

A Spatio-Temporal Typology of Infectious Disease Outbreaks in India (2009–2025): Reg ID: 10

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ABSTRACT

Background: India's diverse ecology drives a complex infectious disease burden, creating distinct regional outbreak patterns. Understanding these zone-specific patterns is therefore critical for effective disease control and prevention. This study analyzes the spatio-temporal patterns of outbreaks across India's biogeographic zones, classifying them to identify national trends, pinpoint hotspots for novel threats, and establish regional risk profiles for targeted public health strategies. **Methodology:** Weekly Integrated Disease Surveillance Programme (IDSP) outbreak reports (2009–2025) were analyzed. Districts were assigned to biogeographic zones and outbreaks were categorized by transmission mode and emergence status. Spatio-temporal patterns were evaluated using time-series and crosstab analyses in SPSS for spatial concentration, seasonality, and long-term trends. **Results:** Two dominant, contrasting epidemiological patterns were revealed. Environmentally-mediated diseases (water/vector-borne) concentrated in the Deccan Peninsula and Western Ghats, peaking during the Southwest Monsoon (June–Nov). In contrast, person-to-person diseases concentrated in the densely populated Gangetic Plains, peaking during winter-spring (Jan–Mar). The Western Ghats was a primary hotspot for emerging diseases, while re-emerging diseases showed geographic expansion into frontiers like the Himalayas. A universal reporting dip occurred during the COVID-19 pandemic (2020–2021), followed by a strong resurgence. **Conclusion:** Environmental transmission peaking with the monsoon in peninsular India contrasts sharply with winter peaks for person-to-person transmission in the northern plains. The emergence and expansion of threats into new territories confirms that a monolithic national strategy is insufficient. Policy must prioritize regionally tailored interventions, including climate-resilient Water, Sanitation, and Hygiene (WASH), targeted vector control, and strengthened One-Health surveillance to mitigate this dynamic burden.

KEYWORDS