University, Pretoria, South Africa
[e] Heidelberg Institute of Global Health, Heidelberg University, Germany
[f] Faculty of Medicine, Nursing and Health Sciences, Monash University, Clayton, Australia

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ABSTRACT

Background: Climate change is one of the biggest threats to global health and primary health care (PHC). In Africa, building climate resilient PHC is a challenge as there is little evidence to inform health systems and policymakers.
Aim: To determine the extent of the literature on climate change and PHC in the African context and identify knowledge gaps.
Methods: A scoping review systematically searched the published and grey literature (2010–2021) including six databases (Scopus, Pubmed, Cinahl, Africa Wide, Web of Science, and Open Grey) and research repositories from prominent African universities. A comprehensive search strategy and data extraction from included studies were used. Data were analyzed both quantitatively and qualitatively.
Results: A total of 1242 studies were identified and 12 included. Most of the articles were published from 2016 onwards. Publications came from five countries, with South Africa and Ghana having more than one. Most studies were narrative reviews or descriptive studies, using qualitative interviews or surveys. PHC services in Africa will experience increasing challenges of malnutrition, infectious diseases, heat-related conditions, injuries, non-communicable diseases, mental health problems and migration. However, there is an absence of actual surveillance or monitoring data. Only one study focused on the use of renewable energy as a means of resilience and mitigation. There were no studies on health financing implications.
Conclusion: The literature is accruing on climate change and health in the African context, but there is a lack of evidence on climate resilient PHC. Ten priority research questions were identified.
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1. Introduction

Climate change is one of the important ecological drivers of changes in air quality, food production, infectious disease exposure, access to fresh water and exposure to natural hazards, such as extreme weather events. Anthropogenic greenhouse gas emissions have significantly increased global temperatures and have led to climate change [1]. Changes in the climate have significant implications for human health and wellbeing as well as healthcare services [2].

The last report of the Intergovernmental Panel on Climate Change projected extensive social and health impacts [3]. The effects of climate change can be rapid-onset (such as cyclones) or slow-onset (such as drought), leading to a range of health effects, which are mostly negative, and include injury and trauma, malnutrition, infectious diseases, heat-related conditions, non-communicable diseases, and poor mental health [4,5]. These health effects are accompanied by related social impacts such as loss of livelihoods, migration and displacement of populations, food insecurity and conflict [6]. The impacts are already being felt and will continue to be disproportionately experienced by vulnerable populations and in locations where adaptive capacity is lowest [7,8]. Low and middle-income countries (LMIC) in Africa are amongst those predicted to experience the worst impacts of climate change [6].

In 2021, at the United Nations Climate Change Conference of the Parties (COP) 26, over two-thirds of the health workforce globally - 600 organizations representing over 46 million health workers from 102 countries - called for meaningful action to address the climate crisis by limiting global warming to 1.5°C. They called this "The Healthy Climate Prescription" [9]. Additionally, 50 countries (18 from Africa) committed to creating climate-resilient, low-carbon, sustainable health systems [10]. This is an effort to make human health and equity central to all climate change mitigation and adaptation

* Corresponding author.
E-mail address: christianl@sun.ac.za (C.L. Lokotola).

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actions. A recent World Health Organization (WHO) survey showed that a lack of funding is one of the main barriers countries face in implementing effective protection measures for their populations [11], with only 0.3% of global adaptation funding currently assisting health systems [12].

Health systems are just beginning to address the effects of climate change on health [11]. The effects can be considered from three different angles. First is the effect of climate change on morbidity and mortality and the ways in which health systems respond to the changing burden of disease [13]. The second is the ways in which health systems must reduce their own carbon footprints [14]. One hundred and ninety-six countries signed the Paris Agreement and have committed to reduce emissions variably over different time scales. In order to deliver on these commitments, health services are being asked to contribute. Thirdly, facilities and health services themselves will be impacted by climate change and need to adapt or become more resilient, to reduce the health risks to populations and maintain service delivery despite climate-related disruptions [15]. For example, extreme weather events may destroy infrastructure, telecommunications, supply chains and reduce access to both emergency and routine services [16].

Primary health care (PHC) is the foundation of every health system and high performing PHC can reduce the vulnerability of communities. The governments of the world recently re-committed themselves to PHC in the Astana Declaration and the three key PHC levers of "multisectoral policy and action, empowered people and communities, and integrated health services with an emphasis on primary care and essential public health functions" [17,18]. Unfortunately, in the African context, PHC is often poorly developed, in terms of both access and quality [19]. The WHO recently published a new framework to help with the measurement and improvement of PHC [20]. This framework includes the core concept of resilient PHC facilities and services. It recognizes that resilient health systems are based on PHC as the foundation for universal health care. The WHO considered climate resilience across the traditional building blocks of the health system: leadership and governance, financing, infrastructure and technology, supply chain, workforce, health information systems and service delivery. This framework is used later to give structure to the discussion of the review findings [15].

One way in which health services can improve their resilience is through research. The WHO states that "building climate resilience calls for both basic and applied research so as to reduce uncertainty about how local conditions may be affected, gain insight into local solutions and capacities, and build evidence to strengthen decision-making" [15]. In the WHO's global survey 46% of countries indicated that a lack of research evidence was a barrier to implementation of national health and climate change plans [11]. The WHO's global research agenda for health and climate change that was published in 2009 did not mention primary health care and focused on assessing the risks of climate change, identifying the most effective interventions, guiding health-promoting mitigation and adaptation strategies in other sectors, improving decision support, and estimating the costs of protecting health from climate change [21].

In order to develop a relevant and robust research agenda for PHC in the African context and respond to the challenge of climate change, we conducted a scoping review of the literature. The aim of the review was to determine the extent of the literature on climate change and PHC in the African context and identify knowledge gaps that can inform a research agenda.

2. Methods

2.1. Study design

This was a scoping review of the scientific literature on PHC and climate change in the African context using recognized methodology [22,23]. The PRISMA (Preferred Reporting Items for Systematic review and Meta-Analyses) guideline informed this scoping review [24].

2.2. Scoping review questions

The scoping review addressed the following questions:

- How is climate change impacting PHC service delivery in Africa?
- How is the PHC system adapting to climate change in Africa?
- How do PHC systems in Africa contribute to climate change?

2.3. Search strategy

2.3.1. Eligibility criteria

Table 1 lists the inclusion and exclusion criteria for the selected articles.

2.3.2. Information sources

To identify the original studies and the grey literature related to PHC and climate change, we systematically searched five databases: Scopus, Pubmed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Web Of Science and Open Grey. The databases were chosen for their international coverage of health sciences literature, interdisciplinarity and complementarity. CINAHL specifically included publications in French. Open Grey is a multidisciplinary open access database containing grey literature from European research institutions. The Africa Wide database and research repositories from selected African universities were searched to incorporate the regional literature. The two top ranking African universities from southern, western, eastern, central and northern Africa were selected [25].

2.4. Search terms

The search terms included both medical subject headings and keywords to identify research studies that addressed the research questions (Table 2). A standard set of search terms for Africa and African countries also were included.

Global warming refers to the annual temperature rise of the planet, but is another search term that might be used to index articles about "climate change" and therefore was included to ensure we identified all possible studies [26].

Two search strings (Box 1) were used with each of the information sources.

Box 1 *Search strings*

(Climate change OR global warming) AND ("Primary health care" OR "primary healthcare" OR "primary care" OR "district health service" OR "district health services" OR "district health system") AND (Africa OR Southern Africa OR East Africa OR Central Africa OR West Africa OR Sub-Saharan Africa OR Sub-Sahara Africa OR Sub Sahara Africa OR Angola OR Benin OR Botswana OR Burkina Faso OR Burundi OR Cameroon OR Cape Verde OR Central African Republic OR Chad OR Comoros OR Congo OR "Democratic Republic of Congo" OR Cote d'Ivoire/Ivory Coast OR Djibouti OR Equatorial OR Guinea OR Ethiopia OR Gabon OR Gambia OR Ghana OR Guinea OR Guinea-Bissau OR Kenya OR Lesotho OR Liberia OR Madagascar OR Malawi OR Mali OR Mauritania OR Mauritius OR Mozambique OR Namibia OR Niger OR Nigeria OR Rwanda OR "Sao Tome and Principe" OR Senegal OR Seychelles OR Sierra Leone OR Somalia OR South Africa OR

Sudan OR "South Sudan" OR Somaliland OR Swaziland OR eSwatini OR Tanzania OR Togo OR Uganda OR Zambia OR Zimbabwe OR Morocco OR Algeria OR Libya OR Egypt OR Tunisia OR Western Sahara OR North Africa)

("Carbon footprint" OR "greenhouse gases" OR environmental harm OR pollution) AND ("Primary health care" OR "primary healthcare" OR "primary care" OR "district health service" OR "district health services" OR "district health system") AND (Africa OR Southern Africa OR East Africa OR Central Africa OR West Africa OR Sub-Saharan Africa OR Sub-Sahara Africa OR Sub Sahara Africa OR Angola OR Benin OR Botswana OR Burkina Faso OR Burundi OR Cameroon OR Cape Verde OR Central African Republic OR Chad OR Comoros OR Congo OR "Democratic Republic of Congo" OR Cote d'Ivoire/Ivory Coast OR Djibouti OR Equatorial OR Guinea OR Ethiopia OR Gabon OR Gambia OR Ghana OR Guinea OR Guinea-Bissau OR Kenya OR Lesotho OR Liberia OR Madagascar OR Malawi OR Mali OR OR Mauritania OR Mauritius OR Mozambique OR Namibia OR Niger OR Nigeria OR Rwanda OR "Sao Tome and Principe" OR Senegal OR Seychelles OR Sierra Leone OR Somalia OR South Africa OR Sudan "South Sudan" OR Somaliland OR Swaziland OR eSwatini OR Tanzania OR Togo OR Uganda OR Zambia OR Zimbabwe OR Morocco OR Algeria OR Libya OR Egypt OR Tunisia OR Western Sahara OR North Africa)

2.5. Selection process

One researcher conducted the initial search on each information source and screened the publications by title and abstract against the inclusion and exclusion criteria. If there was doubt in terms of inclusion or exclusion, a second researcher was consulted (CL and RM). Duplicates were then removed, and full text articles assessed against the eligibility criteria. Articles were not excluded based on quality, because the objective of the scoping review was mapping the evidence. The reference lists of identified articles were also searched to avoid missing relevant articles. All the researchers included in the selection process were academics and researchers in family medicine and primary health care. Two were specifically focused on planetary health and climate change.

2.6. Data collection process

Data were extracted systematically according to a standardized Excel template. The data extraction fields included identifying features (the first author and full reference, year of publication), study design features (study location, the research aim, the study design, the methods), and results related to our three main questions. Researchers returned their extraction templates to CL who then integrated all the data into one spreadsheet. One researcher initially extracted the data from each article. The data were then interpreted by CL and RM, and where necessary, data extraction was checked and clarified.

Table 2
Search terms.

Climate change	Primary Health Care
Global warming	Primary health care
Greenhouse gases	Primary care
Environmental harm	District health service(s)
Pollution	District health system

2.7. Data analysis

The key characteristics of the studies were treated as categorical data and reported as frequencies and percentages. The extracted results were analyzed qualitatively using reflexive thematic analysis to identify the key themes that addressed the scoping review questions.

3. Results

3.1. The search

The search identified 1,242 research studies (Fig. 1). After screening by title and abstract, 26 studies remained. A further 14 articles were excluded as not meeting the eligibility criteria when reading the full text. Twelve studies were included in the final review (Table 1).

3.2. Characteristics of included studies

Most of the articles were published from 2016 onwards (Tables 3 and 4), with frequency of publications increasing slightly over time. Publications came from five African countries with South Africa and Ghana having more than one publication. Most studies were narrative reviews, or descriptive studies using qualitative interviews or surveys.

3.3. How has climate change impacted health and primary health care service delivery in Africa?

3.3.1. Malnutrition and food insecurity

A decrease in the food supply leads to malnutrition [27]. Decrease in food supply was linked to prolonged drought and water scarcity with failure of subsistence farming and death of livestock [33]. Children and the elderly were perceived to be most at risk.

3.3.2. Infectious diseases

Articles reported an increase in outbreaks of food- and waterborne infectious diseases such as viral gastroenteritis, typhoid, cholera, and schistosomiasis [27,33,36]. Water scarcity may lead to more

Table 1
Inclusion and exclusion criteria for selected articles.

	Include	Exclude
Population	Evidence from African settings	Evidence outside Africa
Concept	Evidence addresses both PHC and climate change	Evidence addressing just one/none of the focus concepts
Outcome	Evidence includes outcomes related to climate change impacts, climate change adaptation, climate resilience and mitigation of climate change	Evidence that does not include these outcomes/foci
Study design	Qualitative, quantitative and mixed methods studies. Research synthesis (scoping and systematic reviews)	Commentaries, editorials, reports, opinion pieces or publications that are not original research
Time period	2010–2021	Any studies not in the inclusion period
Language	English and French	Any studies not published in English or French

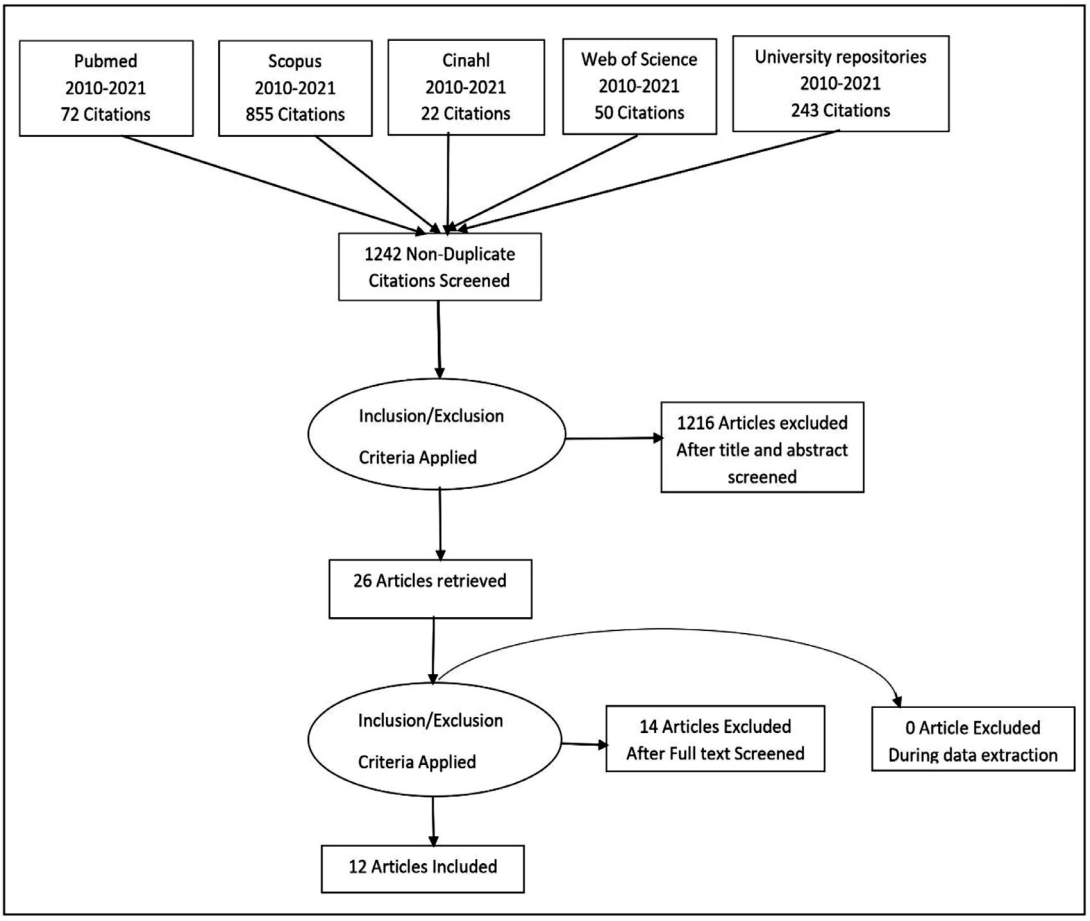


Fig. 1. PRISMA diagram of selection studies

Table 3
Characteristics of the included studies (N=12).

Characteristics	Frequency
Year of publication	
2010-2011	0
2012-2013	2
2014-2015	1
2016-2017	3
2018-2019	3
2020-2021	3
Location of study	
Ghana	3
Nigeria	1
South Africa	2
Sudan	1
Uganda	1
Global	4
Study design	
Literature review	2
Scoping review	1
Descriptive explorative qualitative study	1
Descriptive survey (cross-sectional)	4
Mixed methods	3
Case Study	1

contaminated water and poor hygiene [33]. Flooding in some places may increase the breeding of mosquitos and spread of malaria, particularly in lower socio-economic settings [30,33].

3.3.3. Extreme heat

Living and working in extreme heat may have a number of adverse consequences, particularly for workers [29]. Working in high temperatures may cause sweating, dehydration and cramps and progress to heat exhaustion (muscle weakness, nausea, vomiting, dizziness) and heat stroke (changes in consciousness and behavior) [29]. Extreme heat also is linked to an increase in mortality as well as more cardiovascular events and chronic kidney disease [29,31]. Working in high temperatures also may increase aggression, mental stress and mental health disorders [29]. There were also links to an increase in occupational injuries, infections (e.g. dermatological) [33], and harm to pregnant women [29].

3.3.4. Injuries and trauma

Extreme weather events are likely to cause direct injuries, for example as a result of strong winds, floods or fires. Scarcity of resources such as water may lead to conflict, and high temperatures may make people more aggressive [33]. Trauma may lead to post-traumatic stress and mental health problems [33].

3.3.5. Population served

Climate-related migration may change the composition of the population at risk and those attending health services. People may be displaced by extreme weather events or migrate in search of better healthcare or living conditions [33]. Climate change may disrupt people's livelihoods and increase poverty, while health problems increase out of pocket expenses [33]. In urban areas this may increase the populations living in informal settlements and lead to conflict over employment and other opportunities [33].

Table 4
Characteristics of included studies.

Study No.	First author and citation	Year of publication	Study location	Aim of the study	Study design	Methods	Key results
1	Kafui Hussey, et al. [27]	2019	Ghana	To describe and compare the perceptions of climate-related health risks among health experts and the public.	Mixed methods	Qualitative interviews (n = 20) and quantitative surveys (n = 99) were conducted with health professionals in Savelugu-Nanton and Ada East Districts in Ghana.	Health experts and the community have significantly different perceptions of health risks associated with climate change (OR = 0.02, $p \leq 0.001$). There was limited knowledge of climate change health risks among the public.
2	Franco, et al. [28]	2019	Global South (mainly Africa)	To estimate and evaluate the suitability of various energy sources for healthcare facilities in the Global South	Cross-sectional study	The study described and evaluated energy sources for healthcare facilities based on a set of criteria.	Medium-to-large healthcare facilities need a hybrid energy system. Photovoltaic sources have lower levelized costs of electricity (0.09USD/kwh) than fossil fuel generators (0.25USD/kwh)
3	Ansah, et al. [29]	2021	Low- and Middle-Income Countries (including Africa)	To examine the impact of climate change on the occupational health and safety of workers in developing economies	Scoping review	The study used Google Scholar, Science Direct, PubMed, and Z-library. The selection of papers was based on terms such as 'climate change', 'global warming', 'ambient heat', 'sun heat', 'occupational health and safety', 'health', 'occupational illness', 'workers', 'developing countries' and 'low- and middle-income countries.	Three themes were identified: occupational health risks (explaining heat-stroke, heart, fatigue, sleeplessness, hot and dry skin, etc.); workers' susceptibility to the risks identified, education and lifestyle; workers copying strategies to the risks such early warning or cooling workplaces
4.	Appiah [30]	2016	Ghana	To assess the impact of climate change and socio-demographic factors on malaria transmission	Mixed methods	Time series rainfall and temperature data for Accra (1970-2010), census-based demographic data (1970-2010) and cross-sectional household data were used for the projection of future assessment of malaria transmission	At the local level socio-demographic factors (e.g. type of toilet, age of head of household, perception of risk) may be more important that climatic factors in predicting transmission, but both are needed.
5	Odame [31]	2019	USA, Haiti, Mexico, Guatemala, Burkina Faso, Ghana	To assess heat-related mortality and morbidity risk in rural population and subpopulations	Mixed methods	Systematic and meta-analysis and secondary analysis of cross-sectional data from clinics.	Every 1°C increase in mean daily temperature is associated with 3.0% [RR 1.030 (95% CI: 1.013-1.048)] excess mortality in all-cause and 11.1% [RR 1.111 (95%CI: 1.045-1.181)] excess mortality in cardiovascular diseases.

(*continued on next page*)

Table 4 (*Continued*)

Study No.	First author and citation	Year of publication	Study location	Aim of the study	Study design	Methods	Key results
6	Ebuehi and Olunsanya [32]	2013	Nigeria	To determine knowledge, attitudes, and practices towards climate change among residents of Ogun State	Descriptive cross-sectional survey	An administered questionnaire to 410 residents.	58% respondents had poor knowledge on climate change, 48% had positive attitude, 70% had poor practices concerning the mitigation of climate change
7	Scheerens, et al. [33]	2021	Uganda	To explore the knowledge, awareness, and insights of PHC providers on the nexus (climate change-migration-health)	Descriptive exploratory qualitative study	Focus group interviews with 30 participants attending a family medicine and PHC conference.	There were four key themes related to the reasons for migration, the effects of migration or climate change on health and the role of health care providers and services.
8	Dovie et al. [34]	2017	Ghana	To assess the scope of existing and new health indicators for climate change sensitive disease resilience	Case study	Systematic review, national expert consultation, and focus groups were conducted	In total, 65% of the indicators were sensitive to health impacts of climate change; 24% acted directly; 31% synergistically; and 45% indirectly, with indicator relevance strongly associated with type of health response
9	Abbas and Routray [35]	2013	Sudan	To develop a semi-quantitative risk assessment model for primary health care service interruption during flood	Explorative and analytical study	All PHC facilities in Kassala region were included. A questionnaire was administered. Secondary data from the provincial records were used. .	32% of facilities were isolated due to flooding and 28% were affected by days of isolation, 89% lacked emergency plans.
10	Wright, et al. [36]	2014	South Africa	To consider climate change health risk in South Africa and highlight areas that need special attention	Literature review	A review of empirical evidences of health risk of climate change	The health impacts were direct, such as increased temperatures leading to heat exhaustion, and indirect, such as likely increases in infectious diseases from contaminated water and changes in the distribution and/or magnitude of vector-borne diseases.
11	Wright, [37]	2017	South Africa	To measure the waiting room temperature at the rural PHC	Descriptive cross-sectional observational study	Temperatures were observed at clinics in the Limpopo Province	Indoor temperatures in the clinic waiting room were 2-4°C higher than the outdoor temperatures with apparent temperature >4° C higher
12	Lauriola, et al. [38]	2021	Canada and LMICs (including Africa)	To assess the experience of family doctors and family pediatricians on global environmental threats (climate change, air pollution and waste) and their contribution to adaptation and mitigation actions.	Literature review	A review from Embase, Scopus, Cinhal, Medline, Pubmed and Web of Science.	Although doctors' focus on the health effects of climate change is increasing, many of them were still not confident in their knowledge about the topic.

3.4. How can the primary health care system adapted to the threat of climate change?

3.4.1. Strengthen primary health care systems

Communities should be more resilient when they have comprehensive and well-integrated PHC services [33]. Therefore, policymakers need to redouble existing efforts to strengthen PHC as part of the response to climate change. Many health facilities lack emergency plans and capacity to respond to challenges, such as outbreaks of infectious diseases [33]. This capacity is further weakened by difficulties with retaining staff in badly affected areas [33]. Key issues include the training and retention of a competent workforce, including family physicians, and a community-oriented approach that is tuned in to changes in community health needs.

3.4.2. Create new indicators in health information systems

One study explored the need for new indicators that could help build resilience in PHC to climate-change related changes in morbidity and mortality [34]. New indicators should provide early warning of extreme climate events or changes in local climate-sensitive disease patterns. Thus, more socio-ecological indicators might be needed that are collected outside the health sector. For example, indicators that give information on meteorological events, agriculture and food security, water quantity and quality, or air pollution would be useful. This would require health information system to be more integrated with selected indicators from other sectors.

3.4.3. Strengthen multisectoral collaboration

The complex effects of climate change on agriculture, water, sanitation, food security, poverty and public health require a response that is also multisectoral [33,32]. Multisectoral policy and action will be needed to prepare for and respond to extreme weather events as well as more gradual and long-term effects. Such an approach should look at how to build more community resilience at the household level through adaptation and improved socio-economic status [32].

3.4.4. Educate PHC providers

Family doctors have not yet made sense of their role in responding to the health effects of climate change. They are not confident and do not see themselves as key actors [38]. There is a need to educate primary care providers on climate change and health impacts [33]. Providers should be able to detect a “climate change patient”. Currently, primary care providers are not confident in their knowledge about climate change and health. However, as they will see the consequences first hand they could become advocates for the issues with policymakers. In addition, they also may have to contribute to health promotion and education for their communities on how to prepare for and adapt to climate change risks [38].

3.4.5. Develop resilient and adaptive infrastructure

PHC infrastructure may be damaged by extreme weather events, such as floods or fire [33]. These events are often recurrent and compound previous damage [35]. During these events, energy and water supplies, communication and transport may be affected which disrupts laboratory services, staff and patient travel, medication supplies, and ambulance availability [35].

One study in South Africa showed that the temperature inside clinics was 2-4°C higher on average than outside and when incorporating relative humidity, it could feel more than 4°C higher [37]. As climate change leads to more extreme temperatures, the conditions inside primary care facilities may become dangerous for both staff and patients. The study suggested that during normal office hours, temperatures would easily fall within heat-health warning categories of “caution” and “extreme caution”. Changes to the infrastructure and systems for cooling should be considered in primary care clinics that serve communities in areas likely to experience such high temperatures. In broader terms, the minimum standards for primary health care infrastructure should consider the need to be resilient in the face of local climate-related challenges [33].

3.5. How can the primary health care system mitigate its own contribution to climate change?

One study recommended that health facilities should develop hybrid energy systems [28]. These would include renewable energy sources (e.g. solar, wind, hydro) with a storage system that would provide affordable and sustainable sources of energy in combination with the normal grid [28]. If the facility is off-grid or the grid is disrupted (e.g. load shedding, extreme weather) then this would ensure an energy supply. A back-up diesel generator might still be needed for emergency situations.

4. Discussion

With climate change, PHC services in Africa will face increasing challenges including malnutrition, infectious diseases, heat-related conditions, injuries, non-communicable diseases, mental health problems and migration. Although these problems were anticipated in the review, there was an absence of real surveillance or monitoring data on the actual effects on primary care morbidity and mortality. Several issues were mentioned that impact the resilience and adaptation of PHC services, but again with little substance. A need to strengthen PHC service delivery as a way of building community resilience was noted, as well as the need for new indicators within the health information system that would monitor climate-sensitive diseases and give early warning of extreme events. The importance of multisectoral policy and action and a community-orientated approach also were emphasized. In addition, the need to educate and train healthcare workers on climate change and health was highlighted along with the importance of adapting infrastructure to challenges such as extreme heat. Only one study touched on the use of renewable energy sources as a means of building resilience and contributing to mitigation.

The total number of articles was small, and the evidence was mostly descriptive and qualitative or contained within larger review articles. Going forward there is a need for more observational studies that report on actual changes and associated factors. There is also a need for interventions to be tested in experimental studies and for implementation science to look at how effective interventions can be increased in scale.

The WHO’s operational framework for building climate resilient health systems provides a useful lens to identify the gaps in our knowledge and research questions that need to be addressed [15]. This framework identified 10 key components. Fig. 2 summarizes the findings of the review in terms of this framework.

With respect to *leadership and governance*, none of the included studies analyzed PHC policy to determine if issues related to climate change were included or if there was any explicit accountability or planning. The WHO has noted that few national PHC policies tackle the challenges of climate change [39], while other authors have noted the potential for primary care providers to advocate to policymakers [40]. Where climate change is mentioned in PHC policy, it is usually in relation to multisectoral action, while primary care and community empowerment are overlooked [39]. However, strengthening mechanisms for multisectoral planning and action remains a key focus [39].

The *health workforce* was mentioned in terms of raising awareness of the issues and developing advocacy, but no actual educational initiatives or capacity building innovations were evaluated in the identified studies. Several international commentators have called for training reforms that incorporate planetary health into under- and post-graduate training of health professionals, including primary



Fig. 2. Summary of the key findings using WHO's operational framework for building climate resilient health. Inner circle shows the broad generic building blocks of the health system. Middle circle shows the deconstruction of these into blocks focused on climate resilience. Outer circle summarises the current evidence from the scoping review.

care providers [40,41]. There are also calls for professional bodies to support their members in addressing the issues.

The community-orientated primary care (COPC) approach has been promoted in Africa in order to focus the PHC team on the whole population at risk and not just those that attend the primary care facility [42]. Such an approach is intended to make a "community diagnosis" and to direct interventions towards prioritized community health needs. Such an approach could help identify the particular climate *vulnerabilities of the community* served or specific areas within the community. For example, one group might be those most vulnerable to flooding or contaminated water. No studies were found that combined a COPC approach with the challenges likely to be experienced from climate change and the interventions needed to reduce vulnerability. The COPC approach could also help empower communities to respond to climate emergencies such as floods, fires or drought [39]. Multisectoral engagement and collaboration is also fundamental to the COPC approach [42], and can assist with *managing environmental determinants of health* in a specific community by addressing issues such as air quality, water quantity and quality, food and nutrition security, housing, and waste management [43].

The included studies suggested the need for *integrated risk monitoring and early warning systems* and recommended that health information systems incorporate non-traditional indicators, such as meteorological indicators. Monitoring should include surveillance of climate-sensitive diseases and give warning of extreme weather events [15]. However, there were no in-depth studies that evaluated how to establish such risk monitoring processes in PHC, nor how to ensure early warning systems are effective.

No studies were identified where a particular *health program*, such as HIV, tuberculosis, or non-communicable diseases, evaluated its response to climate change. For example, there were no data on how services could be sustained during an extreme weather event. Noted was a need to incorporate health promotion and climate-relevant behavior change into the management of common diseases [44]. Examples include the co-benefits to health and climate of a healthy diet and physical activity or attention to the prescription of metered dose inhalers [41].

The review contributed to and highlighted the need for tools to evaluate the *emergency preparedness* of PHC facilities and services to withstand climate-related risks. These should be tailored to the likely effects of climate change in a particular country or location. One good example given was the risk of extreme temperatures within health facilities for both staff and patients. None of the included studies evaluated climate resilience in terms of PHC *infrastructure and technologies*. Future studies could address the requirements of PHC facilities to continue offering services in the face of challenges such as cyclones, heat waves or storm surges. In LMICs, the focus should be more on preparing to cope with disruptions to services and new health needs, rather than mitigation [39].

To our knowledge, this is the first scoping review that focuses on PHC and climate change in the African context. The findings help to define a future *research agenda* that needs to be funded, implemented

and findings disseminated for policymakers. There was no economic analysis or studies on the *health financing* implications of climate change in PHC. Several voices have called for more PHC financing, particularly to strengthen PHC in LMICs, as well as to decarbonize PHC services in high-income countries [43].

The Global Green and Healthy Hospital network focuses on how health systems can mitigate their environmental harm [45]. In high-income countries, PHC has started to recommend and take action on mitigation [41,43,46], and recognizes that practices also can role model environmental stewardship [46]. For example, in the United Kingdom the Royal College of General Practitioners has published the Green Impact for Health, with 100 suggested actions [47]. However, Africa's historical contribution to greenhouse gas emissions is negligible and the carbon footprint of PHC in Africa is likely to be insubstantial [48]. It is, therefore, not surprising that only one study looked at mitigation and PHC in Africa. Notwithstanding historical emissions, health system strengthening and the pursuit of universal health coverage needs to be decoupled from emissions, because the relative contribution of Africa to global greenhouse emissions in the future may be very significant. Whether this happens or not will determine whether we reach tipping points that will have devastating consequences for people worldwide, especially those in vulnerable populations.

Many countries in sub-Saharan Africa have obligations to the Paris Agreement [49] and cities, such as Cape Town, have committed to becoming Carbon Net Zero by 2050 [50]. Health services should focus on 10 areas: leadership, energy, water, waste, food, transport, procurement, buildings, chemicals and pharmaceuticals [50]. For PHC facilities in Africa, often in rural and remote locations, there will be other co-benefits to becoming more sustainable. As one example, solar, wind or hydro renewal energy systems also have economic, social and health co-benefits.

4.1. Strengths and limitations

The review included a wide variety of international databases and considered articles in English and French, as well as unpublished studies in university repositories. No studies were excluded on the basis of other languages. A protocol was developed a priori and utilized by all researchers to reduce bias and conduct a transparent, exhaustive and reproducible search. Only selected university repositories were searched, and studies may have been missed at other universities in the African region. A publication bias also may exist not only because positive results are more likely to be published, but also due to barriers that African authors face in academic publishing. Each database was searched independently by a different member of the research team, albeit with support from the first author. It is possible, however, that individual researchers interpreted the criteria slightly differently and might have missed eligible studies.

4.2. Implications

The review revealed that PHC research in Africa has yet to significantly tackle the issue of climate change and health. The discussion outlines a number of knowledge gaps across the 10 point WHO framework for climate-resilient health systems [15], which future research can address. If one key question is taken from each area, an emerging research agenda might include the following:

1. To what extent does PHC policy in Africa incorporate climate change into its future considerations, strategies and plans?
2. What do PHC providers and managers need to know about building climate-resilient facilities and services, and how should these learning needs be addressed?
3. How can PHC providers identify the specific climate-related vulnerabilities of communities in their catchment areas and how can they respond to them?
4. What additional indicators need to be collected in the health information system to monitor risks and give PHC early warning of extreme weather events?
5. What are the priority PHC research questions that address health and climate change?
6. How can PHC infrastructure be more resilient to ensure services continue in the face of climate-related risks and extreme events?
7. How can multisectoral collaboration at a community and PHC level take action on the environmental determinants of health?
8. What changes do health programs need to make to ensure services continue despite climate-related risks and challenges?
9. How can we measure the emergency preparedness of PHC facilities and services to respond to and recover from climate events?
10. What adjustments to PHC financing are needed to prepare for and respond to the effects of climate change?

The review points towards the need for policymakers to strengthen multisectoral governance structures, primary care service delivery and community engagement in order to prepare for the challenges of climate change. In addition, there is a need to better prepare the workforce to understand the challenges and contribute to the development of climate-resilient facilities and services.

5. Conclusion

Climate change has impacts on the burden of disease and the delivery of PHC. There is an urgent need to strengthen PHC to enhance the resilience of vulnerable communities, while continuing to strive for universal health coverage that is decoupled from greenhouse gas emissions. Attention should be paid to preparing the primary care workforce to understand the challenges, respond to changes in morbidity and mortality and to build resilience to cascading and compounding climate-related health threats in the future. Attention also should be paid to multisectoral action and community engagement. The health information system needs to be adapted to include new socio-ecological indicators, and to provide surveillance of climate-sensitive diseases and early warning of imminent extreme weather events. Infrastructure needs to adapt to the challenges and be developed within an environmentally sustainable model. The evidence base is weak with many gaps and is mostly descriptive or qualitative in nature. The researchers suggest a 10-point research agenda, based on the WHO framework for climate resilient health systems.

Author contributions

All authors contributed to the conceptualization of the study. CL, KN, VM and NM conducted the searches and data extraction. CL coordinated the team of authors under the supervision of RM. CL and RM drafted the article and all authors contributed to revisions and editing. All authors approved the final manuscript.

Author agreement

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Ethical consideration

The study did not need ethical approval as it did not have direct contact with human subjects.

Declaration of Competing Interest

There was no competing interest among authors or between the authors and any organizations.

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