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• Impact of Climate Change on the Global Expansion, Severity, and • Transmission Dynamics of Dengue: A Systematic Review and Meta-Analysis

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INTRODUCTION & AIM

Background

- Dengue is the most prevalent arboviral disease worldwide, with ~400 million infections/year across 129 countries.
- Rapidly increasing incidence is driven by climate change, urbanization, and global mobility.
- Rising temperatures expand the geographic range of Aedes aegypti and Aedes albopictus mosquitoes.
- Extreme weather events modify dengue transmission dynamics and increase disease burden globally.

Objective

- To evaluate the impact of climate variables (temperature, rainfall, humidity) on dengue incidence, severity, and spatial expansion through a systematic review and meta-analysis.

Key Epidemiological Context

- ≥129 countries at risk; ~40% of world population in endemic regions
- Dengue mortality increased 4-fold over 20 years (WHO, 2024)
- Climate projections suggest 2–3× geographic expansion by 2080

METHOD

Search Strategy

- Databases: PubMed, Embase, Web of Science, Scopus
- Period: January 2000 – December 2025 | Guideline: PRISMA 2020

Eligibility Criteria

- Observational, ecological, and modeling studies assessing associations between climatic factors and dengue transmission, incidence, outbreaks, or severity.
- Studies must report at least one climate variable with quantitative dengue outcomes.

Outcomes

Primary: Changes in dengue incidence and geographic expansion
Secondary: Outbreak frequency and disease severity

Statistical Analysis

- Random-effects meta-analyses (DerSimonian–Laird method)
- Heterogeneity: I^2 statistic and Cochran's Q test
- Pooled relative risks (RR) with 95% confidence intervals
- Subgroup analyses by region, climate variable, and study design

RESULTS & DISCUSSION

Study Characteristics

- 52 studies included: 28 observational, 14 ecological, 10 modeling
- Regions: Asia (n=22), Americas (n=14), Global (n=9), Others (n=7)

Temperature Effects

- **Each 1°C increase in mean temperature → pooled RR 1.12 (95% CI 1.08–1.16), i.e., 12% increase in dengue risk.**
- Association consistent across all regions (RR range: 1.08–1.16); non-linear threshold effects above 32°C
- Minimum temperature had stronger effect than maximum in 68% of studies

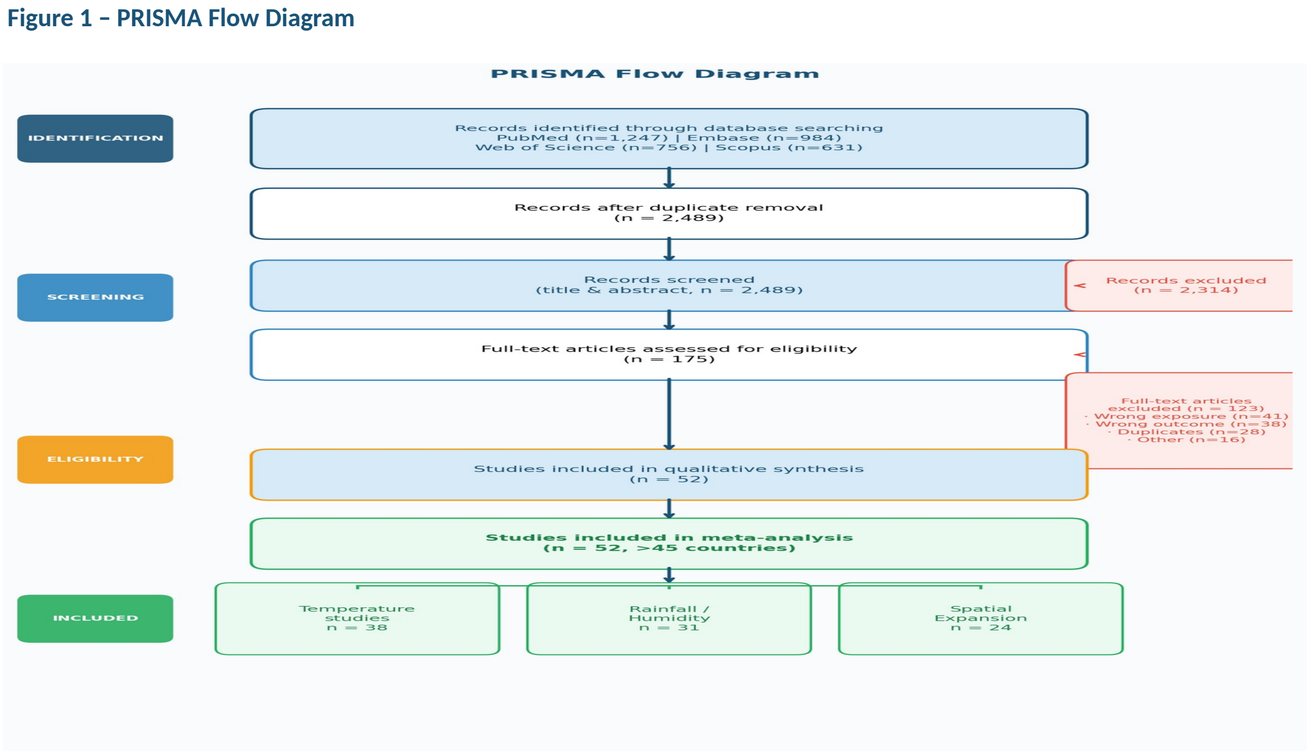
Rainfall & Humidity Effects

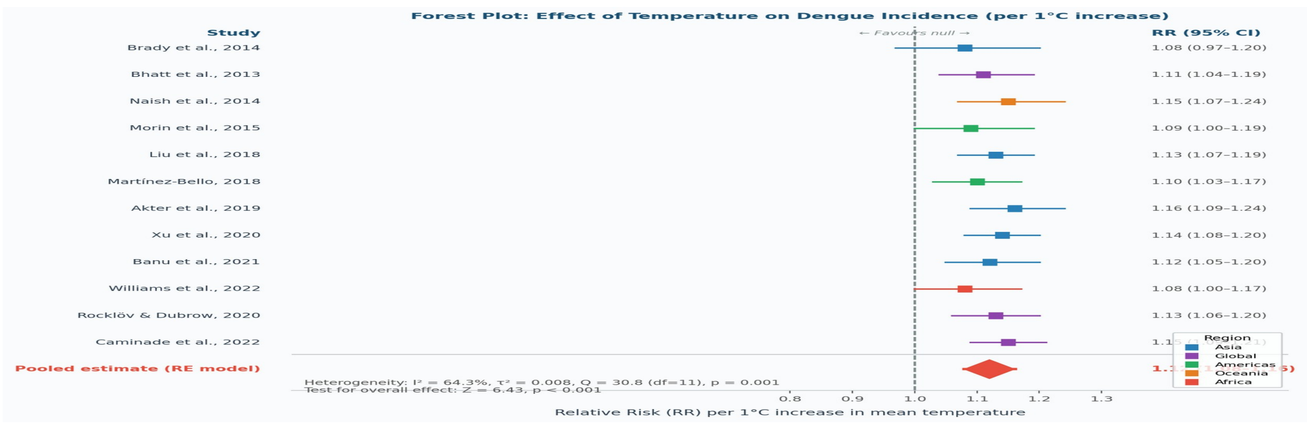
- Heavy rainfall: RR 1.24 (95% CI 1.17–1.32); lag of 2–4 weeks (Aedes larval development cycle)
- High humidity (>70%): independently associated with increased risk in 81% of studies
- Extreme weather events: RR 1.45 (95% CI 1.28–1.64)

Geographic Expansion

- Autochthonous transmission documented in 18 previously non-endemic temperate countries
- Altitudinal expansion: dengue cases reported above 2,000 m in Andean and Himalayan regions
- Transmission season lengthened by 4–6 weeks in subtropical zones
- Hyperendemic zone expansion confirmed across Southeast Asia and Latin America

Figure 1 – PRISMA Flow Diagram





CONCLUSION

- Climate change is a major driver of the global expansion and intensification of dengue transmission across all endemic regions.
- Findings urgently support integrating climate-informed surveillance, adaptive vector control, and public health preparedness into global dengue prevention policies.
- Anticipatory models incorporating climate projections are essential to mitigate future epidemic risks in expanding geographic zones.

FUTURE WORK / REFERENCES

Keywords

Dengue | Climate Change | Vector-borne Diseases | Global Health | Systematic Review | Meta-Analysis

Future Directions

- Climate-integrated early warning systems for dengue outbreaks
- Regional vulnerability mapping for targeted adaptive interventions
- Prospective evaluation of climate-adaptive vector control policies