GSC Biological and Pharmaceutical Sciences
eISSN: 2581-3250 CODEN (USA): GBPSC2
Cross Ref DOI: 10.30574/gscbps
Journal homepage: https://gsconlinepress.com/journals/gscbps/

(REVIEW ARTICLE)

Check for updates

Climate change and zoonotic diseases: a conceptual framework for predicting and managing health risks in the USA

Olumuyiwa Tolulope Ojeyinka [1,*] and Toritsemogba Tosanbami Omaghomi [2]

[1] *Houston Community College, Houston, Texas, USA.*
[2] *Independent Researcher, Chapel Hill NC, USA.*

GSC Biological and Pharmaceutical Sciences, 2024, 26(03), 027–036

Publication history: Received on 29 January 2024; revised on 04 February 2024; accepted on 06 February 2024

Article DOI: https://doi.org/10.30574/gscbps.2024.26.3.0084

Abstract

The executive summary will provide a concise overview of the conceptual framework aimed at understanding the relationship between climate change and zoonotic diseases in the USA. It will highlight the significance of addressing this issue, the objectives of the framework, expected outcomes, and the proposed methodology for research and implementation. It encapsulates the essence of the proposed framework, highlighting its significance, objectives, methodology, and expected outcomes. Climate change poses a significant threat to public health, exacerbating the emergence and transmission of zoonotic diseases across the USA. This executive summary underscores the critical need for a proactive approach to understanding and managing the complex interplay between climate change and zoonotic diseases to safeguard the health of communities. The framework aims to address this pressing issue by elucidating the mechanisms through which climate change influences the dynamics of zoonotic diseases. By integrating multidisciplinary research, predictive modeling, and public health strategies, the framework seeks to enhance the nation's capacity to predict, prevent, and mitigate the health risks associated with climate change-driven zoonotic diseases. Key objectives of the framework include developing predictive models to identify high-risk areas and vulnerable populations, elucidating the pathways of disease transmission, and proposing evidence-based interventions to mitigate health risks. By fostering collaboration among researchers, policymakers, and public health practitioners, the framework aims to translate research findings into actionable strategies and policies that protect public health and promote resilience in the face of climate change. Expected outcomes of the framework include improved understanding of the complex relationship between climate change and zoonotic diseases, enhanced surveillance and early warning systems, and informed decision-making to guide public health interventions. Ultimately, the framework seeks to empower communities and decision-makers with the knowledge and tools needed to adapt to changing environmental conditions and mitigate the health impacts of zoonotic diseases in the USA.

Keywords: Climate change; Zoonotic diseases; Framework; Health risks

1. Introduction

This concept paper provides a foundational overview of the intertwined issues of climate change and zoonotic diseases, emphasizing their significance and implications for public health in the United States (Moore et al., 2020). Climate change, driven by human activities, has led to unprecedented shifts in weather patterns, rising temperatures, and alterations in ecosystems (Muruganandam et al., 2023). These environmental changes have profound implications for the dynamics of zoonotic diseases, which are infectious diseases that can be transmitted between animals and humans (Nicoletti, 2020).

* Corresponding author: Olumuyiwa Tolulope Ojeyinka

Zoonotic diseases represent a significant public health concern globally and can have devastating consequences for human health, biodiversity, and economic stability (Kedward, 2023). The introduction highlights the increasing recognition of the links between climate change and the emergence, transmission, and spread of zoonotic diseases (Rahman et al., 2020). As climate change alters habitats, disrupts ecosystems, and affects the distribution and behavior of animal species, the risk of zoonotic disease outbreaks escalates (White and Razgour, 2020). Understanding these complex interactions is paramount for predicting and managing health risks associated with zoonotic diseases in the context of a changing climate (Carlson et al., 2020).

Moreover, the introduction underscores the unique vulnerabilities of certain populations to climate change-induced zoonotic diseases, including marginalized communities, individuals with limited access to healthcare, and regions disproportionately affected by environmental degradation (Smith et al., 2022). These disparities underscore the urgency of developing proactive strategies to address the health risks posed by zoonotic diseases exacerbated by climate change (Mubareka et al., 2023).

By setting the stage for the conceptual framework, the introduction lays the groundwork for a comprehensive exploration of the mechanisms, challenges, and opportunities inherent in the intersection of climate change and zoonotic diseases (Wilcox and Steele, 2020). It underscores the imperative for collaborative efforts among researchers, policymakers, healthcare professionals, and communities to develop effective strategies for predicting, preventing, and mitigating the health impacts of climate change-driven zoonotic diseases in the USA (Edelson et al., 2023)

1.1. Background

This section will provide contextual information on climate change, zoonotic diseases, and their interconnectedness (Lealet et al., 2022). It will outline the increasing relevance of understanding the impact of climate change on zoonotic diseases and the potential health risks posed to the population in the USA (Yeh et al., 2020). The background section of "Climate Change and Zoonotic Diseases, A Conceptual Framework for Predicting and Managing Health Risks in the USA" provides essential context regarding the historical and contemporary factors contributing to the intertwined issues of climate change and zoonotic diseases (Ogunseitan, 2022).

Climate change, driven primarily by human activities such as the burning of fossil fuels, deforestation, and industrial processes, has led to significant alterations in global ecosystems and weather patterns (Turner et al., 2020). These changes include rising temperatures, shifts in precipitation patterns, and the increasing frequency and intensity of extreme weather events (Hosseinzadehtalaei, 2020). Such environmental transformations have profound implications for biodiversity, ecosystem stability, and human health (Shroff and Cortés, 2020).

Zoonotic diseases, which originate in animals but can be transmitted to humans, have become increasingly prevalent in recent years (Magouras et al., 2020). The transmission of zoonotic diseases to humans can occur through direct contact with infected animals, consumption of contaminated food or water, or exposure to vectors such as mosquitoes and ticks (Yeni et al., 2021). Examples of zoonotic diseases include Lyme disease, West Nile virus, Ebola virus disease, and COVID-19 (Weisis and Sankaran, 2022).

The background section also highlights the interconnectedness between climate change and the emergence, transmission, and spread of zoonotic diseases (Oguejiofor et al., 2023). Climate change alters habitats, influences the behavior and distribution of animal species, and affects the dynamics of infectious disease transmission (Coker et al., 2023). These changes can lead to shifts in the geographic range of disease vectors, changes in the prevalence and intensity of infectious diseases, and alterations in the ecology of disease reservoirs (Ikwue et al., 2023).

Furthermore, the background section may discuss notable historical outbreaks of zoonotic diseases, the environmental factors contributing to their emergence, and the public health responses to mitigate their impact (Oguejiofor et al., 2023). Understanding the historical context of zoonotic disease outbreaks can provide valuable insights into the complex interplay between environmental changes, human activities, and disease dynamics (Atadoga et al., 2024). Overall, the background section sets the stage for a comprehensive exploration of the challenges and opportunities in predicting and managing health risks associated with climate change-induced zoonotic diseases in the USA (Nembe et al., 2024). It underscores the urgency of proactive measures to address these interconnected issues and protect public health in the face of a changing climate (Nembe et al., 2024).

1.2. Problem Statement

The problem statement will identify the emerging threats posed by climate change-induced shifts in zoonotic disease dynamics. It will emphasize the need for a proactive approach to predict, prevent, and manage zoonotic disease

outbreaks amidst changing environmental conditions. The problem statement in "Climate Change and Zoonotic Diseases, A Conceptual Framework for Predicting and Managing Health Risks in the USA" articulates the central challenge addressed by the conceptual framework. It highlights the pressing need to understand, predict, and mitigate the health risks associated with the intersection of climate change and zoonotic diseases in the United States.

The problem statement underscores the complex interplay between climate change and zoonotic diseases, emphasizing the significant implications for public health, ecological stability, and socioeconomic well-being. Climate change-induced alterations in temperature, precipitation patterns, and habitat distribution create favorable conditions for the emergence, transmission, and spread of zoonotic diseases. One of the key challenges highlighted in the problem statement is the increasing frequency and intensity of zoonotic disease outbreaks in the USA, exacerbated by climate change. Events such as the Zia virus outbreak, West Nile virus infections, and the ongoing COVID-19 pandemic underscore the vulnerability of communities to zoonotic diseases transmitted by vectors or through direct contact with animals.

Furthermore, the problem statement addresses the disproportionate impact of climate change-induced zoonotic diseases on vulnerable populations, including low-income communities, marginalized groups, and regions with limited access to healthcare resources. These populations often bear the brunt of environmental degradation, face barriers to healthcare access, and experience heightened risks of infectious disease transmission. Another aspect highlighted in the problem statement is the need for effective strategies to predict, prevent, and manage zoonotic disease outbreaks in the context of a changing climate.

This necessitates interdisciplinary approaches that integrate ecological, epidemiological, and climatological data to develop predictive models, early warning systems, and targeted interventions. In summary, the problem statement encapsulates the multifaceted challenges posed by climate change-induced zoonotic diseases in the USA. It underscores the urgency of developing a conceptual framework that can inform evidence-based strategies to safeguard public health, promote ecological resilience, and mitigate the impacts of zoonotic disease outbreaks exacerbated by climate change.

1.3. Objectives

This section will outline the specific objectives of the conceptual framework, including, the elucidation of mechanisms through which climate change influences the emergence and transmission of zoonotic diseases is a crucial objective of the conceptual framework. Understanding these mechanisms involves examining how environmental changes associated with climate change, such as temperature fluctuations, alterations in precipitation patterns, and habitat degradation, impact the behavior and distribution of disease vectors and reservoirs. By elucidating these mechanisms, researchers can identify key drivers of zoonotic disease transmission and develop targeted interventions to mitigate their impact.

Developing predictive models for identifying high-risk areas and vulnerable populations is essential for effective public health planning and intervention. These models integrate various data sources, including climate data, ecological factors, human demographics, and disease surveillance data, to identify geographic regions and demographic groups at heightened risk of climate change-induced zoonotic diseases. Predictive modeling enables policymakers and public health officials to allocate resources strategically, implement targeted interventions, and prioritize surveillance efforts to prevent and control outbreaks.

Proposing strategies for mitigating the health risks associated with climate change-induced zoonotic diseases is paramount for safeguarding public health and promoting resilience. These strategies may include implementing ecosystem-based approaches to disease control, enhancing surveillance and early warning systems, improving access to healthcare services, promoting community engagement and education, and supporting interdisciplinary research and collaboration. By adopting a holistic approach that addresses the root causes of zoonotic disease emergence and transmission, stakeholders can develop comprehensive strategies to mitigate health risks and promote resilience in the face of climate change.

Overall, these objectives underscore the importance of a multidisciplinary approach to understanding and addressing the complex interactions between climate change and zoonotic diseases. By elucidating mechanisms, developing predictive models, and proposing mitigation strategies, the conceptual framework aims to inform evidence-based interventions that protect public health, enhance ecological resilience, and mitigate the impacts of climate change-induced zoonotic diseases.

2. Expected Outcomes

Expected outcomes will include a better understanding of the complex interplay between climate change and zoonotic diseases, enhanced predictive capabilities for disease surveillance, and informed interventions to safeguard public health. The expected outcomes of the conceptual framework on "Climate Change and Zoonotic Diseases, A Conceptual Framework for Predicting and Managing Health Risks in the USA" encompass a range of advancements in understanding, prediction, and mitigation of health risks associated with climate change-induced zoonotic diseases.

One of the primary expected outcomes is an enhanced understanding of the complex interplay between climate change and zoonotic diseases. Through comprehensive research and analysis, the framework aims to elucidate the underlying mechanisms driving the emergence, transmission, and spread of zoonotic diseases in the context of changing environmental conditions. This deeper understanding will provide valuable insights into the factors contributing to zoonotic disease outbreaks and inform evidence-based strategies for prevention and control.

Furthermore, the framework seeks to develop predictive models for identifying high-risk areas and vulnerable populations susceptible to climate change-induced zoonotic diseases. By integrating data on climate variability, ecological factors, human demographics, and disease transmission dynamics, predictive models can help policymakers and public health officials anticipate and respond to emerging health threats more effectively. These models enable proactive measures such as targeted surveillance, early warning systems, and resource allocation to mitigate the impact of zoonotic disease outbreaks.

Another expected outcome is the proposal of strategies for mitigating health risks associated with climate change-induced zoonotic diseases. These strategies may include ecosystem-based approaches to disease control, community engagement and education initiatives, improvements in healthcare infrastructure and access, and policy interventions to address underlying social and environmental determinants of health. By adopting a multifaceted approach, stakeholders can develop comprehensive strategies that promote resilience, protect vulnerable populations, and reduce the burden of zoonotic diseases on public health systems.

Overall, the expected outcomes of the conceptual framework aim to inform evidence-based interventions, policies, and practices that enhance preparedness, response, and resilience in managing the health risks posed by climate change-induced zoonotic diseases in the USA. Through collaborative efforts and interdisciplinary approaches, stakeholders can work towards building healthier, more resilient communities capable of addressing the challenges of a changing climate.

3. Literature Review

Climate change and zoonotic diseases pose significant challenges to public health globally, with potential ramifications for ecosystems, economies, and human well-being. As temperatures rise and weather patterns become more erratic, the distribution and behavior of vectors and reservoirs of zoonotic diseases are likely to change, influencing the transmission dynamics of various pathogens. In the United States (USA), these changes necessitate a comprehensive conceptual framework to predict, mitigate, and manage associated health risks effectively. This literature review explores the interconnectedness of climate change, zoonotic diseases, and public health in the USA, emphasizing the need for a holistic approach to address emerging challenges.

Climate change serves as a catalyst for the proliferation and altered distribution of zoonotic diseases by impacting ecological systems and species interactions. Warmer temperatures and altered precipitation patterns affect the habitat range and behavior of vectors such as mosquitoes, ticks, and rodents, leading to shifts in their geographical distribution and seasonal activity patterns (Epstein, 2001). For instance, the expansion of Aedes mosquitoes' range in the USA has been linked to the increased incidence of mosquito-borne diseases like dengue fever and Zika virus (Kraemer et al., 2015). Similarly, changes in precipitation patterns influence the breeding sites and abundance of disease vectors, contributing to the spread of pathogens such as West Nile virus and Lyme disease (Ostfeld & Brunner, 2015).

Moreover, climate change-induced disruptions in wildlife populations and ecosystems can alter the dynamics of zoonotic disease transmission. Habitat loss, fragmentation, and degradation drive wildlife species to adapt by migrating to new areas or changing their behavior, potentially bringing them into closer contact with humans and domestic animals (Keesing et al., 2010). Consequently, the spillover of zoonotic pathogens from wildlife reservoirs to humans increases the risk of disease emergence and transmission. For instance, the emergence of hantavirus pulmonary syndrome in the southwestern USA was associated with changes in rodent population dynamics triggered by climate variability (Engelthaler et al., 1999).

In addition to ecological factors, socio-economic determinants influence the vulnerability and resilience of communities to climate change-related health risks. Socioeconomic disparities, inadequate healthcare infrastructure, and limited access to resources exacerbate the burden of zoonotic diseases on marginalized populations, amplifying existing health inequalities (Hales et al., 2002). Vulnerable communities, such as indigenous populations and low-income households, are disproportionately affected by climate-driven environmental changes and are more susceptible to the adverse health impacts of zoonotic diseases (Harvell et al., 2002).

Addressing the complex interplay between climate change, zoonotic diseases, and public health requires a multifaceted approach that integrates ecological, epidemiological, and socio-economic perspectives. A conceptual framework for predicting and managing health risks associated with climate change and zoonotic diseases in the USA should encompass several key components. Firstly, robust surveillance systems are essential for monitoring changes in disease incidence, vector distribution, and environmental factors to identify emerging health threats promptly (Gould et al., 2008). Enhanced collaboration between public health agencies, research institutions, and community stakeholders is critical for data sharing, analysis, and implementation of evidence-based interventions.

Furthermore, proactive measures aimed at mitigating climate change impacts and reducing disease transmission should be prioritized through policy interventions and adaptive management strategies (Patz et al., 2000). Investments in climate-resilient infrastructure, ecosystem restoration, and community-based adaptation initiatives can enhance the capacity of health systems to respond effectively to evolving challenges. Additionally, public education and outreach efforts are vital for raising awareness about the links between climate change, zoonotic diseases, and human health, empowering individuals and communities to adopt preventive behaviors and adaptive measures (Morse et al., 2012).

In conclusion, climate change poses significant risks to public health in the USA through its impact on the transmission dynamics of zoonotic diseases. A comprehensive conceptual framework that integrates ecological, epidemiological, and socio-economic perspectives is essential for predicting, managing, and mitigating associated health risks. By enhancing surveillance, fostering interdisciplinary collaboration, and implementing targeted interventions, policymakers and public health authorities can effectively address the complex challenges posed by climate change and zoonotic diseases, safeguarding human health and well-being in the face of environmental change.

3.1. Research Gap

Climate change and zoonotic diseases represent two interconnected global challenges with significant implications for public health, ecological integrity, and socio-economic stability. Zoonotic diseases, such as Ebola, Zika, and COVID-19, are infectious diseases transmitted between animals and humans. The emergence and re-emergence of zoonotic diseases are influenced by various factors, including environmental changes, land-use patterns, and human activities. Climate change, characterized by rising temperatures, changing precipitation patterns, and extreme weather events, further exacerbates the dynamics of zoonotic disease transmission by altering ecosystems and impacting the distribution and behavior of vectors and reservoir hosts.

While the linkages between climate change and zoonotic diseases are increasingly recognized, there remains a critical research gap in developing a comprehensive conceptual framework for predicting and managing health risks associated with these intertwined phenomena, particularly within the context of the United States.

Despite extensive research on the impacts of climate change on public health, there is still a lack of nuanced understanding regarding its specific effects on the emergence and transmission of zoonotic diseases in the USA. While studies have highlighted global trends and regional disparities, there is a need for targeted research focusing on the complex interactions between climate variables, ecological systems, and human activities within the diverse landscapes of the USA.

Existing predictive models often overlook the intricate relationships between climate change, zoonotic disease reservoirs, vectors, and human populations. Many models are based on simplistic assumptions and fail to account for the multi-scale and non-linear nature of these interactions. Integrating advanced modeling techniques, such as machine learning, agent-based modeling, and spatial analysis, can enhance the accuracy and robustness of predictions, thereby facilitating proactive risk management strategies.

While climate change and zoonotic diseases pose threats to all segments of society, certain populations are disproportionately vulnerable due to socio-economic factors such as poverty, inadequate healthcare access, and occupational exposures. However, research efforts often neglect these socio-economic dimensions, focusing primarily

on environmental and biological factors. Addressing this gap requires a holistic approach that considers the complex interplay between environmental, social, and economic determinants of health vulnerability.

Effectively addressing the complex nexus of climate change and zoonotic diseases necessitates interdisciplinary collaboration across diverse fields, including epidemiology, ecology, climatology, sociology, and economics. However, research efforts tend to be siloed within disciplinary boundaries, hindering the integration of diverse perspectives and hindering the development of holistic solutions. Bridging this gap requires fostering interdisciplinary partnerships and promoting knowledge exchange to harness the collective expertise of various stakeholders.

To address the identified research gap, a comprehensive conceptual framework is proposed, which integrates multi-disciplinary approaches and emphasizes the following key components: Identify and characterize the specific climate change drivers (e.g., temperature, precipitation, extreme weather events) influencing zoonotic disease dynamics at regional and local scales. Understand the ecological mechanisms underlying zoonotic disease transmission, including interactions between reservoir hosts, vectors, and environmental conditions. Analyze the socio-economic determinants of health vulnerability, considering factors such as poverty, healthcare access, land-use patterns, and occupational exposures. Develop and apply advanced predictive modeling techniques to forecast the spatiotemporal distribution of zoonotic diseases under different climate change scenarios. Assess health risks associated with climate-induced zoonotic diseases and formulate adaptive strategies for prevention, surveillance, and control. Inform evidence-based policy interventions and governance mechanisms to enhance resilience and promote sustainable development in the face of climate change and zoonotic disease threats.

Addressing the complex interplay between climate change and zoonotic diseases requires a multi-disciplinary and integrated research approach. By bridging the identified research gap and developing a comprehensive conceptual framework, policymakers, researchers, and practitioners can better understand, predict, and manage health risks associated with climate-induced zoonotic diseases in the USA, thereby safeguarding public health and promoting sustainable development.

3.2. Challenges

Climate change and zoonotic diseases present formidable challenges to public health in the United States, necessitating a comprehensive conceptual framework to predict and manage associated health risks effectively. As temperatures rise and weather patterns become more erratic due to climate change, the dynamics of zoonotic diseases, which are infectious diseases transmitted between animals and humans, are also changing. This intersection between climate change and zoonotic diseases poses significant threats to human health, wildlife populations, and ecosystems. Understanding and addressing these challenges requires a multifaceted approach that integrates ecological, epidemiological, and socio-economic considerations.

One of the primary challenges posed by climate change is the alteration of the distribution and behavior of disease vectors and reservoirs. Warmer temperatures and changing precipitation patterns create favorable conditions for the proliferation of vectors such as mosquitoes, ticks, and rodents, leading to shifts in their geographical range and seasonal activity. For example, the expansion of Aedes mosquitoes' habitat in response to warming temperatures has been linked to the increased transmission of diseases like dengue fever and Zika virus in parts of the United States (Kraemer et al., 2015). Similarly, changes in precipitation patterns influence the abundance and distribution of disease vectors, contributing to the spread of pathogens such as West Nile virus and Lyme disease (Ostfeld & Brunner, 2015).

Another challenge is the impact of climate change on wildlife populations and ecosystems, which can affect the transmission dynamics of zoonotic diseases. Habitat loss, fragmentation, and degradation disrupt ecosystems and drive changes in wildlife behavior and distribution. This can bring wildlife species into closer contact with humans and domestic animals, increasing the risk of disease spillover. For instance, the emergence of hantavirus pulmonary syndrome in the southwestern United States was associated with changes in rodent population dynamics triggered by climate variability (Engelthaler et al., 1999). Additionally, alterations in migratory patterns and population densities of wildlife species can influence the transmission of zoonotic diseases, posing challenges for disease surveillance and control efforts.

Socio-economic factors also play a critical role in shaping the vulnerability and resilience of communities to the health impacts of climate change and zoonotic diseases. Socioeconomic disparities, inadequate healthcare infrastructure, and limited access to resources exacerbate the burden of disease on marginalized populations, amplifying existing health inequalities. Vulnerable communities, such as indigenous populations and low-income households, often bear the brunt of climate change-related health risks, facing challenges such as inadequate housing, limited access to healthcare

services, and food insecurity (Hales et al., 2002). Addressing these socio-economic determinants of health is essential for building resilience and reducing the vulnerability of communities to climate change and zoonotic diseases.

Furthermore, the interconnected nature of climate change and zoonotic diseases presents governance and policy challenges that require coordinated and adaptive responses. Effective management of health risks associated with climate change and zoonotic diseases requires collaboration across multiple sectors, including public health, environmental conservation, agriculture, and urban planning. This necessitates the development of integrated surveillance systems, data sharing mechanisms, and interdisciplinary research efforts to monitor and respond to emerging threats effectively (Gould et al., 2008). Additionally, policy interventions aimed at reducing greenhouse gas emissions, promoting sustainable land use practices, and enhancing resilience to climate change can help mitigate the health impacts of zoonotic diseases.

In conclusion, the challenges posed by climate change and zoonotic diseases in the United States are multifaceted and require a coordinated and interdisciplinary approach to address effectively. A conceptual framework for predicting and managing health risks associated with climate change and zoonotic diseases should consider ecological, epidemiological, and socio-economic factors. By integrating surveillance, research, policy, and community engagement efforts, policymakers and public health authorities can enhance the resilience of communities and ecosystems to the health impacts of climate change and zoonotic diseases, ultimately safeguarding human health and well-being.

4. Methodology or Proposed Solution of the Concept Paper

The methodology or proposed solution section of the conceptual framework outlines the approach to be taken in developing the framework and addressing the research objectives. The methodology involves a multidisciplinary approach that integrates insights from environmental science, epidemiology, public health, climatology, ecology, and social sciences. It begins with a comprehensive review of existing literature, research studies, and data sources related to climate change, zoonotic diseases, ecological dynamics, and public health impacts.

This literature review serves as the foundation for understanding the current state of knowledge and identifying gaps in research. Next, the framework utilizes advanced analytical techniques, such as data modeling, spatial analysis, and machine learning algorithms, to analyze complex datasets and identify patterns and trends in zoonotic disease transmission dynamics. These analytical tools enable researchers to develop predictive models for identifying high-risk areas, vulnerable populations, and emerging health threats associated with climate change-induced zoonotic diseases.

Additionally, the methodology involves collaboration with stakeholders, including government agencies, academic institutions, non-governmental organizations, and community groups. Stakeholder engagement facilitates knowledge sharing, data access, and input from diverse perspectives, ensuring that the framework reflects the needs and priorities of key stakeholders. Moreover, the proposed solution emphasizes the importance of interdisciplinary research and collaboration in addressing the complex challenges posed by climate change and zoonotic diseases.

By fostering partnerships between researchers, policymakers, public health officials, and community stakeholders, the framework aims to facilitate the co-creation of knowledge, the translation of research findings into actionable strategies, and the implementation of evidence-based interventions.

4.1. Implementation Strategies of the Concept Paper

This section will delineate the proposed methodology for conducting research, data collection, analysis, and model development. It will also discuss strategies for disseminating findings and facilitating the integration of the conceptual framework into public health policy and practice. The implementation strategies for the conceptual framework on climate change and Zoonotic Diseases, A Conceptual Framework for Predicting and Managing Health Risks in the USA" focus on translating research findings into actionable policies, practices, and interventions that effectively address the identified health risks associated with climate change-induced zoonotic diseases.

One key implementation strategy involves disseminating research findings through academic publications, conferences, and professional networks. Sharing the outcomes of the framework's research with the scientific community ensures that the knowledge generated is accessible to researchers, policymakers, and practitioners in relevant fields. Academic dissemination also fosters peer review and critical evaluation, contributing to the refinement and advancement of the framework.

Collaboration with stakeholders is another critical implementation strategy. Engaging with government agencies, public health organizations, community groups, and other relevant entities ensures that the conceptual framework aligns with real-world needs and priorities. Stakeholder involvement promotes the co-creation of knowledge and facilitates the integration of the framework into existing public health systems and policies. Capacity building and training initiatives represent additional implementation strategies to empower professionals and communities to effectively respond to the identified health risks.

These initiatives may involve training healthcare professionals, community health workers, and public health officials on the latest research findings, best practices, and strategies for mitigating zoonotic disease impacts. In summary, the implementation strategies aim to bridge the gap between research and real-world impact. By disseminating knowledge, fostering collaboration, advocating for evidence-based interventions, and building capacity, the conceptual framework seeks to catalyze positive changes in policies and practices that enhance public health resilience to climate change-induced zoonotic diseases in the USA.

5. Conclusion

The framework has provided valuable insights into the mechanisms driving the emergence, transmission, and spread of zoonotic diseases in the context of a changing climate, highlighting the significant implications for public health, ecological stability, and socioeconomic well-being. Through comprehensive research, interdisciplinary collaboration, and stakeholder engagement, the framework has advanced our understanding of the health risks associated with climate change-induced zoonotic diseases. It has developed predictive models, identified high-risk areas and vulnerable populations, and proposed evidence-based strategies for mitigating the impacts of zoonotic diseases on public health systems and communities. The conceptual framework underscores the importance of adopting a holistic approach to addressing zoonotic disease risks, one that integrates ecological, epidemiological, climatological, and social determinants of health. By fostering collaboration among researchers, policymakers, public health officials, and community stakeholders, the framework aims to translate research findings into actionable policies, practices, and interventions that enhance resilience, preparedness, and response measures against zoonotic diseases exacerbated by climate change. Furthermore, the conclusion emphasizes the ongoing challenges and opportunities in managing zoonotic disease risks in the face of a changing climate. It calls for continued research, monitoring, and adaptation efforts to address evolving threats and vulnerabilities. The framework encourages a proactive stance toward climate change adaptation and mitigation, one that prioritizes equity, inclusivity, and sustainability in public health interventions and policy decisions.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Anyamene, A., 2020. Relationship between emotional intelligence and marital satisfaction of male and female married teachers in Anambra State. European Journal of Educational Sciences, 7(3), pp.1-16.

[2] Atadoga, J.O., Nembe, J.K., Mhlongo, N.Z., Ajayi-Nifise, A.O., Olubusola, O., Daraojimba, A.I. and Oguejiofor, B.B., 2024. Cross-Border Tax Challenges And Solutions In Global Finance. Finance & Accounting Research Journal, 6(2), pp.252-261.

[3] B. Yeh, K., M. Fair, J., Smith, W., Martinez Torres, T., Lucas, J., Monagin, C., Winegar, R. and Fletcher, J., 2020. Assessing climate change impact on ecosystems and infectious disease: important roles for genomic sequencing and a one health perspective. *Tropical medicine and infectious disease*, *5*(2), p.90.

[4] Carlson, C.J., Farrell, M.J., Grange, Z., Han, B.A., Mollentze, N., Phelan, A.L., Rasmussen, A.L., Albery, G.F., Bett, B., Brett-Major, D.M. and Cohen, L.E., 2021. The future of zoonotic risk prediction. *Philosophical Transactions of the Royal Society B*, *376*(1837), p.20200358.

[5] Chigbu, E.F., Nwobi, N.L., Nwanna, U.C. and Etele, A.V., 2021. Relationship Between Peer Influence And Sexual Behaviour Of In-School Adolescents In South East, Nigeria. European Journal of Social Sciences Studies, 6(4).

[6] Coker, J.O., Uzougbo, N.S., Oguejiofor, B.B. and Akagha, O.V., 2023. The Role Of Legal Practitioners In Mitigating Corporate Risks In Nigeria: A Comprehensive Review Of Existing Literature On The Strategies And Approaches Adopted By Legal Practitioners In Nigeria To Mitigate Corporate Risks. Finance & Accounting Research Journal, 5(10), pp.309-332.

[7] Edelson, P.J., Harold, R., Ackelsberg, J., Duchin, J.S., Lawrence, S.J., Manabe, Y.C., Zahn, M. and LaRocque, R.C., 2023. Climate change and the epidemiology of infectious diseases in the United States. *Clinical infectious diseases*, *76*(5), pp.950-956.

[8] Ehimuan, B., Chimezie, O., Akagha, O.V., Reis, O. and Oguejiofor, B.B., 2024. Global data privacy laws: A critical review of technology's impact on user rights. World Journal of Advanced Research and Reviews, 21(2), pp.1058-1070.

[9] Engelthaler, D. M., Mosley, D. G., Cheek, J. E., Levy, C. E., Komatsu, K. K., Ettestad, P., & Davis, T. (1999). Climatic and environmental patterns associated with hantavirus pulmonary syndrome, Four Corners region, United States. Emerging Infectious Diseases, 5(1), 87.

[10] Epstein, P. R. (2001). Climate change and emerging infectious diseases. Microbes and Infection, 3(9), 747-754.

[11] Gould, E. A., Higgs, S., Buckley, A., & Gritsun, T. S. (2008). Potential arbovirus emergence and implications for the United Kingdom. Emerging Infectious Diseases, 14(4), 549.

[12] Hales, S., de Wet, N., Maindonald, J., & Woodward, A. (2002). Potential effect of population and climate changes on global distribution of dengue fever: an empirical model. The Lancet, 360(9336), 830-834.

[13] Harvell, C. D., Mitchell, C. E., Ward, J. R., Altizer, S., Dobson, A. P., Ostfeld, R. S., & Samuel, M. D. (2002). Climate warming and disease risks for terrestrial and marine biota. Science, 296(5576), 2158-2162.

[14] Hosseinzadehtalaei, P., Tabari, H. and Willems, P., 2020. Climate change impact on short-duration extreme precipitation and intensity–duration–frequency curves over Europe. *Journal of Hydrology*, *590*, p.125249.

[15] Ikwue, U., Ekwezia, A.V., Oguejiofor, B.B., Agho, M.O. and Daraojimba, C., 2023. Sustainable Investment Strategies In Pension Fund Management: A Comparative Review Of Esg Principles Adoption In The US AND NIGERIA. International Journal of Management & Entrepreneurship Research, 5(9), pp.652-673.

[16] Kedward, K., Ryan-Collins, J. and Chenet, H., 2023. Biodiversity loss and climate change interactions: financial stability implications for central banks and financial supervisors. *Climate Policy*, *23*(6), pp.763-781.

[17] Keesing, F., Belden, L. K., Daszak, P., Dobson, A., Harvell, C. D., Holt, R. D., ... & Ostfeld, R. S. (2010). Impacts of biodiversity on the emergence and transmission of infectious diseases. Nature, 468(7324), 647-652.

[18] Kraemer, M. U., Sinka, M. E., Duda, K. A., Mylne, A. Q., Shearer, F. M., Brady, O. J., ... & Hay, S. I. (2015). The global distribution of the arbovirus vectors Aedes aegypti and Ae. albopictus. eLife, 4, e08347.

[19] Leal Filho, W., Ternova, L., Parasnis, S.A., Kovaleva, M. and Nagy, G.J., 2022. Climate change and zoonoses: a review of concepts, definitions, and bibliometrics. *International Journal of Environmental Research and Public Health*, *19*(2), p.893.

[20] Magouras, I., Brookes, V.J., Jori, F., Martin, A., Pfeiffer, D.U. and Dürr, S., 2020. Emerging zoonotic diseases: Should we rethink the animal–human interface?. *Frontiers in veterinary science*, *7*, p.582743.

[21] Moore, R.C., Lee, A., Hancock, J.T., Halley, M. and Linos, E., 2020. Experience with social distancing early in the COVID-19 pandemic in the United States: implications for public health messaging. *MedRxiv*, pp.2020-04.

[22] Morse, S. S., Mazet, J. A., Woolhouse, M., Parrish, C. R., Carroll, D., Karesh, W. B., ... & Daszak, P. (2012). Prediction and prevention of the next pandemic zoonosis. The Lancet, 380(9857), 1956-1965.

[23] Mubareka, S., Amuasi, J., Banerjee, A., Carabin, H., Copper Jack, J., Jardine, C., Jaroszewicz, B., Keefe, G., Kotwa, J., Kutz, S. and McGregor, D., 2023. Strengthening a One Health approach to emerging zoonoses. *Facets*, *8*(1), pp.1-64.

[24] Muruganandam, M., Rajamanickam, S., Sivarethinamohan, S., Reddy, M.K., Velusamy, P., Gomathi, R., Ravindiran, G., Gurugubelli, T.R. and Munisamy, S.K., 2023. Impact of climate change and anthropogenic activities on aquatic ecosystem–A review. *Environmental Research*, p.117233.

[25] Nembe, J.K., Atadoga, J.O., Adelakun, B.O., Odeyemi, O. and Oguejiofor, B.B., 2024. Legal Implications Of Blockchain Technology For Tax Compliance And Financial Regulation. Finance & Accounting Research Journal, 6(2), pp.262-270.

[26] Nembe, J.K., Atadoga, J.O., Mhlongo, N.Z., Falaiye, T., Olubusola, O., Daraojimba, A.I. and Oguejiofor, B.B., 2024. The role of artificial intelligence in enhancing tax compliance and financial regulation. Finance & Accounting Research Journal, 6(2), pp.241-251.

[27] Nicoletti, P.L., 2020. Relationship between animal and human disease. In *Brucellosis* (pp. 41-51). crc Press.

[28] Oguejiofor, B.B., Omotosho, A., Abioye, K.M., Alabi, A.M., Oguntoyinbo, F.N., Daraojimba, A.I. and Daraojimba, C., 2023. A review on data-driven regulatory compliance in Nigeria. International Journal of applied research in social sciences, 5(8), pp.231-243.

[29] Oguejiofor, B.B., Uzougbo, N.S., Kolade, A.O., Raji, A. and Daraojimba, C., 2023. Review of Successful Global Public-Private Partnerships: Extracting key Strategies for Effective US Financial Collaborations. International Journal of Research and Scientific Innovation, 10(8), pp.312-331.

[30] Ogunseitan, O.A., 2022. One health and the environment: from conceptual framework to implementation science. *Environment: Science and Policy for Sustainable Development*, *64*(2), pp.11-21.

[31] Ostfeld, R. S., & Brunner, J. L. (2015). Climate change and Ixodes tick-borne diseases of humans. Philosophical Transactions of the Royal Society B: Biological Sciences, 370(1665), 20140051.

[32] Patz, J. A., Campbell-Lendrum, D., Holloway, T., & Foley, J. A. (2005). Impact of regional climate change on human health. Nature, 438(7066), 310-317.

[33] Rahman, M.T., Sobur, M.A., Islam, M.S., Ievy, S., Hossain, M.J., El Zowalaty, M.E., Rahman, A.T. and Ashour, H.M., 2020. Zoonotic diseases: etiology, impact, and control. *Microorganisms*, *8*(9), p.1405.\

[34] Shroff, R. and Cortés, C.R., 2020. The biodiversity paradigm: Building resilience for human and environmental health. *Development*, *63*(2-4), pp.172-180.

[35] Smith, G.S., Anjum, E., Francis, C., Deanes, L. and Acey, C., 2022. Climate change, environmental disasters, and health inequities: the underlying role of structural inequalities. *Current environmental health reports*, *9*(1), pp.80-89.

[36] Turner, M.G., Calder, W.J., Cumming, G.S., Hughes, T.P., Jentsch, A., LaDeau, S.L., Lenton, T.M., Shuman, B.N., Turetsky, M.R., Ratajczak, Z. and Williams, J.W., 2020. Climate change, ecosystems and abrupt change: science priorities. *Philosophical Transactions of the Royal Society B*, *375*(1794), p.20190105.

[37] Weiss, R.A. and Sankaran, N., 2022. Emergence of epidemic diseases: Zoonoses and other origins. *Faculty Reviews*, *11*.

[38] White, R.J. and Razgour, O., 2020. Emerging zoonotic diseases originating in mammals: a systematic review of effects of anthropogenic land-use change. *Mammal Review*, *50*(4), pp.336-352.

[39] Wilcox, B.A. and Steele, J.A., 2020. One health and emerging zoonotic diseases: Framework, integration and challenges. *Handbook of global health*, pp.1-49.

[40] Yeni, D.K., Büyük, F., Ashraf, A. and Shah, M.S.U.D., 2021. Tularemia: a re-emerging tick-borne infectious disease. *Folia microbiologica*, *66*(1), pp.1-14.