Article

A Rapid Review of Impact Assessment of Climate Change on Health and Mental Well-Being in Africa

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Abstract

Despite widespread global attention, the potential threats to human health posed by climate change in Africa still need to be further understood. Although there is mounting concern that climate change is a serious risk to human health, less evidence shows a direct causal relationship between climate change and health risks in Africa. In this rapid review, we discuss our synthesis of available evidence on the health implications of climate change with a focus on Africa. PubMed was systematically searched for relevant articles from 2020 to 2023 using a search strategy. Only eligible articles published in the English language

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with full article access were included for review using the population concept context (PCC) criteria by Joanna Briggs Institute (JBI). After removing duplicates, the selection process began with title and abstract screening, followed by screening full-text articles. Of the 3272 articles retrieved, only 10 were eligible for synthesis. We found mainly reported climate exposures to range from drought, concerning rainfall patterns, and increasing temperatures reported to cause morbidity and mortality through health risks: respiratory diseases, vector-borne diseases, cardiovascular diseases and mental health concerns. Africa still has a huge shortage of available evidence, particularly research focusing on the health implications, including mental health of climate change and interventions to prevent climate change-related health consequences. While the limited global evidence indicates that climate change results in an increased risk to public health, there are gaps in demonstrating the causal links between climate change and societal mental health impacts in Africa. There is also an urgent need for more research on effectively addressing climate hazards that threaten the African continent's public health and well-being.

Keywords: Climate change; public health; mental health; impact assessment; rapid review; Africa

Introduction

Climate change is a global issue with varying degrees of impact in different parts of the world. It is also linked to several health issues, straining healthcare systems, particularly in Africa, where many countries struggle economically (Opoku et al., 2021). Understanding the differences between the key terms used to describe climate change's effects on health is crucial for gaining insights into the impact of climate change on health and mental well-being. For instance, "weather" describes the daily, observable, and palpable changes in the outside environment, such as spring rain and summer sunshine. By averaging the weather across all regions, climate refers to the typical weather conditions in a given area. Therefore, a change in the statistical characteristics of the climate system that lasts for several decades or longer—typically at least 30 years—is referred to as climate change (Australian Academy of Science, 2022; National Aeronautics and Space Administration, 2023). There is evidence that natural phenomena, such as variations in the Sun's radiation, volcanoes, or internal climate variability, impact the Earth's climate over time (Australian Academy of Science, 2022). Studies on the planet's ice cores, rocks, and tree rings reveal an alarming rise in global warming, including everything from rising temperatures to melting ice sheets (National Aeronautics and Space Administration, 2023). In the coming decades, there is an expected increase in the frequency and severity of extreme weather conditions such as heatwaves, storms, and floods. This could potentially result in tens of thousands of deaths per year, primarily from malnutrition, malaria, diarrhoea, and heat stress (World Health Organization, 2021a; Trisos et al., 2022). This is due to climate change causing

food system disruptions, an increase in zoonoses and food-, water-, and vector-borne diseases, as well as mental health issues.

Social and ecological factors that contribute to people's health—such as access to nutritious food, satisfactory housing, and a healthier environment, are all being affected and will continue to be affected by climate change (World Health Organization, 2021b). Unfortunately, the risks to human mental health as a result of the consequences of climate change in Africa remain to be well understood. While evidence indicates that climate change is a predisposing factor resulting in an increased risk to public health, as earlier mentioned, there are gaps in demonstrating the causal links between climate change and health impacts after excluding all plausible confounders in Africa. Also, minimal research has progressed to the point where it is possible to make precise spatial and temporal projections of the health impacts of climate change in Africa (Munzhedzi & Cele, 2021; Nilsson et al., 2021). Health professionals worldwide are already responding to the health consequences of this unfolding crisis, recognising climate change as a serious threat to humanity's health and mental well-being (World Health Organization, 2021b). In this rapid review, we discuss our synthesis of available evidence on the health implications of climate change with a special focus on the African continent. Though Africa is a resource-constrained continent regarding finances, advanced technology, and skilled labour, it is rich in natural resources such as minerals in the soil and agricultural potential that are highly influenced by climate conditions and thus can impact the continent's economy. The latter justifies our focus on the continent. In addition, compared to other developed and well-resourced continents such as America and Europe, less than half of the African population has access to early warning systems for the health effects of extreme weather and climate change (World Meteorological Organization, 2023). In our discussion of the available evidence, we will map out climate-related health risks and pathways as well as interventions that could contribute towards the alleviation of the impact of climate change on health and mental well-being.

Methodology in Obtaining Evidence Reviewed

Search Process

We searched the PubMed database for this rapid review using the below search strategy (Table 1). The inclusion and exclusion of articles applied the population, concept, and context (PCC) criteria described by the Joana Briggs Institute (Munn et al., 2018; Munn et al., 2020). The period for evidence search was from 2020-2023 to obtain the latest evidence on the effects of climate change and its consequences on health and mental well-being.

Table 1: PCC and Search Strategy	
Population	Individuals from the African continent.
Concept	Climate changes and effects on health and mental well-being
Context	Africa
Search strategy	**Search:** ((climate change) OR (climate related)) OR (climate effect)) OR (climate impact)) OR (weather)) OR (weather change)) OR (climate)) AND (health)) OR (human health)) AND (mental well-being)) OR (mental health)) AND (Africa) Filters: Free full text, Humans, English, from 2020 - 2023 **Search key words and mesh permutations:** ("climate change"[MeSH Terms] OR ("climate"[All Fields] AND "change"[All Fields]) OR "climate change"[All Fields] OR (("climate"[MeSH Terms] OR "climate"[All Fields] OR "climates"[All Fields] OR "climate s"[All Fields] OR "climatic"[All Fields] OR "climatically"[All Fields]) AND ("family"[MeSH Terms] OR "family"[All Fields] OR "relation"[All Fields] OR "relatability"[All Fields] OR "relatable"[All Fields] OR "related"[All Fields] OR "relates"[All Fields] OR "relating"[All Fields] OR "relational"[All Fields] OR "relations"[All Fields])) OR (("climate"[MeSH Terms] OR "climate"[All Fields] OR "climates"[All Fields] OR "climate s"[All Fields] OR "climatic"[All Fields] OR "climatically"[All Fields]) AND ("effect"[All Fields] OR "effecting"[All Fields] OR "effective"[All Fields] OR "effectively"[All Fields] OR "effectiveness"[All Fields] OR "effectivenesses"[All Fields] OR "effectives"[All Fields] OR "effectivities"[All Fields] OR "effectivity"[All Fields] OR "effects"[All Fields])) OR (("climate"[MeSH Terms] OR "climate"[All Fields] OR "climates"[All Fields] OR "climate s"[All Fields] OR "climatic"[All Fields] OR "climatically"[All Fields]) AND ("impact"[All Fields] OR "impactful"[All Fields] OR "impacting"[All Fields] OR "impacts"[All Fields] OR "tooth, impacted"[MeSH Terms] OR ("tooth"[All Fields] AND "impacted"[All Fields]) OR "impacted tooth"[All Fields] OR "impacted"[All Fields])) OR ("weather"[MeSH Terms] OR "weather"[All Fields] OR "weatherability"[All Fields] OR "weatherable"[All Fields] OR "weathered"[All Fields] OR "weathering"[All Fields] OR "weathers"[All Fields]) OR (("weather"[MeSH Terms] OR "weather"[All Fields] OR "weatherability"[All Fields] OR "weatherable"[All Fields] OR "weathered"[All Fields] OR "weathering"[All Fields] OR "weathers"[All Fields]) AND ("change"[All Fields] OR

	"changed"[All Fields] OR "changes"[All Fields] OR "changing"[All Fields] OR "changings"[All Fields])) OR ("climate"[MeSH Terms] OR "climate"[All Fields] OR "climates"[All Fields] OR "climate s"[All Fields] OR "climatic"[All Fields] OR "climatically"[All Fields])) AND ("health"[MeSH Terms] OR "health"[All Fields] OR "health s"[All Fields] OR "healthful"[All Fields] OR "healthfulness"[All Fields] OR "healths"[All Fields])) OR (("human s"[All Fields] OR "humans"[MeSH Terms] OR "humans"[All Fields] OR "human"[All Fields]) AND ("health"[MeSH Terms] OR "health"[All Fields] OR "health s"[All Fields] OR "healthful"[All Fields] OR "healthfulness"[All Fields] OR "healths"[All Fields]))) AND (("mental"[All Fields] OR "mentalities"[All Fields] OR "mentality"[All Fields] OR "mentalization"[MeSH Terms] OR "mentalization"[All Fields] OR "mentalizing"[All Fields] OR "mentalize"[All Fields] OR "mentalized"[All Fields] OR "mentally"[All Fields]) AND "wellbeing"[All Fields])) OR ("mental health"[MeSH Terms] OR ("mental"[All Fields] AND "health"[All Fields]) OR "mental health"[All Fields])) AND ("africa"[MeSH Terms] OR "africa"[All Fields] OR "africa s"[All Fields] OR "africas"[All Fields])) AND ((ffrft[Filter]) AND (humans[Filter]) AND (2020:2023[pdat]) AND (english[Filter])) Translations climate change: "climate change"[MeSH Terms] OR ("climate"[All Fields] AND "change"[All Fields]) OR "climate change"[All Fields] climate: "climate"[MeSH Terms] OR "climate"[All Fields] OR "climates"[All Fields] OR "climate's"[All Fields] OR "climatic"[All Fields] OR "climatically"[All Fields] related: "family"[MeSH Terms] OR "family"[All Fields] OR "relation"[All Fields] OR "relatability"[All Fields] OR "relatable"[All Fields] OR "related"[All Fields] OR "relates"[All Fields] OR "relating"[All Fields] OR "relational"[All Fields] OR "relations"[All Fields] climate: "climate"[MeSH Terms] OR "climate"[All Fields] OR "climates"[All Fields] OR "climate's"[All Fields] OR "climatic"[All Fields] OR "climatically"[All Fields] effect: "effect"[All Fields] OR "effecting"[All Fields] OR "effective"[All Fields] OR "effectively"[All Fields] OR "effectiveness"[All Fields] OR "effectivenesses"[All Fields] OR "effectives"[All Fields] OR "effectivities"[All Fields] OR "effectivity"[All Fields] OR "effects"[All Fields] climate: "climate"[MeSH Terms] OR "climate"[All Fields] OR "climates"[All Fields] OR "climate's"[All Fields] OR "climatic"[All Fields] OR "climatically"[All Fields]

	impact: "impact"[All Fields] OR "impactful"[All Fields] OR "impacting"[All Fields] OR "impacts"[All Fields] OR "tooth, impacted"[MeSH Terms] OR ("tooth"[All Fields] AND "impacted"[All Fields]) OR "impacted tooth"[All Fields] OR "impacted"[All Fields] weather: "weather"[MeSH Terms] OR "weather"[All Fields] OR "weatherability"[All Fields] OR "weatherable"[All Fields] OR "weathered"[All Fields] OR "weathering"[All Fields] OR "weathers"[All Fields] weather: "weather"[MeSH Terms] OR "weather"[All Fields] OR "weatherability"[All Fields] OR "weatherable"[All Fields] OR "weathered"[All Fields] OR "weathering"[All Fields] OR "weathers"[All Fields] change: "change"[All Fields] OR "changed"[All Fields] OR "changes"[All Fields] OR "changing"[All Fields] OR "changings"[All Fields] climate: "climate"[MeSH Terms] OR "climate"[All Fields] OR "climates"[All Fields] OR "climate's"[All Fields] OR "climatic"[All Fields] OR "climatically"[All Fields] health: "health"[MeSH Terms] OR "health"[All Fields] OR "health's"[All Fields] OR "healthful"[All Fields] OR "healthfulness"[All Fields] OR "healths"[All Fields] human: "human's"[All Fields] OR "humans"[MeSH Terms] OR "humans"[All Fields] OR "human"[All Fields] health: "health"[MeSH Terms] OR "health"[All Fields] OR "health's"[All Fields] OR "healthful"[All Fields] OR "healthfulness"[All Fields] OR "healths"[All Fields] mental: "mental"[All Fields] OR "mentalities"[All Fields] OR "mentality"[All Fields] OR "mentalization"[MeSH Terms] OR "mentalization"[All Fields] OR "mentalizing"[All Fields] OR "mentalize"[All Fields] OR "mentalized"[All Fields] OR "mentally"[All Fields] mental health: "mental health"[MeSH Terms] OR ("mental"[All Fields] AND "health"[All Fields]) OR "mental health"[All Fields] Africa: "africa"[MeSH Terms] OR "africa"[All Fields] OR "africa's"[All Fields] OR "africas"[All Fields]
Database	PubMed

Data selection, extraction and synthesis

After data retrieval using the search strategy, at least two reviewers identified, screened, and reviewed potentially eligible articles, with a third reviewer resolving conflicts as needed. Data were extracted from relevant articles using PCC criteria. The selection process included title and abstract screening as the first step after removing duplicates. Next was full-text articles screening for identification of final articles for synthesis. Synthesis of eligible articles after full title screening involved mainly qualitative assessment to map and discuss evidence on climate change effects on health and mental well-being.

Results – characteristics of included articles.

The search on 11th December 2023 yielded 3,271 search hits, of which 10 were included based on earlier mentioned eligibility criteria (Figure 1). Articles synthesised included one editorial, four reviews, two qualitative studies and three cross-sectional studies (Table 2).

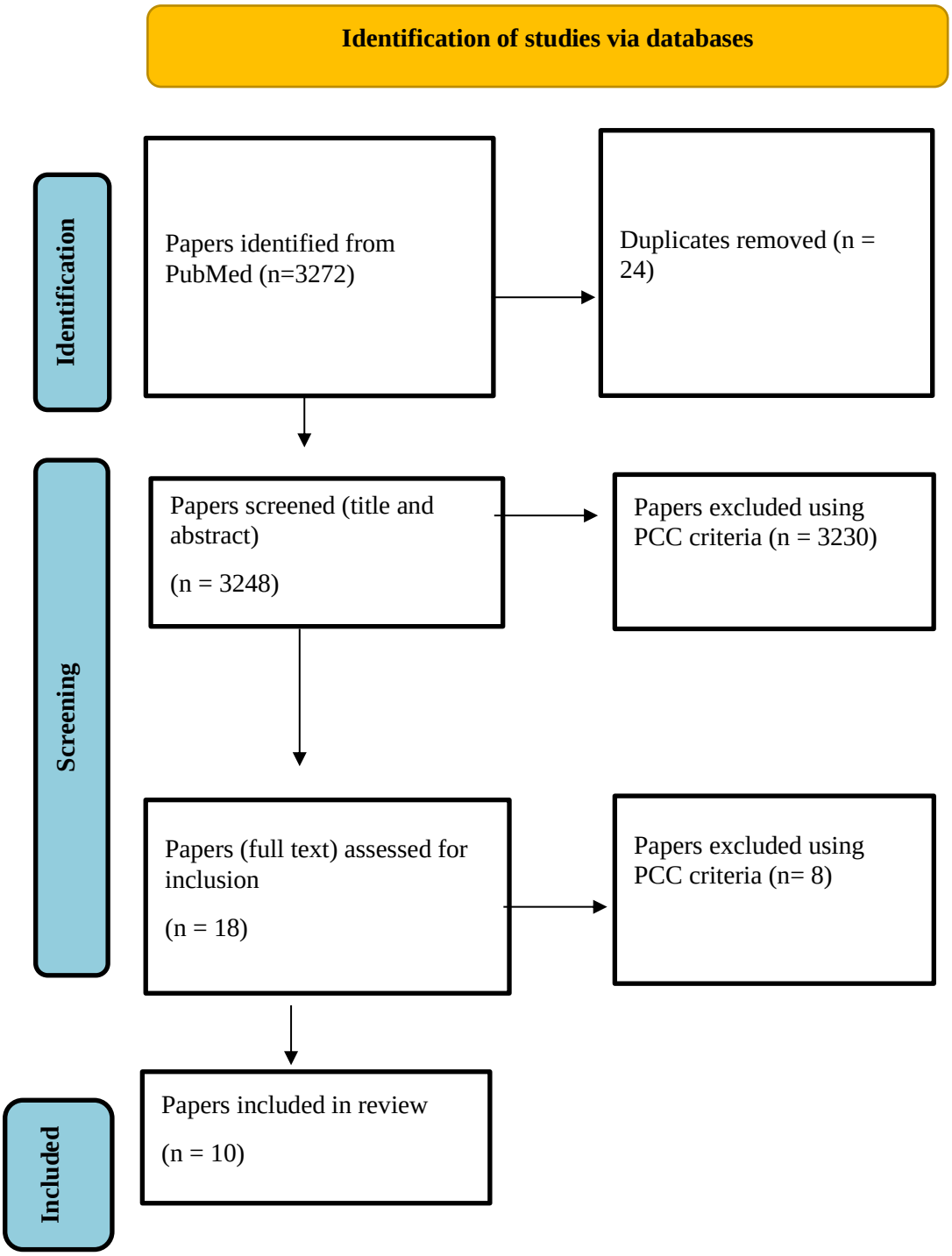
Identification of studies via databases
Identification
Papers identified from PubMed (n=3272)
Duplicates removed (n = 24)
Screening
Papers screened (title and abstract)
(n = 3248)
Papers excluded using PCC criteria (n = 3230)
Papers (full text) assessed for inclusion
(n = 18)
Papers excluded using PCC criteria (n= 8)
Included
Papers included in review
(n = 10)

Figure 1: PRISMA-ScR diagram of screening process and outcome

Discussion Based on Synthesis of Included Articles.

Overview of Climate Change on Human Health

Climate change, influenced by extreme weather events, has a wide-ranging and substantial impact on human health (Ahmad & Javed, 2022). Extreme weather, heat waves, and changes in the geographic distribution of infectious diseases are just a few ways climate has directly impacted human health (Shi, 2018; Ebi, 2020). Other impacts of climate change on human health include increased morbidity and mortality rates associated with various health outcomes (Watkiss & Ebi, 2022). These climate change-related health outcome drivers include respiratory diseases, infectious and waterborne illnesses, food insecurity, heat-related ailments, and mental health issues (Krueger et al., 2015). For example, global warming has been linked to the spread of vector-borne diseases such as malaria (Flahault et al., 2016). According to the United Nations, human activities such as using fossil fuels like coal, oil, and gas have been identified as contributors to increased global average temperatures and precipitation patterns causing climate change since the Industrial Revolution [6]. In the last seven years, the earth has been documented to enter uncharted territory due to increased atmospheric greenhouse gas concentrations and the resulting buildup of heat, which will have far-reaching consequences for both current and future generations.

Furthermore, these gases are produced by land use, industry, transportation, deforestation, agriculture, and construction, which are activities of the industrial revolution (United Nations, 2023). In 2020, new records were set for the atmospheric concentrations of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), with CO_2 reaching 413.2 parts per million (ppm), CH_4 reaching 1889 parts per billion (ppb), and N_2O reaching 123% of its pre-industrial (before 1750) levels. Over the past two decades, the ocean's warming rate has skyrocketed, and in 2021, it hit a new record high. As a result, climate change is now an undeniable fact with disastrous future consequences rather than a looming threat (Hayes et al., 2018).

The Current State of Climate Change Impacts on Human Health and Mental Well-Being Across the Globe

Globally, climate and health experts have observed that climate change poses a significant threat to public health, with some experts dubbing it “the greatest global health threat of the twenty-first century” (Hathaway et al., 2018; Watts et al., 2015). Between 2030 and 2050, the “well understood impacts of climate change” are projected to increase the number of deaths by 250,000 annually, according to the World Health Organization (WHO) (Hayes et al., 2018). The oceans absorb a sizable fraction of the carbon dioxide (CO_2) that humans release into the atmosphere annually. Although CO_2 will increase the pH of salt water, it will react with fresh water to lower the PH. The acidification of water threatens food supplies, fishing, and aquaculture. Although it is

widely acknowledged that climate change, as earlier discussed, has a detrimental impact on human health, identifying specific weather events as the cause of the change is notoriously difficult, even before considering the ripple effects on people's well-being and the mediating role played by ecosystems and social structures.

Nonetheless, empirical evidence from a review highlights that climate change can be relatable to heat, allergies, reduced micronutrient concentrations, thunderstorm asthma, asthma, chronic diseases, toxin exposure, mental health disorders, malaria, renal problems, gento-urinal issues, skin conditions, neurodegenerative diseases, cardiovascular diseases, forest fires, increased algal bloom etc. (Butler, 2018; Bongioanni et al., 2021). Furthermore, another review discovered 1,006 different transmission pathways for climate-related hazards, each of which can increase the incidence and prevalence of pathogenic diseases, 58% of which are human pathogens whose illness can be aggravated (Mora et al., 2022). The authors of this review provided readers with an online database (https://camilo-mora.github.io/Diseases/) containing an interactive display of climatic hazards, transmission types, and more than one thousand human pathogenic diseases, as well as case examples and citations. Even though this database does not display data by world region, it is a novel and exclusive database that provides evidence of the significant relationship between the consequences of climate change and human health. Besides, several non-communicable, chronic respiratory disease conditions are affected by changes in climate, too. Unstable and extreme climate conditions also impact food production, which increases in cases of malnutrition. These conditions also increase the burden of climate-sensitive vector-borne, waterborne and food-borne diseases (Trisos et al., 2022). Indirect health consequences progressively acknowledged in international climate change and health reports include malignant melanoma from ultraviolet radiation exposure, chronic kidney disease caused by dehydration, and illnesses associated with food and water safety (Hayes et al., 2018; Watts et al., 2015). However, little is known and often overlooked globally, particularly the effects of climate change risks and their implications for mental health. The possible factors through which Earth's climate change affects human health risks and mental well-being are depicted in Figure 2 below. "Mental health" encompasses various conditions, from illness or disorder to emotional resilience and psychosocial wellness (Butler et al., 2014; World Health Organization, 2017). A person's psychosocial well-being can be defined as the degree to which their mental health is optimal, the severity of any problems they may be facing, or the absence of any problems (Hayes et al., 2018). The psychological and emotional toll that natural disasters like heat waves, floods, and hurricanes take is one example of the direct psychosocial impact of climate change. Famine, civil war, displacement, and migration are examples of social and economic disruptions caused by climate change that have indirect effects on mental health. In addition, concern about the effects of climate change on the planet and its inhabitants, both now and in the future, can lead to lasting emotional distress, which is one of the main psychosocial consequences of climate change that has been demonstrated to influence mental well-being (Hayes et al., 2018).

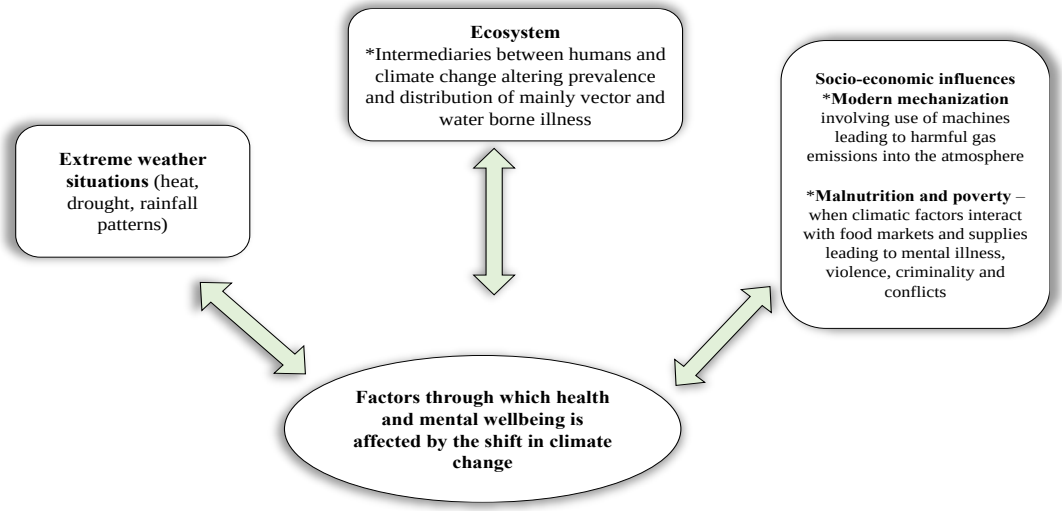

Figure 2: Facilitators of climate change impact on human health risk. Adapted from Wheeler and Watts (2018).

Climate change and disease trends in Africa

Africa is one of the lowest producers of greenhouse gas emissions globally, yet it is one of the continents that is the most susceptible to the impacts of climate change on disease trends (Trisos et al., 2022; Opoku et al., 2021; Erickson, 2017; Szulejko et al., 2017; Watts et al., 2015; Campbell-Lendrum et al., 2015; De-Souza et al., 2015). In 2021, Africa was struck by several calamitous occurrences, including persistent droughts, extensive floods, and tropical cyclones, compounded by protracted conflicts and economic slowdowns and downturns. Furthermore, the impact of the COVID-19 pandemic jeopardised food security, prompted population displacement, and resulted in catastrophic losses and damages that impeded socioeconomic development (World Health Organization, 2021c). The WHO report on the state of climate in Africa for 2021 highlights that compared to the +0.2 °C/decade between 1961 and 1990, Africa warmed by an average of +0.3 °C/decade between 1991 and 2021. A small amount of fresh groundwater is present along the Red Sea and the southwest Indian Ocean due to sea level rise that is close to 4 mm/year. Economic conflicts are predicted to result from the water shortage. As a result of rising temperatures, Africa's agricultural productivity has decreased by 34% since 1961. Malnutrition and food insecurity might rise as a result of this trend. As an example, the yield of wheat in Southern and North Africa is predicted to drop by 20%–60% and maize in West Africa by 9% at a 1.5 °C global warming.

Consequently, increases in the following health issues have been linked to changes in weather patterns in Africa: Zoonotic diseases, vector-borne illnesses such as Rift Valley fever, lymphatic filariasis, onchocerciasis, schistosomiasis, and African trypanosomiasis (Opoku et al., 2021; Campbell-Lendrum et al., 2015); increased risk of respiratory illnesses like lung cancer, asthma, dementia, heart disease and COPD due to poor air quality in many African cities (Opoku et al., 2021; Erickson, 2017; Szulejko et al., 2017). In contrast to the world's developed countries, these illnesses are more common in undeveloped countries, mostly in Africa. We attempted to reflect a plausible

relationship between climate change, the health risk of specific illnesses and mental well-being after synthesising some pertinent literature focused on Africa, as shown in Table 2 below. However, we would like to note that little to no evidence conclusively illustrates direct linkages between differing climate change conditions and risk for specific disease conditions. The synthesised articles in Table 2 below are mapped out evidence summarising the latest evidence available in Africa.

Table 2: The Plausible Relationship Between Climate Change, Health and Mental Well-Being and Recommended Interventions

Article title, authors and year	Type of article – study design	Setting	Summary of findings			
			Climate exposure	Health consequence	Effects on mental well-being	Recommended intervention
COP27 Climate Change Conference: urgent action needed for Africa and the world (Atwoli et al., 2023)	Editorial	Focus in Africa	Climate hazards such as heatwaves, drought, and floods	Infectious diseases such as malaria, dengue, Lassa, Rift Valley, Lyme, Ebola, and West Nile are on the rise as a result of changes in vector ecology and unsanitary environmental conditions, which in turn cause ecosystem collapse, species extinction, and physical health problems. The decline in water quality caused by rising sea levels poses a threat of water-	Not mentioned	The allocation of resources aimed at increasing resilience to the current and unavoidable future impacts of the climate crisis, as well as assisting vulnerable countries in reducing their greenhouse gas emissions.

				borne diseases, such as diarrhoeal diseases—a major killer in Africa. Furthermore, mortality due to food insecurity and malnutrition brought on by water and food supply disruptions caused by extreme weather.		
Systematic mapping of global research on climate and health: a machine learning review (Berrang-Ford et al., 2021)	Systematic review	Global, but summary in the next columns are focussed on Africa	Mainly rainfall	Vector-borne disease.	Reports gap in evidence and implications of environmental migration on cultural and social cohesion	Development and curation of living evidence platforms, for example, are feasible and represent potentially cost-effective opportunities to support decision-making to prepare for, and reduce the current and future effects of, climate change on

						health
Climate Change and African Migrant Health (Sanni et al, 2022)	Review	Africa	Climate change due to flooding, drought, and excess heat	Respiratory illness, malnutrition, and premature mortality	African migrants who were displaced due to climate change had mental health issues including stress, sadness, and loneliness.	Need for more empirical research to increase evidence related to the impact of climate change on the health of African immigrants
A Review on Climate, Air Pollution, and Health in North Africa (Imane et al, 2022)	Review	North Africa	Climate and air pollution	Mortality from hospital admission due to cardiovascular and respiratory diseases	Not reported	Need for more empirical research to establish links between air pollution and health effects
Climate change and health in urban informal settlements in low- and middle-income countries – a scoping review of health impacts and adaptation strategies (Borg et al., 2021)	Scoping review	Low- and middle-income countries – (For Africa, mainly Ethiopia and Kenya)	Temperature-related exposures, like extreme heat events and heat waves; flooding; perceptions of climate change as risks for the future	**Ethiopia** - Food insecurity and malnutrition CDS: Changes to infectious disease transmission e.g. diarrhea, typhoid, and malaria	Impact on the informal urban communities	* Improved sanitation, clothing and water supply * Vaccination * Improved housing conditions and building standards * Create awareness of the dangers of extreme temperatures
				Kenya - Temperature variation, heat waves,	Years of Life Lost, mortality	

				rainfall and cold spells		
Climate Change, Health Risks, and Vulnerabilities in Burkina Faso: A Qualitative Study on the Perceptions of National Policymakers (Sorgho et al., 2021)	Qualitative study	National Policymakers in Burkina Faso	Extreme heat, droughts, floods, and biodiversity loss	Water quality and quantity, heat stress, food supply and safety, vector borne diseases, and air quality	Acknowledged gaps in evidence on effect of climate change on mental well-being especially mental health and the interplay between social factors and complex health risks attributable to climate change.	Training and increased awareness on mental health consequences and social factors
Climate change and primary health care in Chakama, Kilifi County, Kenya (Sheriff & Mash, 2022)	Qualitative study	Kenya	Climate change - drought	Lack of food, the lack of water, poor water quality, locust invasion, conflict with wild animals and migration, which have led to many health effects such as malnutrition, gastroenteritis. Primary health care facilities and	Trauma and mental health problems as a result of the health effects	Increase capacity to respond to climate change through health-care staff training, mentoring, and collaboration with other organisations. Sanitation, rainwater harvesting, borehole water, desalination plants, village clean water storage, farming training for

				services is low, as they face many of the same climate-related challenges such as the lack of water and high temperatures		improved food security and nutrition, and community mobilization for education are further resilience-community led building initiatives.
Analysis of Heavy Rainfall in Sub-Saharan Africa and HIV Transmission Risk, HIV Prevalence, and Sexually Transmitted Infections, 2005-2017 (Nagata et al., 2022)	Cross sectional	21 countries in sub-Saharan Africa	Heavy rainfall was defined based on the extent to which annual rainfall deviated from the historical average (standardized precipitation index ≥1.5) at the enumeration area level	Increased association between heavy rainfall and HIV prevalence and STIs among participants aged older than 20 years and participants in rural areas.	Not reported but inference made to rainfall and resulting weather possibly influencing mental need for sexual activity	HIV prevention strategies especially during climate conditions like rainfall which could foster increased need for sexual activities.
Perception of climate change, loss of social capital and mental health in two groups of migrants from African countries	Cross sectional	Migrants from the following countries - Niger Liberia Mali Afghanistan Burkina Faso Sierra Leone Gambia	Heat waves, a delay in the rainy season, an increase in extreme and catastrophic atmospheric events	Strong correlation between the perception of climate change and the loss of social capital – such as education, electricity, food	Strong correlation between the loss of social capital and emotional disorders due to climate change	Enable increase socio economic positions and capacity to respond to climate change

(Di Giorgi et al., 2020)		Senegal Nigeria Cameroon Ghana		security, social safety, health services availability		
Climate distress, climate-sensitive risk factors, and mental health among Tanzanian youth: a cross-sectional study (Prencipe et al., 2023)	Cross sectional	Tanzanian youths	Awareness of climate change and working in extreme temperatures	Mainly food and water insecurity	Depression was highest among youth who reported severe water and food insecurity (181/365 [50%] and 302/685 [44%], respectively). In the fully adjusted model, youths who had severe water insecurity had 23 percentage points (95% CI 17–28) higher depression than those who did not	Improved education and awareness on climate change.

Identified Gaps in Research on Climate Change and Disease Trends in Africa

Unlike in developed regions like the United States (Center for (Disease Control, 2023; Edelson et al., 2022) and Europe (Semenza & Paz, 2021), where there is evidence and pictorial representation of climate change impacts on a wide range of health outcomes, Africa still has a huge dearth in available evidence specifically demonstrating the health implication of climate change as illustrated in Table 2 above. This lack of evidence is also well documented in a recent extensive review of the literature in the past decade on

climate change and current health research trends, gaps and perspectives for the future by the World Health Organization (2021d). In this WHO paper, priority areas for research were grouped into five (5) as follows: Priority 1: Health vulnerability to climate change; Priority 2: Health protection strategies; Priority 3: Health impacts of potential adaptation and mitigation measures; Priority 4: Decision-support and other tools and Priority 5: Likely financial costs and other resources. In Africa, research is needed in all these areas. However, the most pressing knowledge gaps hindering measures to protect health relate to the direct linkages between climate change and its health effects and effective interventions to protect those at risk. It is, therefore, challenging to draw definitive conclusions about how climate change affects health risk in Africa due to these gaps and underrepresentation of the available evidence, so urgent in-depth and innovative health research is required. Prior research shows that it is difficult to draw definitive conclusions about the relationship between temperature and diseases like malaria due to a contradictory case in Africa, where temperature fluctuation was found to alter the incubation period of the parasite significantly (Wu et al., 2016). Another study found no correlation between malaria epidemics and El Nino/La Nina or other extreme weather events in the highlands of East Africa, where the data was collected. This adds to the discrepancies in the direct link between climate change and diseases like malaria, one of Africa's most prominent infectious diseases of public health importance (Liang & Gong, 2017). Thus supporting our call for immediate research to identify these knowledge gaps and formulate interventions to reduce health risks in Africa.

Awareness of Health Care Professionals in Africa on the Impacts of Climate Change on Health

Spreading awareness of the impacts of climate change on health amongst healthcare professionals may be an effective strategy to reduce public health risks. In the African continent, only one article has recently assessed healthcare professionals' knowledge of the health impacts of climate change (Opoku et al., 2021). In this multinational survey, sixty-three per cent (63%) of those polled said their country had greatly felt the effects of climate change on health in recent years, while 32% said their country had felt them only to a lesser extent. Respondents in Nigeria reported the highest rates (67.7%), followed by those in Kenya (66.6%). Compared to the other countries in the sample, South African respondents felt that climate change had minimal health effects. All Ghanaian and Namibian respondents agreed that health issues related to climate change are widespread in their countries. The study's recommendations emphasise the importance of improving national, regional, and local policies on climate change and public health, as well as strengthening the skills of health professionals.

Conclusion and Recommendations for Future Directions

The African continent faces concerning consequences of climate change, in particular, an increase in physical and mental health detriments due to climate hazards such as erosions, droughts, floods, rising sea levels, and melting glaciers. This further results in a decrease in water resources, a decrease in agricultural output and food security, and a decline in biodiversity (Opoku et al., 2021). According to WHO, Africa must strengthen climate resilience and adaptation capacities to establish robust regional and national early warning systems and climate services for climate-sensitive sectors (Opoku et al., 2021; Hess et al., 2020). To better adapt to a shifting climate, health institutions need to improve their foundational knowledge by implementing workshops and training seminars on the health implications of climate change. Our rapid review seeks to encourage researchers in Africa and worldwide to look into the causal relationships between climate change and its implications on health, taking into consideration other causative factors. Lastly, we recommend that scholars in the continent develop and conduct innovative research that can identify cost-effective interventions to reduce climate change-related health risks and mental health disorders.

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