

Full Length Research Paper

A review of strategies for resilience of health impacts of climate variability in Guinea

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Climate change presents major health threats in Guinea, a low-income nation in West Africa. Rising temperatures, variable rainfall, floods, droughts and coastal erosion increase climate-sensitive health outcomes, including respiratory infections, diarrheal diseases, malaria, undernutrition and heat-related illness. From 1990 to 2004, there was a notable increase in deaths, starting from approximately 17,815 in 1990 and peaking at about 14,382 in 2004. Following this peak, there was a subsequent decline, albeit with varying rates, settling at around 7860 by 2022. Vulnerable groups like children, the elderly, outdoor laborers, and slum residents are disproportionately impacted. This paper reviews evidence on current and projected disease burdens due to climate change in Guinea. It further discusses strategies to build health resilience using the Building Resilience Against Climate Effects (BRACE) framework including improving infrastructure, disease surveillance, health services delivery, and multi-sectoral coordination. Protecting vulnerable groups and communities through integrated interventions anchored in the local context is emphasized. Guinea requires international support and applied research to inform evidence-based adaptation policies that safeguard population health against escalating climate change threats.

Key words: Guinea, climate change, temperature, rainfall variability, extreme weather, health impacts

INTRODUCTION

Climate change, primarily caused by human activities such as burning fossil fuels and deforestation, leads to increased greenhouse gases in the atmosphere, resulting in global warming (Intergovernmental Panel on Climate Change, 2022). The effects of climate change include rising temperatures, changing precipitation patterns, and more frequent and severe extreme weather events. These changes have significant impacts on human health, particularly in tropical developing nations like Guinea, which are experiencing heightened risks (WHO,

2022). The World Health Organization (WHO) has stated that climate change is humanity's biggest health threat (WHO, 2022).

Transitioning to the specific case of Guinea, this West African nation's vulnerability to climate change is amplified due to several factors. These include its reliance on climate-sensitive sectors, dense urban populations, limited infrastructure, and restricted health systems capabilities. These factors and the broader impacts of climate change pose significant challenges to the

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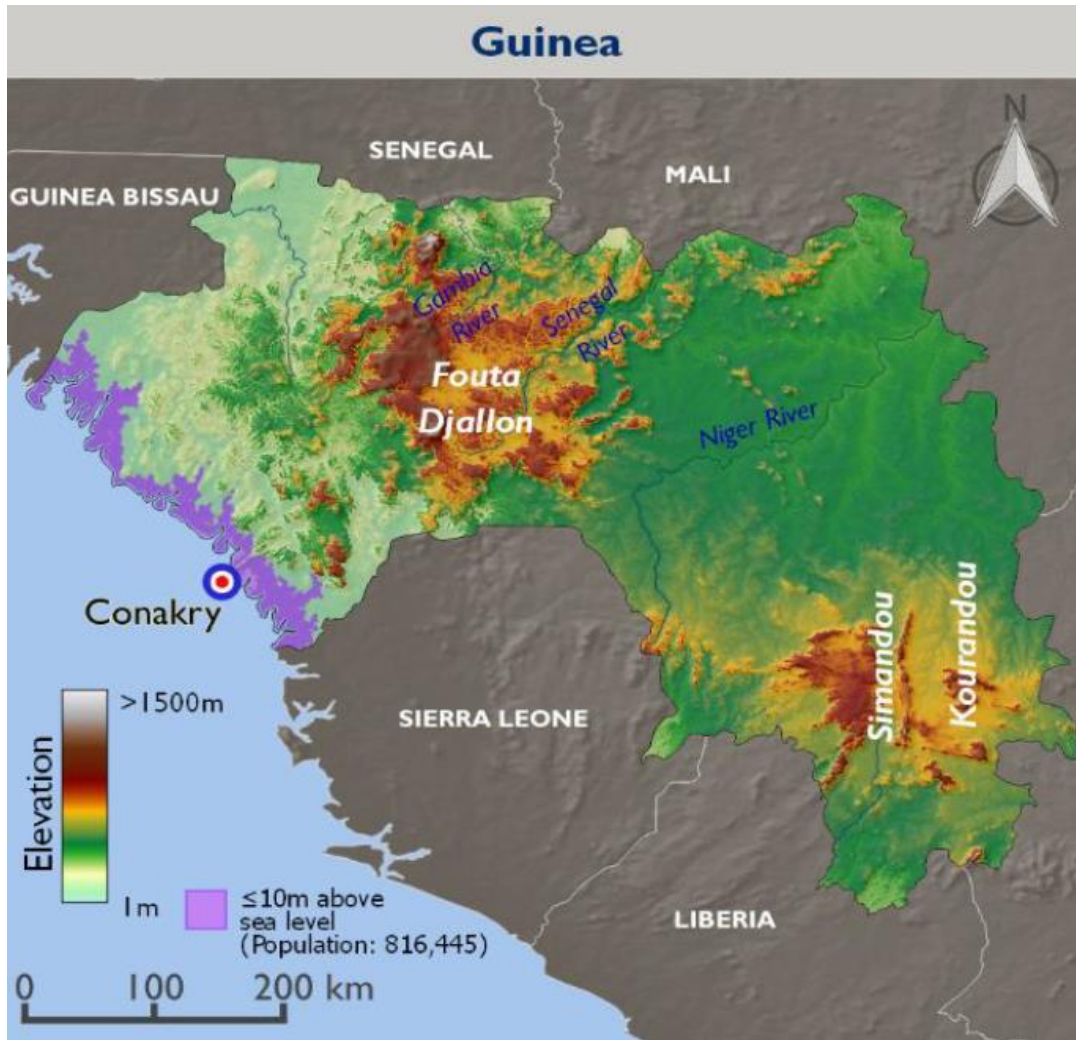


Figure 1. Guinea presentation.
Source: Climate risk profile Guinea, 2018.

country's health and well-being (African Development Bank Group, 2018). A geographical analysis of Guinea reveals distinct topographical features and climatic zones that exacerbate the country's vulnerability to climate-related health issues. Figure 1 illustrates the diverse elevation levels across the country, with a concentration of higher terrains in the Fouta Djallon region and lower elevations towards the coastline where Conakry is located (World Bank, 2017; Climate Risk Profile: Guinea 2018).

Guinea has a tropical climate, with a rainy season from May to October and a dry season from November to April (African Development Bank Group, 2018). Its vast coastline and the country's specific socioeconomic characteristics, such as its reliance on climate-sensitive sectors like agriculture (African Development Bank Group, 2018), make it a critical focal point for understanding the health burdens associated with climate change in Africa.

Despite the significant impacts of climate change on health outcomes, including infectious diseases, mortality, and respiratory, cardiovascular or neurological outcomes (Rocque et al., 2021), there is a noticeable lack of comprehensive systematic reviews that address the complex interplay between climate change and health in Africa. This represents a significant gap in our knowledge and understanding of the health impacts of climate change in Guinea and similar contexts (Rocque et al., 2021).

This systematic review aims to bridge this gap by amalgamating insights on climate change's present and anticipated effects on Guinea's health landscape. It offers a granular examination of a particularly susceptible yet largely overlooked West African country, and broaches potential strategies anchored in the Building Resilience Against Climate Effects (BRACE) framework to bolster health resilience (Centers for Disease Control and

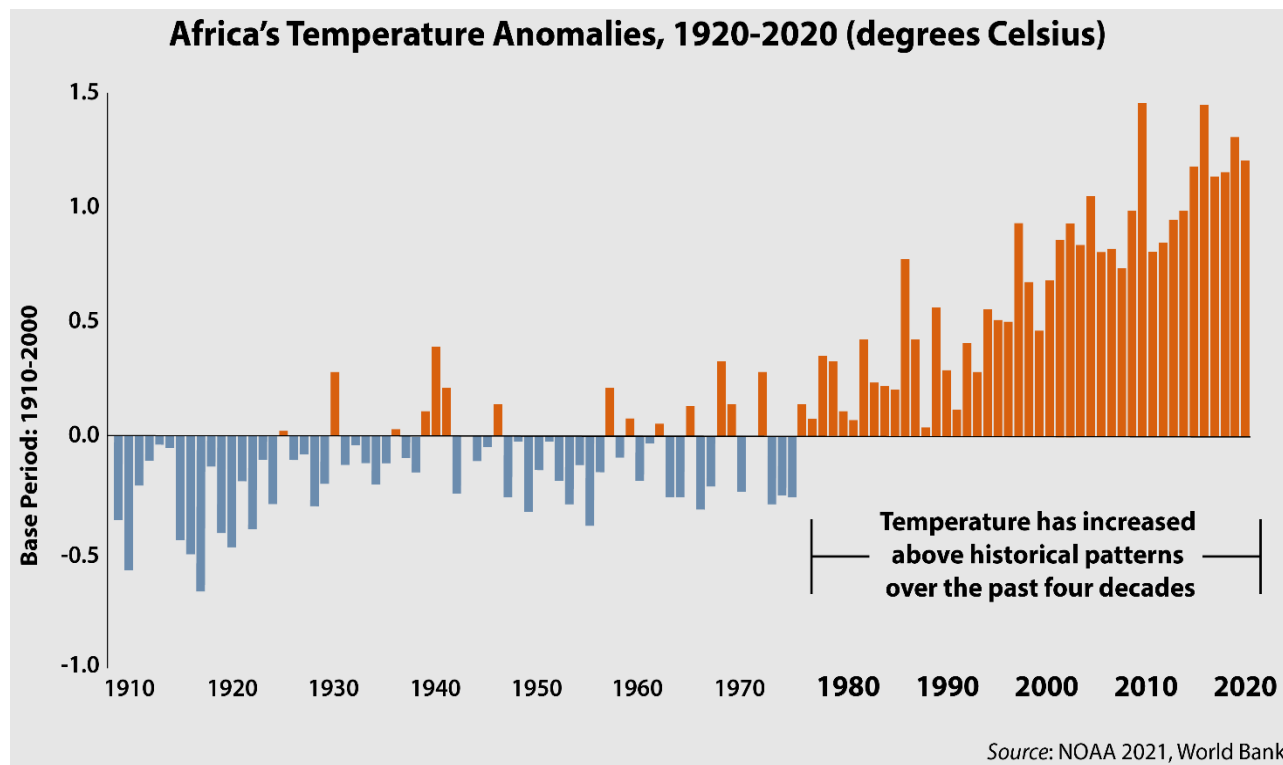


Figure 2. Africa temperature change since 1910.
Source: Africa Center for Strategic Studies (2021).

Prevention, 2022). The CDC BRACE framework provides public health professionals with a useful roadmap to build climate resilience by (1) anticipating climate impacts and assessing vulnerabilities, (2) projecting disease burden, (3) assessing interventions, (4) developing and implementing adaptation plans, and (5) evaluating impacts (Centers for Disease Control and Prevention, 2022).

METHODOLOGY

To unravel the intricate interplay between climate change and health in Guinea, we embarked on a rigorous systematic review encompassing a diverse array of 55 sources, including scholarly articles, government reports, and NGO publications. This expansive review was steered by meticulously crafted inclusion and exclusion criteria, ensuring the capture of both macro-level insights and grassroots nuances to present a multifaceted depiction of the climate-health nexus in Guinea.

Search strategy and source selection

The search was primarily focused on a prominent database, PubMed, Scopus, and Web of Science. Employing a strategic combination of keywords, we sifted through vast information repositories. The keywords encompassed terms like "Guinea", "Climate change", "Temperature rise", "Rainfall variability", "Extreme weather", and "health impacts" (Jalloh et al., 2013) (Figure 2).

Inclusion criteria

1. Peer-reviewed journal articles elucidating the ramifications of climate change on health outcomes in Guinea, including the effects of temperature variations, extreme weather phenomena, and the proliferation of infectious diseases (Rocque et al., 2021).
2. Authoritative reports from globally recognized entities such as WHO, World Bank, IPCC, USAID, and CDC spotlight the interrelation between climate change and health within the African continent, particularly in Guinea.
3. Official publications from the Guinean government detailing climate forecasts, health repercussions, and systemic vulnerabilities.
4. Scholarly books and chapters underscoring the health implications of climate-induced changes (Carlton et al., 2016).

Exclusion criteria

1. Articles from news outlets, opinionated pieces, and general magazine articles were omitted to maintain academic rigor.
2. Investigations narrowly focusing on environmental or health issues without any direct linkages to climate change were sidelined (Cheng et al., 2008).
3. Literature focused on climate change or public health but lacking a targeted focus on Guinea or the broader African region was excluded.

The selection process for sources was rigorously conducted, adhering to predetermined inclusion and exclusion criteria, to ensure a thorough representation of the climate-health nexus within Guinea. Following a meticulous screening procedure, a total of 49 publications were deemed suitable for inclusion in the review.

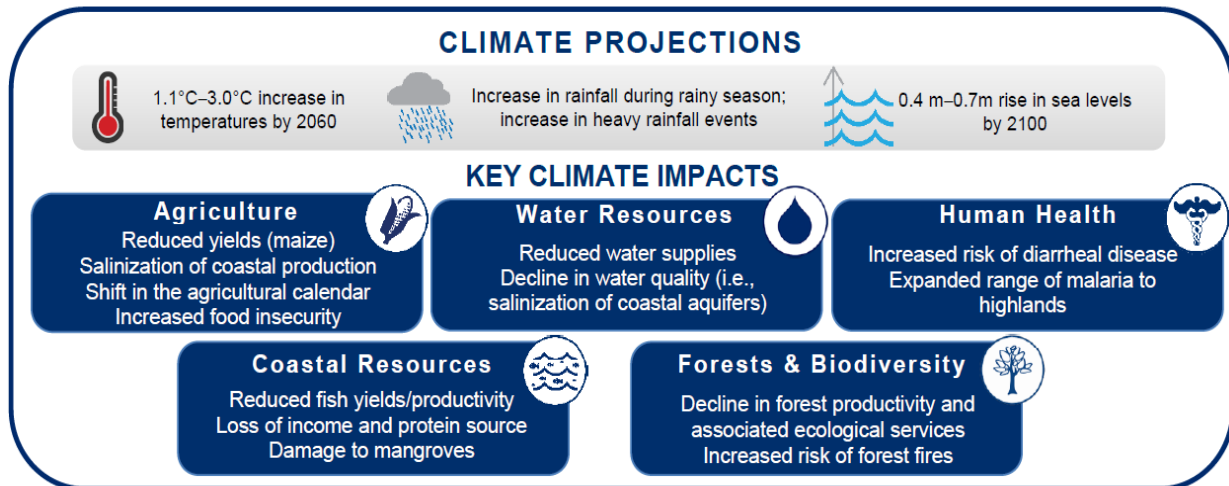


Figure 3. Guinea climate change projection.
Source: Climate risk profile Guinea, 2018.

RESULTS

Current Impacts

Recent observations and projections illuminate the multifaceted impacts of climate change in Guinea, revealing a complex interplay between environmental shifts and public health challenges (Figure 3). Historical climate trends from 1960 to 2016 show a significant increase in average annual temperatures by approximately 0.21°C per year and a decrease in annual rainfall by about 8.14 mm per year since the late 1960s (Loua et al., 2019). This period also saw an increase in the frequency of very hot days and tropical nights, emphasizing Guinea's vulnerability to climate-induced hazards such as floods, storms, and landslides (Byrne, 2021).

Guinea's Second National Communication to the UNFCCC projected further warming between 0.2 and 3.9°C across various regions by 2050, alongside up to a 30% decline in annual rainfall. These climatic changes are poised to exacerbate climate-sensitive health outcomes, including respiratory infections, diarrheal diseases, and malaria, as rising temperatures and fluctuating precipitation patterns create conducive environments for pathogens and vectors (Guinea, 2018; Sylla et al., 2015).

Respiratory infections

Flooding from heavy rainfall promotes mold growth in homes, subsequently increasing asthma symptoms and respiratory infections (Cheng et al., 2008). Drought conditions have been associated with increased airborne dust. This can exacerbate respiratory diseases (Centers for Disease Control and Prevention, 2020). Studies in

sub-Saharan Africa following extreme weather events such as floods and droughts have indicated an increase in acute respiratory infections, particularly in children (Tesema et al., 2022). Additionally, it is well-documented that extreme weather events like floods can significantly impact health, increasing respiratory infections (Rha et al., 2020). Despite the lack of reliable data, it is plausible that similar trends could be observed in Guinea.

Diarrheal diseases

Contaminated food or water sources, often resulting from climate-related events such as floods or droughts, significantly elevate the risk of diarrheal diseases (Grist, 2022). Specifically, cholera outbreaks have been frequently linked to heavy rainfall events, which can lead to the contamination of water supplies with sewage, thereby facilitating the initiation of cholera transmission cycles (AP News, 2022). Research has shown that climate variability is expected to increase the risk of diarrheal diseases, a leading cause of child mortality and morbidity in sub-Saharan Africa (SSA), especially when populations have poor access to improved water and sanitation (Levy et al., 2016). This evidence underscores the necessity for ongoing Water, Sanitation, and Hygiene (WASH) interventions, complemented by climate-informed strategies, to mitigate the heightened risk of diarrheal diseases in such climatically vulnerable regions.

Malaria

Guinea faces significant health challenges due to malaria, which accounts for a considerable proportion of outpatient consultations in the country (President's

Malaria Initiative, 2022). While strides in malaria control have led to reduced morbidity, the interplay between climatic variables and malaria transmission is complex, warranting close attention (Beloconi et al., 2023). Studies predict that climate change could lead to shifts in malaria's geographical distribution within Guinea, potentially increasing its prevalence in the country's forested highlands and decreasing it in savanna lowlands (Tonnang et al., 2010). However, model uncertainties call for improved surveillance and adaptable control strategies.

Recent research conducted in Northern Benin, a region with climatic conditions akin to those in Guinea, offers insightful findings relevant to Guinea's context. Gbaguidi et al. (2024a) identified a significant positive correlation between malaria incidence and climatic variables such as temperature, rainfall, and relative humidity in Northern Benin. The study delineates optimal conditions for malaria transmission, suggesting that precipitation ranging from 80 to 220 mm, temperatures of 25 to 35°C, relative humidity of 55 to 85%, and wind speeds of 1.6 to 2.7 m/s are conducive to malaria proliferation. Notably, the maximal temperature and relative humidity were found to substantially influence malaria's spread in the region. These insights could inform the development of a malaria early warning system, potentially applicable in Guinea.

Further advancing the utility of climate data for malaria prediction, another study by Gbaguidi et al. (2024b) introduced an intelligent malaria outbreak warning model using machine learning techniques to forecast malaria prevalence in Northern Benin. Employing algorithms such as linear regression, support vector machine, and negative binomial regression, the model notably achieved an 82% accuracy in predicting malaria incidence with the support vector machine regression emerging as the most effective. This model's projections under climate change scenarios RCP4.5 and RCP8.5 suggest an increase in malaria incidence, underscoring the critical need for climate-informed malaria surveillance and response strategies in Guinea.

Undernutrition

Child undernutrition remains prevalent in Guinea (SPRING/USAID, 2015). Climate extremes like floods or droughts that damage crop yields and incomes worsen food insecurity and malnutrition risk (Phalkey et al., 2015). The study of Headey et al. (2020) found that seasonal rainfall variability contributed to stunting in young Guinean children by reducing household food access. Social protection programs that expand during climate shocks could safeguard nutrition.

Heat stress

The emergence of escalated heat stress risk in the cities

of Guinea is noted with a recorded rise in mean temperatures (Guinea Country Program, 2017). Urban dwellers, especially those without amenities like air-conditioning, are particularly vulnerable to heat (Planning for Urban Heat Resilience). Urban heat islands, especially dangerous and exacerbated by glass, steel, asphalt, and concrete structures, further elevate the heat stress risks. Those in underserved communities, which often lack vegetative cover to mitigate these effects, are disproportionately impacted (Dirt, 2021). The dilemma is particularly acute for lower-income demographics, and outdoor workers entrapped by soaring temperatures who find even mild physical activities potentially fatal (Scopeblog, 2022). Elderly individuals, who typically do not adapt well to abrupt shifts in temperature and may have chronic conditions or medications altering their physiological response to heat, also find themselves notably susceptible to heat-induced health issues (National Institute on Aging [NIA], 2022). Consequently, ageing outdoor workers may choose between premature retirement and risking their lives under severe meteorological conditions. Heat effects can span from exhaustion and renal dysfunction to cardiovascular issues (Harvard Health Publishing, 2022; The Lancet, 2021), though data specifically elucidating heat health burdens in Guinea are currently absent.

Coastal erosion

Guinea has approximately 320 km of coastline (Central Intelligence Agency, 2022), and the country faces escalating sea-level rise and coastal erosion threats. By 2100, up to 37% of coastal rice-farming areas may be lost to rising seas (Guinea, 2018). This would severely impact local agriculture, food security, ecosystems, settlements, and livelihoods. Strengthened planning, early warning systems, and climate-resilient infrastructure are needed to protect coastal populations (Magnan et al., 2016).

Projected health impacts

The financial repercussions of health issues influenced by climate are considerable. The immediate medical care expenses and secondary costs like decreased work efficiency could burden Guinea's delicate economic structure. Exposure-response relationships will determine Guinea's future disease burdens under climate change, its future socioeconomic development pathways, and adaptation efforts (Intergovernmental Panel on Climate Change, 2014).

Key projections from regional models

The projections include:

1. The shifting geographic risk for malaria transmission in Africa due to climate change is a significant concern. The worst-case regional scenario of climate change predicted an additional 75.9 million people at risk from endemic exposure to malaria transmission in Eastern and Southern Africa by the year 2080. Despite a predominance of reduction in season length, a net gain of 51.3 million additional people is predicted to be put at some level of risk in Western Africa by midcentury according to a study by Ryan et al., (2020).
2. Over 20 additional days exceeding heat thresholds in Guinean cities by 2050; up to 5-10% labor productivity declines on hot days (Guinea Country Program, 2017; Sylla et al., 2015).
3. Increased child malnutrition following extreme weather shocks to agriculture and food systems. Early studies project a 2-6% rise in wasting among Guinean children by 2050 (Phalkey et al., 2015; Lloyd et al., 2011).
4. More frequent cholera and other diarrheal disease outbreaks with heavy rainfall and flooding (Carlton et al., 2016).
5. Worsened asthma and respiratory infections from flooding, droughts, and expanding airborne allergens based on exposure-response relationships (Cheng et al., 2008; Asthma and Allergy Foundation of America [AAFA], n.d; National Institute of Environmental Health Sciences [NIEHS], 2022).
6. Growing risks of illnesses and deaths from heatwaves, especially among the elderly and vulnerable groups.
7. 17-37% loss of coastal rice-growing areas by 2100, impacting livelihoods and food security without coastal zone enhancements (Guinea, 2018).
8. Increased population displacement from coastal zone degradation (Magnan et al., 2016). Guinea has approximately 320 km of coastline (Central Intelligence Agency, 2022) facing escalating sea-level rise and coastal erosion threats.

DISCUSSION

Applying the Building Resilience Against Climate Effects (BRACE) framework, the discussion of Guinea's strategies for mitigating climate change's health impacts will focus on assessing interventions, adaptation planning and implementation, and impact evaluation.

Assessing interventions of public health adaptation strategies

1. Heat warning systems and infrastructure upgrades to reduce heat exposure through cool roofs, green spaces, resilient housing, and air conditioning (Knowlton et al., 2014).
2. Disease surveillance and control programs sensitive to climate fluctuations through enhanced epidemiological

modeling, forecasting, and preparedness (Lowe et al., 2017).

3. Disaster preparedness and response capacity for extreme weather events through early warning systems, stockpiles of medicines/supplies, and emergency infrastructure (Maxwell et al., 2020).
4. Social protection and nutrition supplementation to buffer food security shocks through cash transfers, food banks/kitchens, and nutritional support (Asfaw et al., 2014).
5. Ecosystem conservation to increase coastal resilience through mangrove restoration and sustainable fisheries (International Union for Conservation of Nature [IUCN], 2022).
6. Strengthened coastal zone management and land use planning through setback zones and climate-informed infrastructure (Magnan et al., 2016).
7. Improved meteorological monitoring and climate risk forecasting to guide health adaptation efforts (McSweeney et al., 2015).

Adaptation planning and implementation

A comprehensive national adaptation strategy for health requires:

1. Considering climate change in all national policy development and budgeting.
2. Developing/upgrading sanitation facilities and transport infrastructures.
3. Integrating climate information into disease control and food security early warning systems (Lowe et al., 2017; Kadi et al., 2015).
4. Fostering partnerships across meteorology, environment, agriculture, nutrition, and emergency response agencies.

Impact evaluation key indicators to track adaptation progress

1. Disease rates following climate hazards and early warning triggers.
2. Temperature and extreme weather-related morbidity and mortality.
3. Child nutrition status trends during/after climate shocks.
4. Mental health following extreme events, communities' adoption of adaptation technologies.

Conclusion

Climate change threatens to undermine Guinea's development through adverse health impacts among vulnerable groups. Strategic adaptation guided by the BRACE framework can build resilience and safeguard

population health through integrated investments, policies, partnerships, and research (Centers for Disease Control and Prevention, 2022).

Strengthening Guinea's research capacity is critical for developing localized solutions to climate change-related health issues. Establishing research centers focused on climate and health and facilitating collaboration with international institutes can enhance knowledge sharing.

Regional and global cooperation is needed to provide Guinea with technical expertise and funding that enables locally tailored climate change resilience planning and interventions. With support, Guinea can transit towards a climate-resilient future, protecting its citizens' health against escalating climate threats.

Limitations

During the study, the following are challenges and limitations important to acknowledge.

Data availability

There is a lack of localized data and projections specifically for Guinea. Many studies rely on regional climate models or data from neighboring countries, which may not fully capture Guinea's unique context. More granular data on Guinea disease rates, vulnerabilities, etc., is needed.

Surveillance systems

Gaps in surveillance systems and health data reporting in Guinea constrain efforts to quantify current and projected disease burdens. Improved monitoring and data collection would allow more robust analysis.

Future uncertainty

Uncertainty in future socioeconomic pathways and adaptation efforts makes it difficult to project health impacts precisely. Scenario analysis considering different development pathways could improve projections.

Scope of health outcomes

The review did not consider impacts on all health outcomes that could be climate-sensitive (e.g., injuries, poisonings, and mental health). A more comprehensive scope could reveal further risks.

Complex interactions

Interactions between climate factors and health are

complex. The review simplifies connections between climate variables and specific health endpoints that may not fully capture real-world dynamics.

CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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