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SHORT COMMUNICATION

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Climate change and contagion: the emerging threat of zoonotic diseases in Africa

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ABSTRACT

This article investigates the escalating occurrence of zoonotic diseases in Africa, attributing their spread to climate change and human activities. Africa's unique combination of biodiversity, reliance on animal husbandry, and swift urbanization heightens its susceptibility. Climate change disrupts ecosystems and animal habitats, intensifying human-wildlife interactions. Urbanization, inadequate sanitation, and insufficient healthcare infrastructure further facilitate disease spread. Climate-induced displacement adds another layer of complexity. Mitigation strategies include improving surveillance systems, fostering early detection via point-of-care diagnostics and digital contact tracing, and investing in vaccines and therapeutics. Our purpose of this is to advocate for sustainable land use, robust community-level public health systems, international cooperation, and resource-sharing. We also emphasize the need for effective vector-control policies, dedicated research funding, and annual awareness, vaccination, and early detection campaigns in endemic regions.

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Introduction

While animals enrich human life by offering sustenance, economic opportunities, companionship, and educational experiences, they also pose a risk of transmitting zoonotic diseases that can affect both humans and animals [1]. Despite animals' healthy appearance, they can carry germs that can cause harm to humans through zoonotic diseases [1]. These diseases, while capable of affecting anyone, pose a greater risk to certain individuals who are more susceptible to severe illness or even death, necessitating the need for these individuals to take preventive measures for their own and their family's safety [1]. Zoonotic diseases like Ebola and Hendra, transmitted through microbes such as bacteria and viruses, can become epidemics or endemic respectively, and their eradication hinges on breaking the transmission chain from animals to humans [2]. The increasing incidence of these diseases over the decades has led to global outbreaks, and the challenge is further amplified as these diseases, transmitted from vertebrates to humans, pose significant health risks and economic costs [2].

Zoonotic diseases, a byproduct of civilization growth, have significant climate change implications. They increase with human-induced changes, impacting ecosystems profoundly [3]. Their spread can cause biodiversity loss and habitat disruption, often driven by deforestation, urbanization, and land use changes [2]. For example, clearing forests for agriculture or urban development increases human-animal contact, thereby raising the risk of zoonotic disease transmission [3]. Climate change, marked by rising temperatures and weather shifts, escalates the spread of zoonotic diseases [4]. This leads to economic losses intensifying poverty, trade disruptions affecting agriculture and wildlife-dependent sectors, and heightened healthcare costs straining limited infrastructure [4]. Hence, the complex interplay between zoonotic diseases and climate change is an urgent concern.

Focusing on the African context, as of 2023, Africa had an estimated population of 1,484 million people, equivalent to 18% of the world's population [5]. Africa is the highest ecologically biodiverse continent with 20% occupied by wildlife ecosystems – more than any other continent – which roughly translates into one-sixth of the world's remaining forests [6].

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Dependent on animal husbandry, nearly 62% of the rural population relies on the continent's natural and diverse ecosystem for their livelihood, with 60% of the Gross Domestic Product (GDP) from this and an income with annual exports of live animals [6–8]. Population growth and urbanization with the growing demand for food that is derived from animals along with the encroachment on the habitats of wildlife and climate change has primed Africa as a hotspot for emerging infectious diseases, especially of zoonotic origin [9]. The Africa Center for Strategic Studies in 2022 stated that *'declines in Africa's rich ecological biodiversity threaten millions of livelihoods, increasing food insecurity, conflicts over land, and transmission of zoonotic diseases that can lead to more pandemics'* [6]. This should not be taken lightly – impacting agricultural and social structures – as affected regions become uninhabitable, leading to migrations and significant changes in land use, which has increased zoonoses, even in urban areas [6,9].

This short communication aims to examine the concerning rise of zoonotic diseases in Africa, highlighting how climate change and human behavior are creating a perfect storm for these diseases to emerge and spread.

Climate change as a driver

Climate change is rapidly emerging as a significant threat to biodiversity and our ecosystems globally [10]. Despite ongoing research improving our understanding of Earth's climate and its relationship with the biosphere, predictions indicate increasing and more frequent climate change impacts on our environment and on us [11,12]. Africa, the continent most vulnerable to climate change, saw a 0.7°C temperature rise in the 20th century and is expected to continue warming at a rate of 0.2°C to 0.5°C per decade, depending on the scenario [13–15].

The 0.7°C temperature rise in Africa during the 20th century has had substantial impacts on biodiversity, ecosystems, and animal habitats with alterations in both land and water ecosystems across the continent [16,17]. The increase in temperature has resulted in more frequent and severe droughts and floods, which have disrupted the natural habitats of many species, leading to a decrease in biodiversity [16–18]. For instance, the East and Horn of Africa region is particularly susceptible to the effects of climate change, evidenced by rising temperatures, unpredictable rainfall, and protracted droughts [19]. This has led to severe water shortage, food insecurity with high levels of malnutrition, and outbreaks of zoonotic disease, with millions of people and livestock forced to migrate [19].

Specific examples of zoonotic diseases in Africa already impacted by climate change include Rift Valley fever and malaria which are vector-borne, meaning they are transmitted to humans through the bites of insects such as mosquitoes and ticks [20]. Changes in climate conditions can promote or inhibit the survival, reproduction, abundance, and spread of these vectors, as well as the diseases they carry [20]. As the planet heats up, infectious diseases that were once confined to warmer latitudes are slowly expanding their range, with zoonotic diseases taking advantage of the greater range made available by climate change [21]. Human activities that harm the environment can lead to new infections, as changing our surroundings increases our contact with wildlife, exposing us to more disease-causing agents [22,23]. This poses an increasing risk to human health, especially in regions like Africa where the effects of climate change are particularly pronounced [19].

Risk factors, challenge and consequences

Official predictions put the continent of Africa as having the highest population growth rate globally, with the number of people in Africa predicted to double by 2050 [24,25]. The majority of the spillover of this increasing population is expected to be in urban areas, in addition to rural-to-urban migration trends with are also on the rise [26]. This is exemplified in light of two cities' zoonotic disease outbreaks which occurred due to the increasing poor urban residents, without adequate sanitation and clean water, namely Harare, suffering from cholera (2008–2009) and Ebola in Monrovia (2014–2016) [27]. These vulnerable populations faced forced displacement from their homes, as conflicts arose over valuable urban spaces showing that outbreaks are political [27]. The Ebola outbreak in Monrovia, Liberia (2014–2016), rapidly spread through informal settlements, showing that these precarious populations – highly mobile between urban and rural settings – facilitated the transmission of Ebola in densely populated urban areas [27]. These challenges were experienced globally during the COVID-19 pandemic, caused by the SARS-CoV-2 virus, which overwhelmingly affected urban centers highlighting that overcrowded environments, inadequate housing, and poor sanitation contribute to the rapid spread of the virus in cities [28]. Further, deficient urban policies and improper waste management via poor urban governance have demonstrated that urban planning is unable to keep up with safely managing sanitation increasing the potential for zoonoses rapidly spreading [27].

Water-based zoonoses and water-related vector-borne zoonoses are due to heavily polluted wastewater leading to outbreaks of dengue and Zika as inadequate vector control measures are hotspots for dengue transmission and exacerbate the risk of

diarrheal outbreaks such as salmonella infections [29]. Monkeypox cases have been rising along with Marburg cases too, with improving sanitation and hand hygiene required to limit their spread [30,31]. This situation is particularly alarming in regions with high numbers of internally displaced persons (IDPs), where access to sanitation facilities and healthcare services can be challenging. The 2023 global report of internal displacement cites that '*…(in) the previous 10 years, sub-Saharan Africa and the Middle East and North Africa had the highest numbers of IDPs*', with Africa currently having 45% of the global total of internally displaced persons (IDPs) including those displaced due to climate change-related disasters [32]. Climate change, migration, and diseases from animals to humans are linked, and climate change impacts how these diseases, their carriers, and hosts survive, reproduce, spread and influence the frequency and transmission of these diseases [19]. As mentioned earlier, the eastern horn of Africa regions face significant challenges due to rising temperatures, erratic rainfall patterns, and prolonged droughts resulting in severe water shortage, food insecurity with high levels of malnutrition, and outbreaks of communicable disease, with millions of people and livestock forced to migrate [19]. The region's vulnerability is exacerbated by its vast drylands, pastoralist communities, unresolved water rights issues, and historical experiences with natural disasters and conflicts [19].

As a result of this unprecedented human movement across borders, a rise in zoonotic diseases is increasingly being reported in Africa, revealing 28,934 people affected by rickettsiosis, toxoplasmosis, and Q-fever amongst others, with the deadliest being Marburg, Ebola, and leptospirosis from 2000 to 2022 [33]. Further, a systematic review identifies significant gaps in primary data on zoonotic diseases in displacement, highlighting risk factors such as loss of health services, increased population density, and socio-economic factors [34]. There is little evidence of large-scale zoonotic disease outbreaks linked to livestock in displacement so the review calls for further interdisciplinary primary research to help address these gaps [34].

In many African countries, the implementation of the One Health approach, a collaborative interdisciplinary effort addressing health issues at the crossroads of human, animal, and environmental health, is hindered [35]. This is largely due to communication challenges among key stakeholders such as farmers, stockbreeders, investigators, and physicians, particularly in the context of zoonotic diseases [35].

To effectively combat the emergence of these diseases, it is crucial to foster active intersectoral collaboration and enhance communication strategies for prevention and risk stratification [35]. However, the effectiveness of these strategies is often compromised by the lack of healthcare access, diagnostic resources, and infrastructure in many African countries, which hinders early detection and response to zoonotic diseases [35,36]. The pivotal role of the advancement of diagnostic methodologies in the early detection and response to zoonotic diseases was underscored during the previous Ebola epidemic, where a significant delay was observed between the initial case and the identification of the virus [35]. This situation was particularly evident in Nigeria, where limited access to healthcare and diagnostic tools impeded the early detection and response to disease outbreaks [37]. During the COVID-19 outbreak, Nigeria's response efforts were complicated due to an initial lack of adequate testing capacity, which delayed the prompt diagnosis of cases [37]. Such delays could significantly affect future responses to zoonotic outbreaks [35,37].

Post-pandemic, across Africa, the active surveillance and response efforts have been weakened due to critical shortages of healthcare workers, personal protective equipment (PPE), and testing platforms [38]. An additional aspect is to focus on strengthening vector surveillance and vector control efforts in the context of the changing environment applying a One-Health strategy. This is particularly important given the potential for new vectors arriving – such as the introduction of Anopheles Stephensi from Asia – which has now adapted and colonized parts of Africa and could potentially increase malaria transmission in urban settings or arboviruses [39].

Furthermore, limited access to healthcare services in some regions can cause delays in diagnosing and treating zoonotic infections, thereby allowing the diseases to spread unchecked [36]. This unchecked spread is particularly concerning given that there have been outbreaks of deadly diseases such as monkeypox, Rift Valley Fever, and Ebola viral disease in sub-Saharan Africa, which have had significant consequences for human health, although these diseases have varying case fatality rates depending on the specific pathogen [33].

Among the recent outbreaks of zoonotic diseases in Africa was the Ebola outbreak in West Africa in 2014 which has been part of ongoing public health emergencies faced by communities in the region as did the Lassa fever outbreak in Nigeria from 2015 to 2022 [40]. There were also recent Ebola outbreaks in Uganda, the Democratic Republic of Congo, Guinea and Marburg in Equatorial Guinea as well as monkeypox outbreaks in many countries in the region, resulting in high morbidity and mortality rates, causing widespread social and economic disruptions [36,38,40].

The increasing frequency and rapid spread of these zoonotic diseases over the past two decades

underscores the urgent need for early detection, rapid response, and effective public health interventions to mitigate the spread and impact of zoonotic diseases on communities across the African continent [33,40].

Urgent action needed

To ensure early detection and effective response to outbreaks, it's crucial to bolster our surveillance systems in Africa [41]. This includes equipping our healthcare workers with the necessary training to swiftly identify infectious diseases and initiate appropriate responses [42]. In this endeavour, the World Health Organization (WHO) has been instrumental, in aiding countries in enhancing their diagnostic capabilities and fortifying their readiness for public health emergencies [43].

One of the key strategies adopted by the WHO in this regard is the promotion of early warning systems [44]. Early warning systems are designed to detect potential disease outbreaks or changes at an early stage, providing valuable time for public health officials to implement effective response measures [44]. However, the success of these systems is contingent upon a broader, more comprehensive approach to health [45]. To implement a comprehensive health concept, there is a need for interdisciplinary and cross-sectoral exchanges and cooperation. [45] One of the practical applications of this cooperation is the development and use of Point-of-Care diagnostics (POCTs). Point-of-care diagnostics (POCTs) also play a crucial role in the rapid detection and management of zoonotic diseases [44]. POC offers several key advantages including immediate results, ease of operation, and portability [44].

In the same vein of immediate and accurate responses to health crises, digital contact tracing has become an essential tool in the battle against zoonotic diseases, particularly in its ability to quickly and accurately track disease transmission [44]. This technique utilizes digital technologies, such as mobile applications and data analytics to identify interactions between individuals and potential transmission chains of infectious diseases [44]. While digital technologies provide us with the tools to track and manage the spread of diseases, it is equally important to address the diseases at their source, by investing in the research and development of vaccines and therapeutics for zoonotic diseases such as viral hemorrhagic fevers (Lassa fever, Ebola, Marburg) [46].

Promoting sustainable land-use practices and reducing human-animal interaction is another area that is needed to minimize spill-over of pathogens from animals to humans [47]. Moreover, it is vital to fortify both the public health and healthcare systems at the community level [48]. Enhancing healthcare accessibility, implementing local public health policies for efficient waste management, and fostering the development of water, hygiene and sanitation facilities in susceptible communities are all essential elements in bolstering underdeveloped health systems in Africa [48]. In regions with limited access to healthcare services, telemedicine has emerged as an instrumental tool in managing zoonotic diseases [44]. Notably, it has also been applied in the management of close contacts of mpox, enabling effective prevention and monitoring [44]. Finally, there is an urgent need to enhance international collaboration and resource-sharing platforms to address this shared global threat [44]. Such platforms enable various stakeholders, including public health officials, healthcare providers, researchers and the general public to exchange timely and accurate information about disease outbreaks [44].

Conclusion and recommendations

To enhance international collaboration and resource-sharing platforms, particularly in Africa, the first line of defence is controlling the transmission vectors by establishing an agenda on vector-control policies and securing funding from the Network of African Parliamentary Committees of Health to promote trans-disciplinary epidemiological research by non-profit organizations such as The African Institute for Development Policy (AFIDEP) which is an African-led, regional non-profit research policy institute that helps bridge the gaps between research, policy and practice in development efforts in Africa, Malaria Eradication Scientific Alliance (MESA), African Field Epidemiology Network (AFENET) among other scientific collaborations [49,50]. These organizations can then share their findings on the distribution and spread of vector-borne diseases with the World Health Organization (WHO) through the Vector Control Advisory Group (VCAG), aiding in the creation of the WHO disease thread map [51,52].

Secondly, the availability of human and animal vaccines against zoonotic diseases and diagnostic tools for early detection of disease and subsequently early response could be supported by annual campaigns in endemic regions made by the World Organization for Animal Health (WOAH), WHO, the African Union epidemiological groups, and disease control and prevention centers [53].

Lastly, it is crucial to raise awareness about the use of biosafety management and biosecurity in poultry and farm animals. This can be achieved through national campaigns and scientific conferences supported by the African Union, which could also offer a safe program to recycle organic waste [54,55]. The complex challenge of zoonotic diseases, exacerbated

by climate change, necessitates a multi-pronged approach [56].

There is, however, a beacon of hope in the form of Nepal's inspiring story of combating these diseases. Since the 1960s, more than 90% of Nepal's population has been grappling with diseases such as Malaria, Kula-azar, Japanese encephalitis, and dengue [57]. In recent years, the Nepalese government and the World Health Organization (WHO) have joined forces to mitigate the high risk of vector-borne diseases, aiming to achieve zero cases by 2026. This mission is particularly challenging given the additional hurdles posed by climate change. However, the efforts have been fruitful, with a statistical analysis conducted by specialists in 2023 revealing a 55% decrease in the high and moderate risk of malaria, and significant control of the disease in many districts from 2011 to 2018 [58].

In light of these findings, this review serves as a call to action for all African organizations. It urges them to support the WHO in gathering more comprehensive reports about affected regions and encourages all African governments and unions to adhere to public health precautions. This collective effort is crucial in addressing this imminent threat to our collective health.

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