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Differential Impacts of Extreme Weather Events on Vector-Borne Disease Transmission Across Urban and Rural Settings: A Scoping Review Protocol

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ADMINISTRATIVE INFORMATION

Support - No external funding.

Review Stage at time of this submission - Study completed but protocol being registered retrospectively.

Conflicts of interest - None declared.

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 1 August 2025 and was last updated on 1 August 2025.

INTRODUCTION

Review question / Objective Primary question using PCC framework: What is known about how extreme weather events differentially affect vector-borne disease transmission dynamics in urban versus rural settings, and what evidence exists for adaptation strategies in each context? Population: Human populations in urban, rural, and peri-urban settings exposed to vector-borne diseases. Concept: Extreme weather events (floods, droughts, heatwaves, storms) and their impacts on vector-borne disease transmission including malaria, dengue, chikungunya, Zika, and leishmaniasis. Context: Global settings with emphasis on low- and middle-income countries where vector-borne disease burden is highest. Secondary questions address mechanistic pathways, adaptation strategies, and knowledge gaps limiting understanding of urban-rural differences in climate-driven disease transmission.

Background Climate change has intensified extreme weather events globally, directly influencing vector-borne disease transmission through altered temperature, precipitation, and humidity patterns affecting vector survival and pathogen development. Vector-borne diseases represent over 17% of infectious diseases globally, causing more than 700,000 annual deaths. These diseases are climate-sensitive due to dependence on arthropod vectors whose ecology is closely tied to environmental conditions. Rapid urbanization has concentrated over half the world's population in urban areas, creating distinct climate vulnerabilities across settlement types. Urban environments face amplified climate risks through heat island effects while rural populations experience greater baseline vulnerability due to climate-dependent livelihoods and limited adaptive capacity. Temperature extremes alter vector development rates and pathogen replication, while precipitation variability creates dynamic breeding conditions. Despite extensive research, comparative evidence examining differential

impacts across urban versus rural settings remains critically limited.

Rationale Most existing studies focus on single contexts without systematic comparison of transmission dynamics or intervention effectiveness between settlement types. This evidence gap limits development of context-specific frameworks and targeted interventions accounting for distinct exposure patterns across settlement types. Urban areas demonstrate infrastructure-mediated transmission through drainage failures and heat islands, while rural settings exhibit ecosystem-mediated pathways involving diverse vector communities and agricultural factors. Understanding these differential mechanisms is essential for developing early warning systems and targeted interventions. Comprehensive evidence synthesis is critical to inform climate adaptation planning, resource allocation, and development of settlement-specific prevention strategies. This scoping review addresses heterogeneous climate-vector-borne disease evidence by accommodating varied study designs and outcomes across diverse contexts to map knowledge clusters and research gaps.

METHODS

Strategy of data synthesis Comprehensive searches conducted across PubMed, EMBASE, Web of Science, and Scopus using iteratively developed terms combining controlled vocabulary (MeSH terms, EMTREE) and free-text terms. Search terms include: climate change, extreme weather, temperature, precipitation, floods, droughts, heatwaves, storms, vector-borne diseases, malaria, dengue, chikungunya, Zika, leishmaniasis, urban, rural, peri-urban, transmission, epidemiology, adaptation, and prevention. Boolean operators (AND, OR) used to combine terms. Temporal scope: 2000-2025. Language: English only. Database-specific search strategies developed with assistance from information specialists. Citation management using EndNote 21. Reference lists of included studies reviewed for additional sources. Grey literature searched through organizational websites and reports. Complete search strategies documented in supplementary materials.

Eligibility criteria Types of participants: Human populations in urban, rural, or peri-urban settings exposed to vector-borne disease transmission risks during extreme weather events. No restrictions on age, gender, or socioeconomic status. Concept: Studies examining relationships between climate variables (extreme weather events including floods, droughts, heatwaves, storms, compound events) and vector-borne disease dynamics (malaria, dengue, chikungunya, Zika, leishmaniasis, others). Must include data on disease incidence, vector abundance, transmission dynamics, or climate-disease associations. Context: Global settings with preference for comparative analysis across settlement types. Inclusion criteria: Peer-reviewed articles, grey literature, and reports providing empirical data from urban, rural, or peri-urban settings. Exclusion criteria: Studies focusing solely on endemic transmission without extreme weather context, lacking clear urban-rural distinction, addressing only theoretical modeling without empirical data, or not published in English.

Source of evidence screening and selection Single reviewer (author) will conduct all screening stages due to resource constraints. Two-stage screening process: (1) Title and abstract screening using predefined inclusion/exclusion criteria, (2) Full-text review of potentially eligible studies. Screening decisions documented with reasons for exclusion. EndNote 21 used for citation management and duplicate removal. Standardized screening forms developed and pilot-tested. When eligibility unclear, studies included for full-text review. Inter-rater reliability not applicable due to single reviewer. Quality assessment using Newcastle-Ottawa Scale adapted for observational studies to evaluate study design, exposure measurement, outcome assessment, and potential confounding. Disagreement resolution not applicable for single-reviewer design.

Data management Standardized data extraction form developed and pilot-tested on 5 included studies. Variables extracted include: bibliographic details, study characteristics (design, setting, population), extreme weather event types, vector-borne disease outcomes, urban-rural comparisons, mechanistic pathways, adaptation strategies, and quality assessment scores. Single extraction by author with iterative form refinement. EndNote 21 used for reference management. Data stored in secure, password-protected files with regular backups.

Reporting results / Analysis of the evidence Narrative synthesis approach due to anticipated methodological heterogeneity. Data organized by settlement type (urban vs rural), extreme weather event category, and vector-borne disease type. Thematic analysis of transmission mechanisms and adaptation strategies. Structured narrative synthesis with explicit discussion of contextual variations. Quantitative summary of study

characteristics including geographic distribution, disease types, and methodological approaches.

Presentation of the results Results will be presented through: (1) PRISMA-ScR flow diagram showing study selection process, (2) Descriptive tables summarizing study characteristics, climate exposures, and outcomes by settlement type, (3) Conceptual framework illustrating differential climate-VBD transmission pathways across urban-rural gradients, (4) Narrative synthesis organized by urban-specific and rural-specific transmission dynamics, (5) Comparative analysis highlighting key differences in vulnerability patterns and adaptation strategies, (6) Evidence gap mapping identifying research priorities and geographic inequities in evidence generation. Visual presentations will include tables, figures, and conceptual models to illustrate complex climate-health relationships across settlement types.

Language restriction English language only.

Country(ies) involved Saudi Arabia.

Other relevant information This protocol follows PRISMA-ScR guidelines for scoping reviews. Study addresses critical knowledge gaps in climate-health research with implications for policy and practice.

Keywords climate change; vector-borne diseases; urban health; rural health; extreme weather; scoping review.

Dissemination plans Results will be disseminated through: peer-reviewed journal publication in climate-health or public health journal, presentation at international climate-health conferences, policy brief development for public health practitioners and climate adaptation planners, and engagement with relevant organizations working on climate adaptation and vector-borne disease prevention. Findings will inform evidence-based climate adaptation planning and resource allocation strategies.

Contributions of each author

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