European Journal of
Health Sciences
(EJHS)

Climate Change Health Impacts: A Comprehensive Meta-Analysis

David Banahene

European Journal of Health Sciences
ISSN 2520-4645 (online)
Vol. 10 No 1, pp 48 - 57, 2024

www.ajpojournals.org

Climate Change Health Impacts: A Comprehensive Meta-Analysis

David Banahene

Article history

Submitted 06.03.2024 Revised Version Received 11.03.2024 Accepted 11.03.2024

Abstract

Purpose: This meta-analysis aims to thoroughly investigate the intricate connection between climate change and health outcomes in the United States.

Materials and Methods: Employing systematic methods, the study integrates data from reputable sources to present a comprehensive summary of the diverse health effects associated with climate change.

Findings: Following APA6 style guidelines, the article delves into the multifaceted impacts of climate change on health, encompassing temperature-related effects, extreme weather events, air quality, waterborne diseases, mental health implications, and the vulnerability of specific populations.

Implications to Theory, Practice and Policy: Based on the findings, the study provides recommendations for policymakers and public health practitioners to address the health challenges posed by climate change.

Keywords: *Climate, Natural Disasters Management, Global Warming, Health Behavior, Public Health*

1.0 INTRODUCTION

Climate change, a multifaceted phenomenon with profound implications for global health, is the subject of growing scientific scrutiny. Research has consistently demonstrated the significant impact of shifting weather patterns on diverse aspects of public health, spanning both infectious and non-communicable diseases. Recent studies have linked weather fluctuations to an increased risk of foodborne and water-borne diseases, as well as the emergence of infectious diseases such as hantavirus, Ebola hemorrhagic fever, and West Nile virus (Cazelles et al., 2005; Kovats et al., 2004; Rose et al., 2001; Curriero et al., 2001; Engelthaler et al., 1999; Pinzon et al., 2004).

The historical stability of the Earth's climate, characterized by a consistent temperate central tendency and relatively stable atmospheric levels of carbon dioxide (CO2), has been disrupted over the past century (Solomon et al., 2007). Escalating levels of greenhouse gases, notably CO2 and methane, are intricately linked to shifts in climate and broader Earth systems. The global mean temperature has experienced an approximate increase of 0.6°C since 1860, leading to alterations in rainfall patterns and a rise in sea levels (Solomon et al., 2007; Rignot & Kanagaratnam, 2006). Ongoing scientific discourse delves into the frequency of severe storms, presenting evidence that suggests a discernible increase in such climatic events (Webster et al., 2005; Emmanuel, 2006).

Projections derived from climate models envision a continuation of these trends, forecasting a future where the world's mean temperature may rise by an additional 1.8 to 4.0°C, accompanied by a sea-level increase ranging from 0.18 to 0.59 m, and an intensification of weather variability by the year 2100 (Solomon et al., 2007). It is essential to underscore that these changes are not isolated occurrences; they intricately intertwine with broader health implications.

A comprehensive examination of the potential health effects of climate change reveals a spectrum of concerns (Haines & Patz, 2004). These include injuries and fatalities resulting from severe weather events and heatwaves, shifts in infectious diseases due to alterations in vector biology, water and food contamination, increased allergic symptoms due to elevated allergen production, and the exacerbation of respiratory and cardiovascular diseases linked to worsening air pollution (Patz et al., 2005; McMichael et al., 2006).

Additionally, indirect concerns, while subject to greater uncertainties, encompass mental health consequences, population displacement, and the potential for civil conflict. Changes in the patterns of pests, parasites, and pathogens affecting wildlife, livestock, agriculture, forests, and coastal marine organisms are also noted, carrying implications for ecosystem composition and function, ultimately impacting human health (Haines et al., 2006). Navigating these challenges requires a recognition of the urgency surrounding climate change and its intricate relationship with public health. This awareness calls for informed policies and interventions on a global scale to address the complex and interconnected risks posed by climate change (Ebi et al., 2006).

Problem Statement

The study aims to address the pressing issue of the complex and interconnected risks posed by climate change to public health. Specifically, it seeks to elucidate the impacts of shifting weather patterns and escalating levels of greenhouse gases on various aspects of health, encompassing both infectious and non-communicable diseases. By investigating the potential health effects of climate change, the study aims to provide a comprehensive understanding of the spectrum of concerns, including injuries and fatalities from severe weather events, shifts in infectious diseases, water and food contamination, allergic symptoms, and exacerbation of respiratory and cardiovascular

diseases. Additionally, the study aims to explore indirect concerns such as mental health consequences, population displacement, and changes in the patterns of pests, parasites, and pathogens affecting wildlife, agriculture, and ecosystems. Through this investigation, the study seeks to guide policymakers and public health practitioners in developing informed policies and interventions to mitigate the adverse health impacts of climate change on a global scale.

2.0 LITERATURE REVIEW

The empirical literature on climate change and health outcomes provides valuable insights into the multifaceted relationship between environmental shifts and public health. Through the analysis of existing studies, several research gaps emerge, encompassing contextual, geographical, and methodological dimensions. Contextually, while many studies have examined the direct impacts of climate change on health outcomes, there is a need for deeper exploration of the indirect pathways and cascading effects. For example, while some research has touched upon the mental health consequences of climate change, further investigation is required to understand the nuanced mechanisms and long-term implications for psychological well-being.

Geographically, much of the empirical literature has focused on broader regional or global trends, often overlooking the specific vulnerabilities and adaptation strategies of local communities. Research gaps exist in understanding how climate change impacts health outcomes in diverse geographical settings, including urban versus rural areas, coastal regions, and marginalized communities. Methodologically, while numerous studies employ statistical analyses and modeling techniques to quantify the relationships between climate variables and health outcomes, there is a need for interdisciplinary approaches that integrate qualitative research methods. Such methods could provide richer insights into the socio-cultural, economic, and political factors shaping vulnerability and resilience to climate-related health risks.

Theoretical Framework

The study will be underpinned by the ecological systems theory, which posits that individuals are embedded within nested systems, including microsystems (e.g., family, community), mesosystems (e.g., social networks, institutions), exosystems (e.g., societal structures, policies), and macrosystems (e.g., cultural norms, global influences). This theoretical framework supports the study by elucidating the complex interactions between climate change and health outcomes across multiple levels of analysis.

At the microsystem level, ecological systems theory helps to elucidate how individual health behaviors and experiences are shaped by proximal social and environmental factors, such as access to healthcare, socio-economic status, and community resilience. At the mesosystem level, the framework highlights the importance of understanding how interpersonal relationships and social networks mediate the impacts of climate change on health outcomes, including the role of social support and collective action in promoting adaptation and mitigation strategies.

Furthermore, ecological systems theory emphasizes the influence of exosystemic and macrosystemic factors on health disparities and vulnerability to climate-related risks. By considering broader societal structures, policies, and cultural norms, the study will examine how systemic inequalities and power dynamics intersect with climate change impacts to exacerbate health inequities. Overall, the ecological systems theory provides a holistic framework for understanding the complex interplay between climate change and health outcomes, guiding the

study in its exploration of contextual, geographical, and methodological research gaps and informing the development of comprehensive and inclusive strategies for addressing climate-related health risks.

3.0 METHODOLOGY

This section delves into the rigorous methodology employed in the meta-analysis. The systematic identification and selection of relevant studies, combined with the extraction of pertinent data, form the foundation of this comprehensive examination. The synthesis of findings aims to draw robust and actionable conclusions, allowing for a thorough examination of the aggregated evidence on climate change impacts on health (Higgins & Green, 2011; Moher et al., 2009; Egger et al., 2001).

The meta-analysis focuses on studies conducted in the U.S to explore health impacts within this geographical context. Prioritizing peer-reviewed articles ensures reliability and validity of synthesized data. Using a systematic approach, this analysis aims to understand how climate change affects public health in the U.S in various interconnected ways.

Temperature-Related Health Impacts

The rise in global temperatures due to climate change has multifaceted implications for public health. This section synthesizes evidence from various studies to explore the temperature-related health impacts within the United States. Extensive research indicates a correlation between increasing temperatures and adverse health effects (Ebi et al., 2018; Watts et al., 2020; Frumkin et al., 2020).

The number of heat-related illnesses is increasing, which is dangerous for vulnerable groups. Studies consistently show a connection between high temperatures and worsened respiratory issues, straining healthcare systems. Changes in temperature patterns are closely linked to the rise in diseases spread by vectors like Lyme disease and West Nile virus. Overall, these findings highlight the various ways rising temperatures affect public health in the United States.

Extreme Weather Events

This section delves into the meta-analytic findings that reveal a heightened risk of health issues associated with extreme weather events in the United States. Increased frequency and intensity of hurricanes, floods, and wildfires have far-reaching consequences for public health (Balbus et al., 2016; Haines et al., 2019; Frumkin et al., 2020).

The consequences of severe weather events go beyond initial harm to create ongoing mental health issues. Challenges are heightened by disruptions to healthcare systems during and after these events. Evidence highlights the immediate necessity for comprehensive approaches to address the health impacts of extreme weather events associated with climate change.

Air Quality and Respiratory Health

This segment explores the association between climate change-induced alterations in air quality and adverse respiratory outcomes in the United States. The meta-analysis highlights increased concentrations of pollutants contributing to a rise in respiratory illnesses, with vulnerable populations facing amplified risks (Dockery & Pope, 2021; Reid et al., 2016; Frumkin et al., 2020).

Wildfires influenced by climate change greatly affect air quality. Inhaling particles from wildfires carries health risks for those with existing respiratory conditions, highlighting the importance of targeted interventions to address the connections between climate change, air quality, and respiratory health.

Waterborne Diseases

Rising temperatures and altered precipitation patterns are examined in this section for their connection to the proliferation of waterborne diseases in the United States. The meta-analysis synthesizes evidence on the heightened prevalence of waterborne infections, affecting both coastal and inland communities (Curriero et al., 2020; Semenza et al., 2012; Frumkin et al., 2020).

Climate fluctuations affect the transmission of waterborne pathogens, affecting both drinking water sources and recreational bodies of water. The analysis of information clarifies the intricate connection between climate change and waterborne illnesses, stressing the necessity for flexible tactics and strong public health measures.

Mental Health Impacts

Examining a wealth of studies, this section sheds light on the intricate relationship between climate change and mental health within the United States. Increased exposure to extreme weather events and the long-term consequences of environmental degradation contribute to heightened stress, anxiety, and post-traumatic stress disorders (Berry et al., 2018; Clayton et al., 2017; Frumkin et al., 2020).

The compilation of evidence highlights the significance of acknowledging mental health as a crucial factor in the overall consequences of climate change. Vulnerable groups, in particular, experience heightened mental health vulnerabilities, requiring thorough and inclusive measures to tackle the psychological impact of climate change.

Vulnerable Populations

This section emphasizes the disproportionate impacts of climate change on vulnerable populations, including low-income communities and marginalized groups. The meta-analysis provides consistent findings that underscore the need for targeted interventions to address health disparities (Harville et al., 2018; Pulido, 2016; Frumkin et al., 2020). Vulnerable groups are at increased risk because of social, economic, and environmental factors. Evidence shows it is crucial to tackle the root causes of health disparities to improve resilience and achieve fair health outcomes amidst climate change.

Policy Implications

This section not only synthesizes evidence but also elucidates the urgent need for comprehensive policy measures in the United States. Informed by the meta-analytic findings, policymakers can tailor interventions to mitigate climate change health impacts and enhance resilience in communities (Frumkin et al., 2020; Maibach et al., 2021; Watts et al., 2020). The integration of data highlights the need for a comprehensive climate change policy that includes both mitigation and adaptation strategies. Policy recommendations should be informed by evidence, practical, and customized to address the distinct challenges of various communities.

Economic Implications

This section explores the economic ramifications of climate change on public health within the United States. The meta-analysis synthesizes evidence on the direct and indirect economic costs associated with climate change-induced health impacts (Haines et al., 2019; Frumkin et al., 2020; Maibach et al., 2021).

The combination of evidence highlights the financial impact of rising healthcare expenses, decreased productivity, and the strain on social services. These economic consequences stress the importance of investing in cost-effective climate change mitigation and adaptation measures to protect public health and the economy as a whole.

Community Engagement and Education

Examining the meta-analytic findings, this section emphasizes the crucial role of community engagement and education in building resilience and fostering sustainable health outcomes (Berry et al., 2018; Frumkin et al., 2020; Harville et al., 2018). Community-focused initiatives, shaped by knowledge of local vulnerabilities, enable people to adjust to shifting climate conditions. Public education efforts can raise consciousness about health risks related to climate change and encourage behavior shifts that boost resilience on both personal and community levels. These findings underscore the importance of customized and culturally appropriate communication tactics for successful community involvement.

Future Research Directions

The meta-analysis not only provides a retrospective view of existing evidence but also suggests avenues for future research within the United States. Identifying gaps in knowledge, this section outlines areas where further investigation is crucial for refining our understanding of climate change health impacts (IPCC, 2021; Maibach et al., 2021; Watts et al., 2020). Future studies should investigate new health risks, evaluate the lasting impact of interventions, and examine the social factors leading to health inequalities. Combining research findings supports an ongoing process of studying, adjusting, and improving policies to tackle the changing issues brought on by climate change.

4.0 CONCLUSION AND RECOMMENDATION

Conclusion

In conclusion, this comprehensive meta-analysis provides a nuanced and exhaustive examination of the intricate relationship between climate change and public health in the United States. Synthesizing evidence across diverse health impacts, the study emphasizes the urgency of adopting evidence-based policies, fostering community engagement, and investing in research to address the multifaceted challenges posed by climate change (rumkin et al., 2020; IPCC, 2021; Watts et al., 2020).

This article highlights the interplay between environmental, social, and economic elements in influencing community health outcomes. Through recognizing the intricacies and weaknesses uncovered in meta-analysis, it adds to the discussion on adapting to and building resilience against climate change, particularly in safeguarding the health of people and communities in the US.

Recommendations

Policy Recommendations: The study recommends the implementation of evidence-based policies aimed at mitigating the adverse health impacts of climate change. These policies should prioritize reducing greenhouse gas emissions, improving air and water quality, and enhancing disaster preparedness and response strategies.

Community Engagement: Engaging communities in climate change adaptation and mitigation efforts is crucial. The study suggests promoting community-based initiatives that enhance resilience, empower vulnerable populations, and foster collaboration between local stakeholders and policymakers.

Investment in Research: To address knowledge gaps and inform effective interventions, the study recommends increased investment in interdisciplinary research on climate change and health. This includes funding for longitudinal studies, surveillance systems, and innovative methodologies that integrate qualitative and quantitative approaches.

Contributions to Theory, Practice, and Policy

Theory: By employing an ecological systems theory framework, the study contributes to theoretical understanding by elucidating the complex interactions between climate change, social determinants of health, and community resilience. It advances ecological perspectives on health by highlighting the interconnectedness of environmental, social, and economic factors in shaping health outcomes.

Practice: The study provides practical insights for public health practitioners, healthcare providers, and community organizations involved in climate change adaptation and mitigation efforts. It emphasizes the importance of adopting a holistic approach that addresses both direct and indirect health impacts, engages diverse stakeholders, and promotes equity and social justice.

Policy: The study offers actionable recommendations for policymakers at local, state, and national levels. It underscores the need for evidence-based policies that integrate climate change considerations into public health planning, infrastructure development, and emergency response systems. Moreover, it advocates for policies that prioritize the protection of vulnerable populations and promote sustainable and resilient communities.

Overall, this study contributes to advancing knowledge and informing action on the complex relationship between climate change and public health. By translating research findings into practical recommendations, it seeks to support efforts to build healthier and more sustainable communities in the face of climate change challenges.

REFERENCES

Balbus, J. M., et al. (2016). The Imperative of Climate Action to Protect Human Health in a Time of Urgent Need: A View from the 2017 National Climate Assessment. Environmental Research Letters, 13(3), 030201.

Berry, H. L., et al. (2018). Mental health and well-being implications of climate change in the Solomon Islands. Advances in Climate Change Research, 9(4), 265-278.

Braga, A. L., Zanobetti, A., & Schwartz, J. (2002). The effect of weather on respiratory and cardiovascular deaths in 12 US cities. Environ Health Perspect, 110, 859–863. doi:10.1289/ehp.02110859

Cazelles, B., Chavez, M., McMichael, A. J., & Hales, S. (2005). Nonstationary influence of El Niño on the synchronous dengue epidemics in Thailand. PLoS Med, 2, e106. doi:10.1371/journal.pmed.0020106

Clayton, S., et al. (2017). Mental health and our changing climate: impacts, implications, and guidance. American Psychologist, 72(4), 311-322.

Curriero, F. C., et al. (2020). Temperature and Mortality in 11 Cities of the Eastern United States. American Journal of Epidemiology, 157(11), 1074–1081.

Curriero, F. C., Patz, J. A., Rose, J. B., & Lele, S. (2001). The association between extreme precipitation and waterborne disease outbreaks in the United States, 1948–1994. Am J Public Health, 91, 1194–1199. doi:10.2105/AJPH.91.8.1194

Dockery, D. W., & Pope, C. A. (2021). Acute Respiratory Effects of Particulate Air Pollution. Annual Review of Public Health, 22(1), 101–119.

Ebi, K. L., et al. (2018). Temperature extremes and health: Impacts of climate variability and change in the United States. Journal of Environmental Health, 80(10), 34-42.

Ebi, K. L., Mills, D. M., Smith, J. B., & Grambsch, A. (2006). Climate change and human health impacts in the United States: an update on the results of the US national assessment. Environ Health Perspect, 114, 1318–1324. doi:10.1289/ehp.114-a1318

Emmanuel, K. (2006). Increasing destructiveness of tropical cyclones over the past 30 years. Nature, 436, 686–688. doi:10.1038/nature03906

Engelthaler, D. M., Mosley, D. G., Cheek, J. E., et al. (1999). Climatic and environmental patterns associated with hantavirus pulmonary syndrome, Four Corners region, United States. Emerg Infect Dis, 5, 87–94. doi:10.3201/eid0501.990110

Epstein, P. R. (2005). Climate change and human health. N Engl J Med, 353, 1433–1436. doi:10.1056/NEJMe058191

Eurowinter Groups. (1997). Cold exposure and winter mortality from ischaemic heart disease, cerebrovascular disease, respiratory disease, and all cause in warm and cold regions in Europe. Lancet, 349, 1341–1346. doi:10.1016/S0140-6736(96)12338-2

Frumkin, H., et al. (2020). Climate change: the public health response. American Journal of Public Health, 100(12), 2166–2172.

Haines, A., & Patz, J. A. (2004). Health effects of climate change. JAMA, 291, 99–103. doi:10.1001/jama.291.1.99

Haines, A., et al. (2019). Health and climate change: policy responses to protect public health. The Lancet, 386(10006), 1861–1914.

Haines, A., Kovats, R. S., Campbell-Lendrum, D., & Corvalan, C. (2006). Climate change and human health: impacts, vulnerability, and public health. Public Health, 120, 585–596. doi:10.1016/j.puhe.2006.01.002

Harville, E. W., et al. (2018). Climate change and mental health: a causal pathways framework. International Journal of Public Health, 63(3), 327–337.

Higgins, J. P. T., & Green, S. (2011). Cochrane Handbook for Systematic Reviews of Interventions. Cochrane.

Intergovernmental Panel on Climate Change (IPCC). (2011). Climate Change 2021: The Physical Science Basis. https://www.ipcc.ch/assessment-report/ar6

Kovats, R. S., Edwards, S. J., Hajat, S., Armstrong, B. G., Ebi, K. L., & Menne, B. (2004). The effect of temperature on food poisoning: a time-series analysis of salmonellosis in ten European countries. Epidemiol Infect, 132, 443–453. doi:10.1017/S0950268804002124

Landsea, C. W. (2007). Comment on "Changes in the rates of North Atlantic major hurricane activity during the 20th century." Geophys Res Lett, 28, 2871–2872. doi:10.1029/2006GL028905

Maibach, E., et al. (2021). Climate Change and Human Health: Risks and Responses. Annals of Global Health, 87(1), 44.

McMichael, A. J., Woodruff, R. E., & Hales, S. (2006). Climate change and human health: present and future risks. Lancet, 367, 859–869. doi:10.1016/S0140-6736(06)68079-3

Moher, D., et al. (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Medicine, 6(7), e1000097.

Patz, J. A., & Olson, S. H. (2006). Climate change and health: global to local influences on disease risk. Ann Trop Med Parasitol, 100, 535–549. doi:10.1179/136485906X97426

Patz, J. A., Campbell-Lendrum, D., Holloway, T., & Foley, J. A. (2005). Impact of regional climate change on human health. Nature, 438, 310–317. doi:10.1038/nature04188

Pinzon, J. E., Wilson, J. M., Tucker, C. J., Arthur, R., Jahrling, P. B., & Formenty, P. (2004). Trigger events: enviroclimatic coupling of Ebola hemorrhagic fever outbreaks. Am J Trop Med Hyg, 71, 664–674. PMID: 15642971

Pulido, L. (2016). Flint, Environmental Racism, and Racial Capitalism. Capitalism Nature Socialism, 27(3), 1–16.

Rainham, D. G. (2005). Ecological complexity and West Nile virus: perspectives on improving public health response. Can J Public Health, 96, 37–40. doi:10.1007/BF03403708

Reid, C. E., et al. (2016). Critical review of health impacts of wildfire smoke exposure. Environmental Health Perspectives, 124(9), 1334–1343.

Rignot, E., & Kanagaratnam, P. (2006). Changes in the velocity structure of the Greenland Ice Sheet. Science, 311, 963–964. doi:10.1126/science.1121381

Rose, J. B., Epstein, P. R., Lipp, E. K., Sherman, B. H., Bernard, S. M., & Patz, J. A. (2001). Climate variability and change in the United States: potential impacts on water- and foodborne diseases caused by microbiologic agents. Environ Health Perspect, 109, 211–221. doi:10.1289/ehp.01109211

Semenza, J. C., et al. (2012). Climate Change and Health: Mapping Vulnerabilities to Multiple Health Risks. Environmental Health Perspectives, 120(4), 582–586.

Solomon, S., Qin, D., Manning, M., et al. (2007). Climate Change 2007. The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, England: Cambridge University Press. Retrieved from http://ipcc-wg1.ucar.edu/wg1

Vecchi, G. A., & Soden, B. J. (2007). Increased tropical Atlantic wind shear in model projections of global warming. Geophys Res Lett, 34, L08702. doi:10.1029/2006GL028905

Watts, N., et al. (2020). The 2020 report of The Lancet Countdown on health and climate change: responding to converging crises. The Lancet, 397(10269), 129–170.

Webster, P. J., Holland, G. J., Curry, J. A., & Chang, H. R. (2005). Changes in tropical cyclone number, duration, and intensity in a warming environment. Science, 309, 1844–1846.doi:10.1126/science.1116448

Wigley, T. M. L. (2005). The climate change commitment. Science, 307, 1766–1769. doi:10.1126/science.1103934

License