Vector-Borne Diseases in a Warming World: New Risks and Adaptive Strategies

Abstract

The research conducted to evaluate Vector-Borne Diseases in a Warming World globally, with a systematic literature review to analyze new Risks and Adaptive Strategies. The research aims to explicate how climate change intensifies vector-borne disease (VBD) risks and identify adaptive health policy and strategy. The research explored the interplay of climatic, social, and ecological factors driving VBD proliferation and proposed actionable interventions designed for adaptive strategies. The research methodology adapted as secondary qualitative systematic literature review integrating papers from Asia economies, Europe, the UK, and the US and documents from qualitative and quantitative data from peer-reviewed studies (2019–2024). The data collection process entailed searching academic databases for relevant articles, 10 core articles were selected, and studies were based on their focus on climate change and VBDs, and extracting data on study design, variables, and evaluation of Risk and adaptive strategies for VBD. The research analysis was performed through a thematic approach, coding data to identify five emergent themes. The core themes gained from research are the climatic drivers amplifying outbreaks, geographic expansion of VBDs, urbanization increasing risks, social determinants worsening burdens, and vector adaptations to climate. The research results reveals that rising temperatures and extreme weather intensify diseases like dengue and malaria, vectors expand to new regions, urban settings create breeding hotspots, social inequities exacerbate vulnerability, and vectors adapt behaviorally; hence, transmission of those diseases is increased. The study offers a framework for climate-sensitive surveillance, equitable health policies, urban planning, and innovative vector control. The study is significant for the healthcare sector, policymakers, and health practitioners in mitigating VBD risks, emphasizing interdisciplinary strategies to protect vulnerable populations globally in a warming world.

Keywords: Vector-Borne Diseases, Global Warming, Adaptive Strategies and Risks.

1. Introduction

1.1 Background of research and Research Problem

The dynamic changes in ecological and Climate change are a global challenge, profoundly impacting environmental stability and public health through the increased vector-borne diseases (Khan et al., 2023). Increasing global temperatures, shifting rainfall patterns, and increasing frequency of changing weather events create optimal conditions for vector diseases. The increase in warm temperature vectors, such as mosquitoes, ticks, and sandflies, enables them to expand their geographic ranges and prolong transmission in different weather conditions (Caminade et al., 2019). The VBD diseases, including malaria, dengue, Zika, and Lyme disease, are surging, straining healthcare systems and threatening vulnerable populations. In high-temperature regions, previously unaffected areas are now experiencing VBD emergence due to warmer climates. Southern Europe has reported increased dengue cases linked to the climate-driven spread of Aedes mosquitoes (Adepoju et al., 2023). In regions like sub-Saharan Africa, malaria prevalence is rising as higher temperatures enhance mosquito reproduction and pathogen growth in various geographic regions (Gizaw et al., 2024).

Understanding climate change and VBD's role involves ecological, social, and behavioral dimensions. The VBD Insect vectors adapt physiologically and behaviorally to warmer environments, increasing their competence to enhance transmissions (Abbasi, 2025). The mosquito exhibits higher biting rates and shorter pathogen incubation periods in elevated temperatures, increasing disease spread in those regions (Ma et al., 2022). Increased urbanization and land-use changes worsen these risks by creating breeding grounds, such as stagnant water in urban slums or deforested areas (Ferraguti et al., 2023). In economies with low income and socioeconomic factors

like poverty, inadequate housing, and limited healthcare access heighten vulnerability, particularly in conflict-affected areas (Abdulwahab et al., 2024). The report by WHO explained that many neglected tropical diseases, vector-borne, disproportionately affect marginalized communities and enhance the importance of interventions (WHO, 2024)

The globalization and movement of people from various regions also enhance the rapid spread of climate change and spread of VBD diseases. However, the specific mechanisms linking environmental shifts to VBD transmission remain the areas of investigation in many economies. The research evaluates the isolated factors, such as temperature, rainfall, without integrating social and ecological causes (Thomson & Stanberry, 2022). This core literature gap requires the development of comprehensive risk adaptation strategies, and the evaluation of the role of the economic burden of VBDs is significant, with malaria alone costing Asian and African economies billions annually in the healthcare sector (Abdulwahab et al., 2024).

Research Problem

Environmental, Ecological, and Climate change drastically intensify the transmission of vector-borne diseases, posing a critical public health challenge. However, the specific drivers remain inadequately evaluated, and those areas must be explored. The increasing temperatures and altered rainfall patterns expand vector habitats, increasing the incidence of diseases like malaria and dengue in both widespread and newly affected economies (Alqassim, 2024). Considering the Asian economies and African regions, particularly low-income and conflict-affected states, limited healthcare infrastructure and socioeconomic constraints leave communities less equipped with resources and healthcare facilities (George et al., 2024). The exploratory research evaluated the gaps by investigating how climate-driven changes influence VBD transmission and identifying integrated adaptation strategies to reduce the spread of VBD (Abdulwahab et al., 2024).

Research Purpose

The secondary qualitative exploratory research was conducted to evaluate the significant impact of climate change on VBD transmission, focusing on the ecological, social, and behavioral factors that increase the growth and spread of VBD. With the change in temperature and increased global warming in various economies like Asia, Africa, and Europe, changing rainfall patterns, and human activities influencing vector populations and disease incidence, the research aims to identify sustainable public health involvements. The research explored the spread of VBD in vulnerable populations in low-resource settings, aiming to reduce the growing burden of VBDs, enhance community resilience, and provide the core areas and challenges.

1.2 Justification of issue

The drastic increase in vector-borne diseases driven by climate change justifies urgent research for effective public health responses. The rapid increase of VBD in global environment due to heavy technology, machinery, and the high production of multinational organizations has not followed the sustainable development goals. Additionally, extreme weather events are expanding vector habitats, increasing VBD incidence in tropical and temperate regions in economies like Asia, Africa, and Europe (Paz, 2024). In economies like Asia and particularly in sub-Saharan Africa, there are low-income, weak healthcare systems, and socioeconomic challenges, such as poverty and conflict, exacerbate vulnerability, limiting adaptive capacity to stop the spread of VBD (Abdulwahab et al., 2024). The lack of integrated approaches that address ecological, social, and behavioral drivers hampers disease control efforts, leaving gaps in designing new adaptive strategies (Alqassim, 2024). For instance, urban slums with poor sanitation create breeding sites, amplifying risks (Ferraguti et al., 2023). Without usefull interventions, VBDs will continue to impose significant health and economic costs, particularly in resource-constrained settings. This research is critical to developing evidence-based adaptation strategies that reduce VBD

prevalence, protect vulnerable populations, and promote resilience, aligning with global health priorities (Thomson & Stanberry, 2022).

1.3 PICO Model and Research Questions

Major research question:

How does climate change influence the transmission of vector-borne diseases, and what are the ecological, social, and behavioral factors driving their spread?

Sub-Questions

RQ1: How specific climatic factors, such as temperature and precipitation changes, enhance vector proliferation and VBD transmission?

RQ2: How do social and behavioral determinants, including urbanization and community practices, contribute to the spread of VBDs under climate change?

RQ3: What ecological adaptations in vectors, such as behavioral or physiological changes, are triggered by climate change, and how do they impact disease transmission?

Table 1: PICO Model and research questions

Research Question	PICO Component	Description
RQ1: What specific climatic factors, such as temperature and precipitation changes, enhance vector proliferation and VBD transmission?	Population	Communities in tropical and temperate zones affected by climate-driven temperature increases and precipitation changes.
	Intervention	Climate-informed vector control strategies, like targeted insecticide spraying and environmental management.
	Comparison	Communities using standard vector control methods not tailored to climate factors.
	Outcome	Reduced vector proliferation and decreased VBD incidence (e.g., malaria, dengue).
RQ2: How do social and behavioral determinants, including urbanization and community practices, contribute to the spread of VBDs under climate change?	Population	Urban and peri-urban communities in low-resource settings with high-risk social and behavioral practices.
	Intervention	Community-based behavioral interventions, like education campaigns for water storage and bed net use.
	Comparison	Communities with general public health campaigns, not targeted behavioral interventions.
	Outcome	Reduced VBD transmission through fewer breeding sites and increased preventive behaviors.
RQ3: What ecological adaptations in vectors, such as behavioral or physiological changes, are triggered by climate change, and how do they impact disease transmission?	Population	Populations where vectors exhibit climate-induced adaptations, like increased biting rates.
	Intervention	Innovative vector control, like genetic modification or novel insecticides.
	Comparison	Populations using conventional vector control not adapted to vector changes.
	Outcome	Decreased vector competence and lower VBD incidence.

The PICO framework guides this research by defining the target population as communities in climate-affected, low-resource regions where VBDs are prevalent. The intervention focuses on climate-informed strategies, such as enhanced vector control, early warning systems, and community-based adaptation programs. The comparison evaluates outcomes in areas lacking these interventions to assess their efficacy. The desired outcome is a significant reduction in

VBD incidence, providing evidence for scalable solutions (Mengist et al., 2020).

1.3 Describe the significance of research

The research evaluates the most pressing environmental and health issue: the rising incidence of vector-borne diseases in various economies due to climate change. The increase in VBDs like malaria and dengue imposes substantial health and economic burdens, particularly in low-income economies with low resources and facilities of health care (George et al., 2024). In Asian economies like Pakistan, Malaysia, Indonesia, and Bangladesh, malaria contributes to millions of cases annually, draining national budgets and resisting economic and social development (Abdulwahab et al., 2024). In economies like Southern Europe, emerging VBDs threaten tourism-driven economies, highlighting the global scope of the issue (Thomson & Stanberry, 2022). In the process of effective adaptation strategies, this study explains the new adaptive strategies to face the risks and design the policies that reduce the VBD disease burden, enhance community resilience, and support sustainable development. The research findings impact resource-constrained settings facing climate and conflict challenges, contributing to global health equity and environmental sustainability in different economies (Adepoju et al., 2023).

1.4 Describe Relevant Literature

Climatic Drivers of Vector Borne Spread

The rise in global warming and temperature, rainfall shifting, mosquitoes, ticks, and sandflies can now live in more places. Because vectors reproduce more often in warmer areas, significantly increasing VBD spread (Caminade et al., 2019). Rising temperatures in Southern Europe have caused Aedes mosquito numbers to grow, which has resulted in more dengue infections (Adepoju et al., 2023). Abundant rainfall allows mosquitoes to breed, and dry periods draw insects to town, increasing the risks (Gizaw et al., 2024). The changing climate affects how we fight disease, so we must use methods that respond to important thresholds like the temperature vectors needed to survive. VBD spread can be estimated by combining meteorological data with predictive models, which helps create methods to minimize their effects (Paz, 2024).

Impact of Extreme Weather on VBD Transmission

The results of devastating floods, hurricanes, and heatwaves, viral disease transmission increases as new habitats are created for disease carriers. More floodwater means mosquitos will still have water for reproduction, and crowds displaced by a disaster face increased chances of getting bit by disease carriers (Thomson & Stanberry, 2022). Malaria cases have gone up in Haiti after hurricanes because of problems with healthcare and the growth of more breeding sites (Balthazard-Accou et al., 2021). More often, models predict extreme climate events, raising the threat of VBDs in at-risk regions (George et al., 2024). To help reduce these impacts, we should ensure our infrastructure is tough and our warning systems are working early. Public health planning that considers climate forecasts can improve how we respond to and safeguard communities from significant increases in VBD cases (Ma et al., 2022).

Social Determinants of VBD Spread

The social determinants like poverty, quality and living standards are important to consider as people may not having enough housing, and being unable to get many health services become significant factors in the spread of VBDs in the face of climate change. Roadside residences and filthy water sources in poor places prepare as good environments for breeding mosquitoes and other magnets for disease (Marina et al., 2023). In regions that do not have enough water, improper community habits of leaving water exposed can enhance such risks (Alqassim, 2024). Because bed nets and similar tools are so costly, those facing socioeconomic challenges remain

particularly at risk (Ferraguti et al., 2023). Working to resolve these factors using community programs, better infrastructure, and additional healthcare options can limit the effects of VBDs and increase our ability to resist impacts caused by climate change (Bardosh et al., 2017).

Behavioral Influences on VBD Transmission

There are various behavioral influences the VBD as Climate change, migration, urbanization, and how we use land affect the spread of VBD. As growth in development of forests are cleared due to poor planning, more people come into contact with insects known to spread diseases (Wilcox et al., 2019). Because VBDs are easily carried by migratory animals, their spread has become more challenging in influent areas throughout Asia (Zain et al., 2024). Preventive actions such as bed net usage and arranging cleaning campaigns for communities reduce the risks, but they should be adapted to fit specific cultural and financial barriers (Alqassim, 2024). Public health should use behavioral insights to help lower VBD spread in climate-shaped areas (Tohit et al., 2024).

Environmental (Climatic) and Ecological Shifts and VBD Dynamics

Table 2: Environmental and Ecological shifts and global change drivers pertinent to Vector diseases

Global Change Driver	Potential Effects on Vector, Pathogen, and Host Environments	Potential Effects on Vectors, Pathogens, and Hosts
Higher CO_2 concentration	Rise in air temperature and vegetation biomass; expansion of woody plants and extended humid growing periods.	Longer vector lifespan in moist areas, potentially expanding the range of humidity-loving species.
Temperature increase (regional/temporal variation)	Broader warm climate zones, prolonged growing seasons, fewer cold extremes, and more frequent heat waves.	Accelerated development cycles for vectors and pathogens, with expanded ranges for heat-tolerant species.
Rainfall	Regional unpredictability, though extreme rainfall events may become more common.	Changes in mosquito breeding habits; flooding may flush breeding sites, increasing spread.
Urbanization	Denser human populations with limited sanitation; suburban sprawl into forested zones.	Elevated disease transmission risks and more breeding locations for vectors; increased human-vector interaction.
Deforestation	Greater human presence in forests and accumulation of water due to land clearing for farming.	More breeding environments and enhanced exposure of humans to vector species.
Irrigation and water storage	More stagnant water sources and prevention of natural flood cycles.	Greater abundance of breeding habitats; reduced cleansing effects of floodwaters.
Intensification of agriculture	Increased disruption of ecosystems and habitats; decline in biodiversity due to land use intensification.	Wider range of breeding conditions for vectors and reduced predator populations.
Chemical pollution	Introduction of harmful chemicals and endocrine disruptors into the environment.	Compromised immune defenses in human populations.
Increased trade	Growth in global shipping volumes and cross-border movement of goods.	Facilitated movement of disease vectors, potentially leading to their establishment in new regions.

Source: *World Health Organization (WHO), (2024), Information sourced from the US Centers for Disease Control and Prevention*

Changes in climate lead to changes in things like biodiversity and the type of land in an area, which greatly affect VBD dynamics. Destroying forests and increasing agricultural areas upsets ecosystems, making people more likely to come into contact with diseases (Ferraguti et al., 2023). Changes in how land is used in African drylands have been connected to a higher rate of malaria (Wilcox et al., 2019). Even so, researcher's report that certain groups of vectors may be decreasing because of a reduction in their habitats, reflecting how closely related species

are to each other (Escobar et al., 2016). Knowing these relationships is necessary for predicting trends in VBD and designing lasting actions. When public health actors use ecological details, they can withstand the effects of climate change-related VBDs (Gizaw et al., 2024).

As a result of climate change, some insects and other vectors become better equipped to infect people with diseases. Higher temperatures make mosquitoes more eager to bite and speed up when the virus develops, so transmission increases (Abbasi, 2025). Aedes mosquitoes can adapt to urban life, thrive better in warmer conditions, and move into more areas (Ma et al., 2022). Growth in vector numbers, sometimes brought on by changes in their reproductive behavior, hinders control attempts (Zhang et al., 2024). Both genetic modification and new insecticides can play a role in stopping these adaptations, and VBD spread. Vector biology research is needed in the face of climate change to design better interventions (Krishnasastry, 2024).

2. Methods and Sources

2.1 Research Philosophy and Design

The research conducted by using secondary qualitative research followed by Interpretivism philosophy based on epistemological context. The study focuses on understanding the subjective and contextual nature of climate change's impact on the increased VBD transmission. The philosophy of Interpretivism allows for exploring complex social, ecological, and behavioral dynamics through qualitative insights to evaluate the relationships of constructs with the rise in VBD (Saunders & Darabi, 2024). The researcher adapted the qualitative research using an inductive approach to derive patterns and themes from existing literature without prepositions. This design facilitates a deep exploration of climatic, social, and ecological factors driving VBDs, drawing on diverse data sources to construct meaningful interpretations based on a grounded theory approach and insights into VBD adaptation strategies for managing the risks (Macura et al., 2019).

2.2 Research Approach and Type

The research adopted the exploratory and grounded theory framework; the type of research is qualitative and systematically analyzes existing literature to uncover patterns and relationships in how climate change influences VBD transmission and literature studies from various economies (Proudfoot, 2023). The exploratory approach follows the investigation of climatic, social, and ecological factors, enabling the identification of novel insights and research propositions. The researcher adopted the ground theory approach and used the iterative coding and categorization of data, ensuring themes emerge directly from the literature studies and evaluate the social phenomena (Creswell & Hirose, 2019). The Qualitative exploratory approach is suitable for this research as the study is designed for complex, multifaceted research questions, as it facilitates the synthesis of diverse perspectives from secondary sources with the use of leveraging peer-reviewed studies; the approach ensures robust with relevant findings to evaluate the public health strategies and analyzing the risks of VBD (Macura et al., 2019).

2.3 Theoretical framework

The research is based on a grounded theory approach, and the underpinning theory for this research is the socio-ecological model (SEM), which reflects the interplay of individual, community, and environmental factors in the context of climate change and the spread of VBD. The socio-ecological model explores the environmental and social context to evaluate health outcomes (Zhou et al., 2024). The theory posits that health outcomes, such as VBD prevalence, are influenced by multiple levels of individual behaviors like water storage, community practices like Urbanization, and environmental conditions. The research explored the study's focus on climatic, social, and ecological drivers, providing a holistic lens to analyze how these factors exacerbate VBDs. By

applying SEM, the research can identify leverage points for interventions, such as community education and vector control that address interconnected factors in various economies. The theory explains that flexibility supports the inductive approach, allowing emergent themes to be contextualized within a research context (Creswell & Hirose, 2019).

2.4 Search Strategy

Table 3: Search Strategy with Ley Terms

Search Term Category	Keywords	Boolean Operators
Population	climate-affected communities, tropical regions, temperate regions, low-resource settings	(climate-affected communities OR tropical regions OR temperate regions OR low-resource settings)
Intervention	vector control, insecticide spraying, environmental management, community education, genetic modification	(vector control OR insecticide spraying OR environmental management OR community education OR genetic modification)
Comparison	standard vector control, general public health campaigns, conventional methods	(standard vector control OR general public health campaigns OR conventional methods)
Outcome	VBD incidence, vector proliferation, transmission rates, vector competence	(VBD incidence OR vector proliferation OR transmission rates OR vector competence) AND (malaria OR dengue OR Zika)
Combined Search	climate change, vector-borne diseases, temperature, precipitation, urbanization, behavioral practices, vector adaptations	(climate change AND vector-borne diseases) AND (temperature OR precipitation OR urbanization OR behavioral practices OR vector adaptations) NOT (veterinary OR animal health)

The secondary qualitative research is based on a systematic literature review to explore climate change and vector-borne diseases (VBDs) by aligning keywords with the PICO model. The study explains the Population, Intervention, Comparison, Outcome, and Combined Search. The table includes terms like "climate-affected communities" and "vector control," targeting climatic, social, and ecological determinants of vector-borne. The researcher used the articles with a search strategy and used the Boolean operators (AND, OR, NOT) to refine searches in databases like Scopus, ensuring relevance by combining the terms "climate change AND vector-borne diseases" and excluding unrelated topics "NOT veterinary" (Mengist et al., 2020).

2.5 Key words and use of Boolean Operators

Table 4: Search Terms with Boolean Operators

Research Question	PICO Component	Boolean Operators
RQ1: What specific climatic factors, such as temperature and precipitation changes, enhance vector proliferation and VBD transmission?	Population	"AND" Communities in tropical and temperate zones affected by climate-driven temperature increases and precipitation changes.
	Intervention	"OR" Climate-informed vector control strategies, like targeted insecticide spraying and environmental management.
	Comparison	"AND" Communities using standard vector control methods not tailored to climate factors.
	Outcome	"OR" Reduced vector proliferation and decreased VBD incidence (e.g., malaria, dengue).
	Population	"AND"

		Urban and peri-urban communities in low-resource settings with high-risk social and behavioral practices.
RQ2: How do social and behavioral determinants, including urbanization and community practices, contribute to the spread of VBDs under climate change?	Intervention	Community-based behavioral interventions, like education campaigns for water storage and bed net use. "AND"
	Comparison	"OR" Communities with general public health campaigns, not targeted behavioral interventions.
	Outcome	Reduced VBD transmission through fewer breeding sites and increased preventive behaviors. "AND" "OR"
RQ3: What ecological adaptations in vectors, such as behavioral or physiological changes, are triggered by climate change, and how do they impact disease transmission?	Population	Populations where vectors exhibit climate-induced adaptations, like increased biting rates. "OR"
	Intervention	Innovative vector control, like genetic modification or novel insecticides. "OR"
	Comparison	Populations using conventional vector control not adapted to vector changes. "AND"
	Outcome	"OR" Decreased vector competence and lower VBD incidence.

The above table shows the effective use of the PICO model and Boolean operators to analyze and use the PICO model to explore the research articles based on the topic and evaluate the climatic factors, social/behavioral determinants, and vector adaptations in VBD transmission. The researcher used the organized PICO components (Population, Intervention, Comparison, Outcome) and combined using AND, OR, and NOT to reduce the search process and search specific and related articles (Macura et al., 2019). The search was based on research questions and the use of databases like Scopus and PubMed, ensuring precise retrieval of peer-reviewed articles from 2019 to 2024 (Mengist et al., 2020). The research effectively enhances the efficiency and specificity of the literature review, capturing studies aligned with the research objectives and questions from authentic sources.

2.6 Inclusion and exclusion criteria

Table 5: Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
Time Period	Articles published between 2019 and 2024	Articles published before 2019 or after 2024
Domain	Studies on climate change and human vector-borne diseases (e.g., malaria, dengue)	Studies on non-human VBDs or unrelated health topics
Publication Type	Peer-reviewed journal articles in Scopus, Taylor & Francis, or high-impact factor journals	Non-peer-reviewed sources,
Quality of Papers	Only those which are authentic papers and published in authentic sources and relevant to topic and objectives are selected	Those papers which are not relevant and not authentic to topic are not selected for review
Language	English (United Kingdom) those articles are selected	Articles apart from English (United Kingdom) are not selected for review

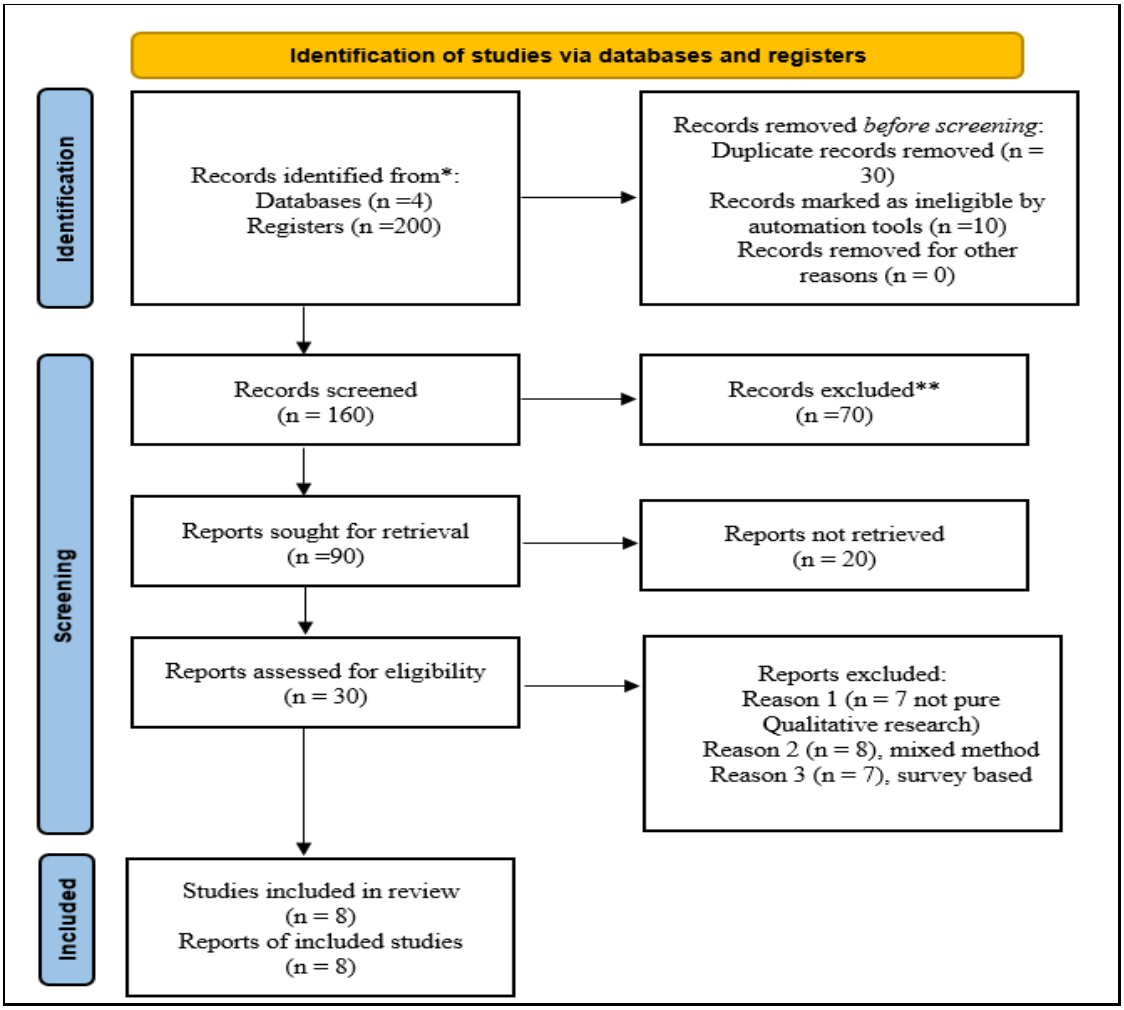
The table explains the inclusion and exclusion criteria and articles selected from 2019 to 2024 to ensure recent,

relevant data on climate change and VBDs. The inclusion criteria explain the VBDs, focusing on diseases like malaria and dengue, to align with the research questions. Only peer-reviewed articles from credible sources like Scopus, Taylor & Francis, high-impact factor journals, and sites like PubMed are used to ensure authenticity and rigor. Exclusion criteria eliminate outdated studies, non-human VBD research, and non-peer-reviewed sources to maintain quality and relevance with effective use of approach ensures a focused, high-quality literature review to explore the dimensions of VBD (Mengist et al., 2020).

2.7 Selection of studies

The research explored the dimensions and research guided by the research domain (climate change and VBDs), main research questions, and emergent themes abstracted from literature studies. The research articles are chosen related to climatic factors like temperature, rainfall, and social and brand behavioral determinants. These include Urbanization and water storage, which increase the chances of VBD due to increase of mosquitoes and biting rate changes.

Figure 1: PRISMA Model



The above PRISMA model explain the process of selection of study and explore the research paper found, included and excluded based on measures and criteria. From selected research papers core themes abstracted include vector proliferation due to warming, urban breeding sites, and physiological vector changes, ensuring alignment with the grounded theory approach. The selection process involves screening titles, abstracts, and full

texts to confirm relevance, using systematic review protocols to minimize bias (Macura et al., 2019).

2.8 Ethical consideration

The research was conducted based on a secondary qualitative research approach, and the study followed the ethical consideration for secondary data research in ensuring transparency, credibility, and respect for the intellectual rights of authors and journals. The research explored the ethical guidelines by accurately citing all sources, avoiding plagiarism, and acknowledging authors' work by citations within the text (Saunders & Darabi, 2024). The research uses peer-reviewed articles to better synthesize objectively, with no manipulation to fit propositions. It explores the systematic and unbiased selection process, using explicit inclusion and exclusion criteria for research to maintain fairness (Macura et al., 2019). The research is secondary and does not require any human subjects to be involved; ethical risks are minimal, but rigor in methodological reporting upholds research integrity and consideration of research ethics.

3. Results and Findings

3.1 Synthesis of selected studies

The research conducted to explain the multifaceted impact of climate change on VBDs, emphasizing climatic, social, and ecological drivers in developing and developed economies. The research explore the role of climatic factors in amplifying VBD transmission (Caminade et al., 2019). The research explain the temperature and rainfall spikes in 2015–2016 fueled Zika outbreaks in Latin America by enhancing mosquito breeding, hence increase in VBD diseases. The temperature and humidity as drivers of dengue and malaria resurgence in Bangladesh, though they note gaps in microclimatic data along with model how global warming boosts mosquito survival, projecting increased dengue and malaria risks in various economies (Ryan et al., 2019).

The limited public awareness of climate-VBD links, especially in low-income communities, hindering preventive behaviors (Matlack et al., 2023). According to Messina et al. (2023), emphasize how poverty and migration amplify VBD prevalence, as climate-induced displacement exposes populations to vectors. Colón-González et al. (2021) project a 60% rise in dengue cases by 2080, driven by urbanization and climate change, highlighting the interplay of human and environmental factors. These studies call for integrated public health and social equity interventions to mitigate VBD burdens.

Ecologically, vectors adapt to climate shifts, expanding VBD ranges and seasons. Paz (2024), documents malaria and West Nile virus extending to new regions like East Africa and Europe due to warming. Semenza et al. (2022) describe vectors' behavioral adaptations, such as extended mosquito activity, enhancing Zika transmission. The studies stresses that land use changes and extreme weather alter vector distributions, prolonging transmission seasons (de Souza & Weaver, 2024). The research studies explored the adaptive vector control and predictive modeling to address evolving VBD risks under climate change in different regions.

3.2 Thematic Analysis

Table 6: Thematic Table

Themes	Sub-Themes	"Quote from Literature"
Climatic drivers amplify VBD outbreaks	Warming, Temperature, rainfall, VBD transmission (Zika, dengue, malaria)	"Climate phenomena such as El can lead to significant increases in temperature and rainfall, creating favorable conditions for mosquito breeding and subsequent outbreaks of diseases like Zika, dengue, and malaria in affected regions" (Matlack et al., 2023).
	Climate literacy, health literacy and Public awareness of VBD risks	

Geographic expansion of VBDs	Temperature, rainfall, land use, human mobility; VBD transmission	"Global warming has facilitated the northward expansion of vectors, with malaria now reported in parts of East Africa and West Nile virus in Europe, driven by prolonged heat waves and milder winters" (Jibon et al.,2024).
	Temperature, precipitation; Mosquito population dynamics, VBD risk	
Urbanization amplifies VBD risks	Multifaceted drivers of VBD spread	Urbanization, coupled with climate change, significantly increases dengue risk, as cities provide abundant breeding sites and higher temperatures extend mosquito activity, potentially leading to a 60% rise in cases by 2080 (Paz, 2024).
	Temperature impacts vector survival	
Social determinants worsen VBD burden	Climate scenarios, urbanization; Dengue incidence	"Social determinants such as poverty and migration amplify VBD prevalence, as climate-induced displacement forces populations into areas with poor sanitation, increasing exposure to vectors like Aedes mosquitoes" (de Souza & Weaver, 2024).
	Social determinants (poverty, migration); VBD prevalence	
Vector adaptations to climate	Climate alters disease epidemiology	"Vectors exhibit adaptive behaviors under climate change, with mosquitoes extending activity periods due to warmer temperatures and altered humidity, enhancing transmission efficiency for pathogens like Zika and chikungunya." (Ryan et al., 2019).
	Temperature, humidity; Vector behavior, pathogen transmission	

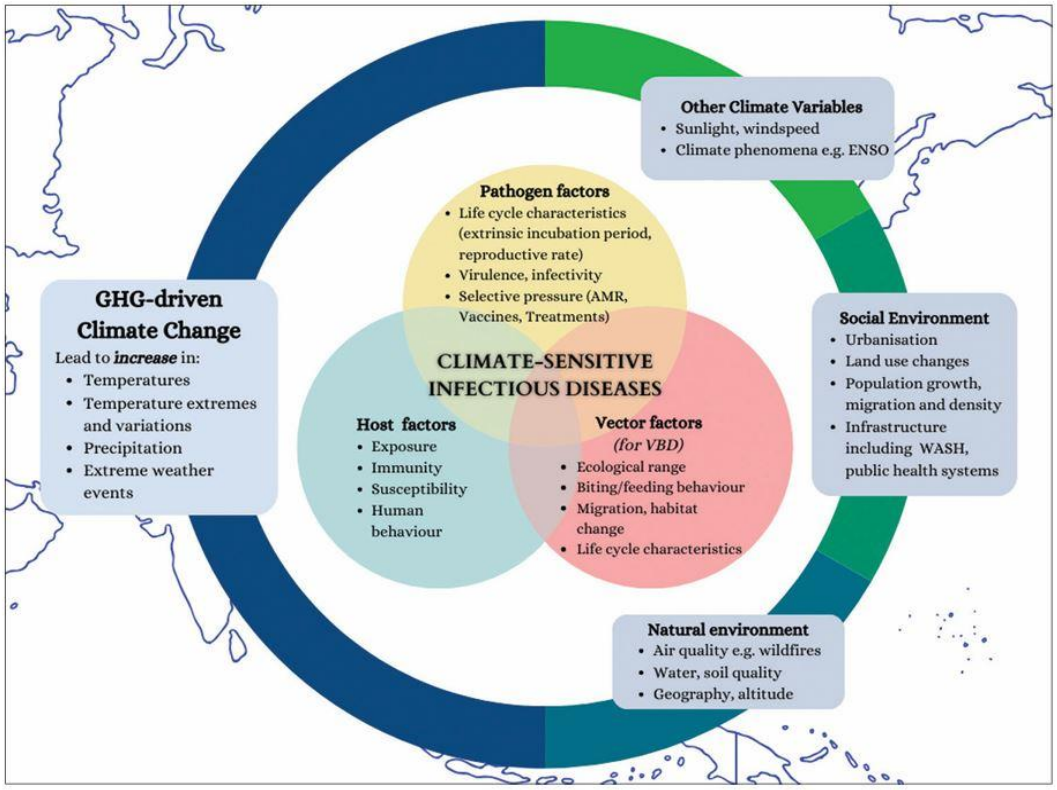
The above table summarizes the core themes from the literature review. Based on selected studies, the sub-themes and themes are identified. These themes explain the core dimensions of VBD diseases and enhance growth and development. The core themes identified include Climatic drivers that amplify VBD outbreaks, Geographic expansion, Urbanization that amplifies VBD risks, social determinants that worsen VBD Burden, and Vectors' adaptations to climate.

Theme I: Climatic drivers amplify VBD outbreaks

The dramatic increases in temperatures increasing and rainfall shifting, mosquitoes, ticks, and sandflies can now live in more places. Because vectors reproduce more often in warmer areas, significantly increasing VBD spread (Caminade et al., 2019). Rising temperatures in Southern Europe have caused Aedes mosquito numbers to grow, which has resulted in more dengue infections (Adepoju et al., 2023).

The figure 2, shows the relationship between climate change, infectious diseases, and their spread in Asia. When temperatures rise, mosquitoes reproduce more and spread diseases faster, making more people get dengue and malaria. Intense rainfall contributes to the rise of breeding spots and increases the number of outbreaks, mainly in South Asia. Living in crowded cities makes it more likely that diseases will infect humans. In rural areas, poverty makes people more exposed to risks. A changed climate enables VBD-carrying vectors to work longer, intensifying the disease in many Asian countries (Zain et al., 2023)

Figure 2: Climate change and its impact on infectious diseases in Asia



Source: Zain et al., (2023)

Disruptions from unusual weather conditions block vector control activities and increase outbreaks. Warmer temperatures increase the ability of vectors to carry diseases, making problems like Zika more likely to spread. Because the climate can change so quickly, we must monitor carefully and warn people early, using strong systems to manage outbreaks properly (Zain et al., 2023). Without taking action, the number of VBDs is set to increase in these regions more than anywhere else.

When the climate changes, the chances of VBD becoming more widespread increase because the conditions are right for numerous vectors. When temperatures rise, mosquitos develop faster, leading to a higher number of them. Rain from El Niño or similar events causes water to collect in places where mosquitoes can breed easily. Because of these conditions, diseases such as dengue and malaria are spread longer, placing tremendous pressure on public health systems.

Theme II: Geographic expansion of VBDs

Cold climates in northern Europe and Africa once kept these diseases from spreading, but now that is changing. Growing cases arise as health systems are not equipped for the diseases brought by this expansion. The drastic changes ecosystems caused by climate changes support the movement of vectors, allowing infectious diseases to be introduced into new regions. Public health must change its approaches to monitor and deal with new vector threats to prevent large outbreaks. With rising temperatures and different rainfall, mosquitoes and ticks can now inhabit places where VBDs had not been found before. Winter temperatures have risen, and summers have grown longer, so mosquitoes and ticks live even in regions far from the Equator.

Theme III: Urbanization amplifies VBD risks

A rapidly developing urban areas increase chances of VBDs because it helps vectors and their eggs multiply.

Areas with packed cities and poor waste disposal fill the environment with many places where mosquitoes can breed. Overcrowding in live-able spaces allows diseases to spread quickly, adding pressure to medical services. Building infrastructure in nature often makes room for more pesky creatures that can transmit disease. Because they do not have access to resources, lifestyles in urban poverty can worsen risks. Dealing with VBD issues in cities calls for proper waste disposal, pest control, and teaching the public about health to overcome the challenges created by urban life and climate change.

Theme IV: Social determinants worsen VBD burden

Climate change makes social inequalities a bigger burden on conditions related to zoonotic a type of VBD diseases. As communities suffer from poverty, they have limited chances to see a doctor or use prevention methods, making them more susceptible to malaria and other VBD. Climate migrants often search for new homes and go to places overrun by diseases, insects, and poor sanitation. Having many people in one area encourages faster spread of disease. A lack of information about VBD risks makes it hard for communities to use bed nets to prevent the disease. Also, women in some areas may be more likely to breathe in toxic particles while cooking or cleaning. When combined with social issues, climate stressors affect disadvantaged groups to a larger extent, requiring extraordinary efforts to manage and reduce these impacts.

Theme V: Vector adaptations to climate

When the weather becomes warmer and wetter, vectors gain better opportunities to carry diseases. The warmer temperatures last longer, so mosquitoes bite more and are active more often, boosting the spread of malaria and dengue. Rising temperatures help vectors produce more offspring and lower the time for diseases to appear, helping infection happen sooner. Changes in humidity help insect vectors live outside of their regular area, spreading farther. Another VBD, Lyme disease is more common because ticks can thrive in warm environments. These adaptations make it challenging to manage with usual control tactics, which is why scientists now look to genes and use specific chemicals to lower vector numbers and keep the public safe.

4. Discussion and Conclusion

4.1 Discussion on emergent themes

The increase in global warming and rising temperatures affect climate change and increase the likelihood of VBDs because of connected climate, social, and ecological factors. Due to high temperatures and weather events such as El Niño make dengue, Zika, and malaria outbreaks more likely by helping mosquitoes reproduce and spreading the pathogens (Jibon et al., 2024). The spread of Vectors in new regions is exposed to infectious diseases, and East Africa and Europe are now seeing malaria and West Nile virus (Paz, 2024; de Souza & Weaver, 2024). Due to urbanization, there are more places for mosquitoes to breed, and dengue risks are increasing in cities (Rocklöv & Dubrow, 2020). The rising problem of VBD occurs in communities that lack resources and are exposed to migration and financial struggles, limiting the use of prevention measures (Messina et al., 2023). With climate change, vectors behave differently, making VBD-like Zika transmission last longer (Semenza et al., 2022). These results strongly argue for using flexible methods such as observing climate-related diseases, sharing resources fairly, and finding new ways to control insects to address the increasing threat of global VBDs caused by climate change.

The systematic literature describes higher temperatures and extreme weather as important reasons for increased VBD outbreaks (Caminade et al., 2019). The study explained that temperature and rainfall boosts due to El Niño linked to Zika in Latin America, agreeing with Ryan et al. (2019), who created models for how warmer temperatures can help mosquitoes live longer. Like India, Jibon et al. (2024), found that climatic conditions contributed to a rise in dengue and malaria in Bangladesh. However, there are still gaps in the collection of

microclimatic information. The dynamics of VBDs changing with regions due to climate change is important, as shown by Paz (2024), who reports malaria and West Nile virus cases in East Africa and Europe.

By examining new areas of VBD, the study identifies problems with how health systems are prepared, a point discussed in a previous study by (Semenza et al., 2022). This means that due to the change in weather and longer vector seasons, networks everywhere are needed to watch emerging areas for mosquitos and act swiftly to prevent major outbreaks.

The growth of Urbanization found that Colón-González et al. (2021), predicted that by 2080, dengue will likely increase by 60% due to more urbanization and climate change. According to Rocklöv & Dubrow (2020) point out that cities have urban heat islands that make mosquitoes more active. When linking city breeding sites to more dengue cases. The growing cases of VBD are affected more by poverty and migration, and (Messina et al., 2023), report that people displaced by climate change have greater exposure. Low knowledge about climate VBDs among the population makes it challenging to prevent diseases (Matlack et al., 2023). These insects' adaptation to different temperatures extends the spread of Zika and studies conducted by Semenza et al. (2022) and Ryan et al. (2019) mention observable differences in vector behavior.

4.2 Research Findings and Conclusion

The research results explain that environmental, social, and climate changes are causing increased risks of vector-borne diseases as the planet warms. Research shows that dengue, Zika, and malaria outbreaks tend to increase with El Niño-related temperature changes and weather, mainly because these events promote mosquito growth and pathogen transfer. Global warming has made the climate warm, and high temperatures in East Africa and Europe have spread vectors to new locations and passed along diseases such as malaria and West Nile. Urbanization provides many breeding spots for mosquitoes in cities; thus, dengue increases during hot climates. Thanks to social factors such as poverty and migration, VBD burdens increase, making it harder to protect those who are vulnerable. The behavior of vectors adjusts, allowing diseases such as Zika to spur more during the year, making it harder to control.

Strategies that adjust over time are necessary to control these risks. We can predict outbreaks and take timely preventative actions using systems that measure temperature and rainfall. Global networks are needed to watch for changes in the range of vectors in different parts of the world. One meaningful way to prevent VBD in cities is for urban planning to address vector control, including cleaning up water and waste collection areas. When people in marginalized belongings get fair health services and educational opportunities, social determinants that place them at higher risk can be addressed. Enhancing mosquito control, such as with gene technologies, supports efforts to reduce adaptation. The research findings elaborate on the dangers and adaptable strategies for controlling VBDs, which is crucial as the world grows. Public health can deal with novel risks by combining top technology in surveillance, international teamwork, prepared urban environments, socially just practices, and advanced techniques. The results elaborate that human and ecological aspects are tied, pushing policymakers and researchers to work together to help safeguard the world from rising VBDs because of climate change and environmental imbalances across various economies.

4.3 Theoretical contribution of research

The research used the theoretical understanding by developing an interdisciplinary framework that integrates climate change, social determinants, and ecological adaptations to evaluate the concepts and dimensions of VBD in various economies. The researcher adapted the theoretical framework of social-ecological model (SEM) to evaluate findings of study. It extends ecological theory by demonstrating how climate shifts disrupt vector-host-pathogen interactions, creating novel transmission pathways. The study enriches social-ecological systems theory

by illustrating how social inequities, such as poverty and migration, interact with environmental changes to amplify VBD risks, emphasizing feedback loops between human and ecological systems. It also refines epidemiological models by incorporating vector behavioral adaptations as a dynamic variable, challenging traditional static assumptions about disease transmission. By synthesizing climatic, social, and ecological dimensions, the research proposes a comprehensive model that predicts VBD emergence in a warming world. This framework highlights the interplay of global and local factors, offering a robust theoretical lens for understanding VBD trends. It contributes to public health theory by framing VBDs as a socio-environmental phenomenon, urging scholars to prioritize adaptive, systems-based approaches over conventional control strategies, thus advancing the study of climate-driven infectious diseases.

4.4 Practical implications of research

The research provides actionable insights for public health and urban planning. Climate-informed surveillance systems, using real-time climate data, enable early outbreak detection, allowing rapid response to VBD threats. Urban planners can design cities with effective drainage and waste management to eliminate mosquito breeding sites, reducing diseases like dengue. Public health campaigns should target low-literacy communities, promoting behaviors like using bed nets to enhance prevention. Policymakers can address social inequities by improving healthcare access for marginalized groups, mitigating their vulnerability to VBDs. The researcher applied the model to analyze the Vector Borne such as genetically modified mosquitoes or targeted pesticides, counters climate-driven adaptations, protecting communities and advance the health care sector. These practical measures empower governments, health organizations, and communities to build resilience against VBDs in a warming world, ensuring sustainable health outcomes through proactive, evidence-based interventions.

4.5 Research recommendations and areas of further study

The study evaluated the adaptive strategies by assessing the risk factors like urbanization, rainfalls, water storage, humidity, increasing population, diversity in cultures, and drainage systems, essentially increasing vector-borne insects and patients with VBD diseases. The management, healthcare sector, and Government should focus on Climate-informed surveillance systems. The management and healthcare sector evaluate social interventions to reduce inequities and test innovative vector control technologies. Investigating urban design's impact on vector reduction and exploring behavioral adaptations in vectors will strengthen adaptive strategies and increase the robust response system to enhance the health care systems and directive for an adaptive strategy for reducing risks. The core recommendations based on the study are explained below;

- Management and policymakers should develop advanced Climate-Sensitive Surveillance Systems and create real-time monitoring platforms integrating temperature, rainfall, and humidity data to predict VBD outbreaks accurately. This would enable proactive interventions in regions like Asia and African economies with high rates of VBD diseases.
- The research explored promoting Equitable Public Health policy, expanding healthcare access, and launching education campaigns in vulnerable communities to address social determinants, reduce inequality, increase income, and ensure that people from different backgrounds have the same facilities in hospitals.
- The management is concerned with enhancing urban planning for Vector Control: Implement city designs with improved drainage, waste management, and green spaces to eliminate mosquito breeding sites and reduce the chances of the spread of VBD diseases.
- Governments and policymakers in economies like Asia, Africa, and Southern Europe should invest in Innovative Vector Control Technologies to control transmission and its spread.

- Policymakers should establish global vector monitoring networks to build international systems to track vector range shifts and disease emergence with control in timely decisions.
- These are a few recommendations provided to review the comprehensive roadmap for researchers and policymakers to address the complex drivers of VBDs, fostering adaptive strategies to mitigate new risks and protect the environment from warming.

References

Abbasi, E. (2025). Climate Change and Vector-Borne Disease Transmission: The Role of Insect Behavioral and Physiological Adaptations. *Integrative Organismal Biology*, obaf011.

Abdulwahab, A. A., Adebisi, Y. A., Adeniyi, A. M., Olawehinmi, T., & Olanrewaju, O. F. (2024). Climate Change, Vector-Borne Diseases, and Conflict: Intersecting Challenges in Vulnerable States. *J Infect Dis Epidemiol*, *10*, 326.

Adepoju, O. A., Afinowi, O. A., Tauheed, A. M., Danazumi, A. U., Dibba, L. B., Balogun, J. B., ... & Balogun, E. O. (2023). Multisectoral perspectives on global warming and vector-borne diseases: a focus on Southern Europe. *Current Tropical Medicine Reports*, *10*(2), 47-70.

Alqassim, A. Y. (2024). Social, behavioral and environmental determinants of vector-borne diseases: A narrative review of evidence and implications for integrated control approaches. *Journal of Vector Borne Diseases*, *61*(4), 525-535.

Balthazard-Accou, K., Millien, M. F., Michel, D., Jean, G., Telcy, D., & Emmanuel, E. (2021). Vector-Borne diseases and climate change in the environmental context in Haiti.

Bardosh, K. L., Ryan, S. J., Ebi, K., Welburn, S., & Singer, B. (2017). Addressing vulnerability, building resilience: community-based adaptation to vector-borne diseases in the context of global change. Infectious diseases of poverty, 6, 1-21.

Caminade, C., McIntyre, K. M., & Jones, A. E. (2019). Impact of recent and future climate change on vector-borne diseases. Annals of the New York Academy of Sciences, 1436(1), 157-173.

Creswell, J. W., & Hirose, M. (2019). Mixed methods and survey research in family medicine and community health. Family medicine and community health, 7(2).

de Souza, W. M., & Weaver, S. C. (2024). Effects of climate change and human activities on vector-borne diseases. Nature Reviews Microbiology, 22(8), 476-491.

Escobar, L.E., Romero-Alvarez, D., Leon, R., Lepe-Lopez, M.A., Craft, M.E., Borbor-Cordova, M.J. and Escobar, L. E., Romero-Alvarez, D., Leon, R., Lepe-Lopez, M. A., Craft, M. E., Borbor-Cordova, M. J., & Svenning, J. C. (2016). Declining prevalence of disease vectors under climate change. Scientific Reports, 6(1), 39150.

Ferraguti, M., Magallanes, S., Suarez-Rubio, M., Bates, P. J., Marzal, A., & Renner, S. C. (2023). Does land-use and land cover affect vector-borne diseases? A systematic review and meta-analysis. *Landscape Ecology*, *38*(10), 2433-2451.

George, A. M., Ansumana, R., de Souza, D. K., Niyas, V. K. M., Zumla, A., & Bockarie, M. J. (2024). Climate change and the rising incidence of vector-borne diseases globally. International journal of infectious diseases, 139, 143-145.

Gizaw, Z., Salubi, E., Pietroniro, A., & Schuster-Wallace, C. J. (2024). Impacts of climate change on water-related mosquito-borne diseases in temperate regions: A systematic review of literature and meta-analysis. *Acta Tropica*, 107324.

Jibon, M. J. N., Ruku, S. R. P., Islam, A. R. M. T., Khan, M. N., Mallick, J., Bari, A. M., & Senapathi, V. (2024).

Impact of climate change on vector-borne diseases: Exploring hotspots, recent trends and future outlooks in Bangladesh. Acta Tropica, 259, 107373.

Khan, A., Yasin, M., Aqueel, M. A., Farooqi, M. A., Akram, M. I., Yousuf, H. M. B., ... & Maqsood, A. (2023). Vector-borne disease and climate change. In *Arthropods-New Advances and Perspectives*. IntechOpen.

Krishnasastry, S. (2024). Climate Change and Its Impact on Vector-Borne Diseases. *Kerala Medical Journal*, *17*(2), 75-78.

Ma, J., Guo, Y., Gao, J., Tang, H., Xu, K., Liu, Q., & Xu, L. (2022). Climate change drives the transmission and spread of vector-borne diseases: an ecological perspective. Biology, 11(11), 1628.

Macura, B., Suškevičs, M., Garside, R., Hannes, K., Rees, R., & Rodela, R. (2019). Systematic reviews of qualitative evidence for environmental policy and management: an overview of different methodological options. *Environmental Evidence*, *8*, 1-11.

Marina, R., Ariati, J., Anwar, A., Astuti, E. P., & Dhewantara, P. W. (2023). Climate and vector-borne diseases in Indonesia: a systematic literature review and critical appraisal of evidence. *International Journal of Biometeorology*, *67*(1), 1-28.

Mengist, W., Soromessa, T., & Legese, G. (2020). Method for conducting systematic literature review and meta-analysis for environmental science research. *MethodsX*, *7*, 100777.

Messina, S., De Falco, D., & Petruzzi, M. (2025). Oral Manifestations in Paraneoplastic Syndromes: A Systematic Review and Meta-Analysis. Oral Diseases, 31(1), 81-88.

Paz, S. (2024). Climate change: a driver of increasing vector-borne disease transmission in non-endemic areas. PLoS Medicine, 21(4), e1004382.

Proudfoot, K. (2023). Inductive/deductive hybrid thematic analysis in mixed methods research. Journal of mixed methods research, 17(3), 308-326.

Rocklöv, J., & Dubrow, R. (2020). Climate change: an enduring challenge for vector-borne disease prevention and control. Nature immunology, 21(5), 479-483.

Ryan, S. J. (2020). Mapping thermal physiology of vector-borne diseases in a changing climate: shifts in geographic and demographic risk of suitability. Current environmental health reports, 7, 415-423.

Saunders, M. N., & Darabi, F. (2024). Using multi-and mixed methods research designs. In Field Guide to Researching Employment and Industrial Relations (pp. 71-87). Edward Elgar Publishing.

Semenza, J. C., Rocklöv, J., & Ebi, K. L. (2022). Climate change and cascading risks from infectious disease. Infectious diseases and therapy, 11(4), 1371-1390.

Thomson, M. C., & Stanberry, L. R. (2022). Climate change and vectorborne diseases. New England Journal of Medicine, 387(21), 1969-1978.

Tohit, N. F. M., Aidid, E. M., & Haque, M. (2024). Climate Change and Vector-Borne Diseases: A Scoping Review on the Ecological and Public Health Impacts. Bangladesh Journal of Medical Science, 23(4), 915-933.

Van Wijk, M., Naing, S., Diaz Franchy, S., Heslop, R. T., Novoa Lozano, I., Vila, J., & Ballesté-Delpierre, C. (2020). Perception and knowledge of the effect of climate change on infectious diseases within the general public: A multinational cross-sectional survey-based study. *PloS one*, *15*(11), e0241579.

Wilcox, B. A., Echaubard, P., de Garine-Wichatitsky, M., & Ramirez, B. (2019). Vector-borne disease and climate change adaptation in African dryland social-ecological systems. Infectious diseases of poverty, 8, 1-12.

World Health Organization (WHO), (2024), Information sourced from the US Centers for Disease Control and

Prevention, World Health Organization to be neglected tropical diseases, https://www.who.Int/neglected_diseases/diseases/summary/en, (Accessed May 12th, 2025).

Zain, A., Sadarangani, S. P., Shek, L. P. C., & Vasoo, S. (2024). Climate change and its impact on infectious diseases in Asia. Singapore medical journal, 65(4), 211-219.

Zhang, Y., Wang, M., Huang, M., & Zhao, J. (2024). Innovative strategies and challenges mosquito-borne disease control amidst climate change. *Frontiers in Microbiology*, *15*, 1488106.

Zhou, Y., Zhou, Y., & Machtmes, K. (2024). Mixed methods integration strategies used in education: A systematic review. Methodological Innovations, 17(1), 41-49

Appendix A

Table 1: Literature Framework Table

Authors and Year	Study Design	Variables and Constructs	Findings	Core Theme
Caminade et al., (2019)	Systematic review	Warming, Temperature, rainfall, VBD transmission (Zika, dengue, malaria)	Climatic conditions in 2017 and afterwards enhanced Zika transmission in Latin America, with models showing optimal mosquito-borne transmission risks.	Climatic drivers amplify VBD outbreaks
Matlack et al., (2023)	Scoping review	Climate literacy, health literacy and sPublic awareness of VBD risks	Few studies focus on climate-VBD literacy, with gaps in low-income regions and limited public understanding of climate-driven VBD risks.	Public literacy gaps in VBD-climate nexus
Jibon et al., (2024)	Systematic review (PRISMA)	Temperature, rainfall, humidity and VBD incidence (dengue, malaria)	Dengue research dominates in Bangladesh, with climate change increasing VBD hotspots, but studies lack microclimatic data.	Climate-driven VBD resurgence
Paz et al., (2024)	Perspective review	Temperature, heat waves; VBD geographic expansion (malaria, West Nile)	Warming temperatures have expanded malaria and West Nile virus to non-endemic areas like Africa and Europe.	Geographic expansion of VBDs
de Souza & Weaver (2024)	Narrative review	Temperature, rainfall, land use, human mobility; Vector distribution, VBD transmission	Climate change, combined with land use and mobility, redistributes vectors, increasing VBD risks in tropical and subtropical areas.	Multifaceted drivers of VBD spread
Ryan et al., (2019)	Modeling study	Temperature, precipitation; Mosquito population dynamics, VBD risk	Global warming enhances mosquito survival and VBD transmission, particularly for dengue and malaria.	Temperature impacts vector survival
Tohit et al., (2021).	Projection modeling	Climate scenarios, urbanization; Dengue incidence	Climate change and urban growth could increase dengue cases by 60% by 2080 under high-emission scenarios.	Urbanization amplifies VBD risks
Messina et al., (2023)	Systematic review	Social determinants (poverty, migration); VBD prevalence	Social inequities like poverty and migration exacerbate VBD spread in climate-vulnerable regions.	Social determinants worsen VBD burden
Rocklöv & Dubrow (2020)	Narrative review	Climate change, extreme weather; Infectious disease patterns	Climate shifts alter VBD epidemiology, increasing transmission seasons and intensity.	Climate alters disease epidemiology
Semenza et al. (2022)	Mixed-methods review	Temperature, humidity; Vector behavior, pathogen transmission	Vectors adapt behaviorally to warmer climates, extending transmission periods for diseases like Zika.	Vector adaptations to climate