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Proactive, Risk-Based Thresholds for Dengue Early-Warning

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Dengue surveillance in many countries still relies on a simple outbreak rule: declare an alert when reported cases exceed the historical mean + 2 standard deviations. Although easy to apply, this cut-off does not adapt to changing transmission patterns, generates frequent false positives, and ignores forecast uncertainty. We develop and evaluate risk-based outbreak thresholds that incorporate both the probability of future cases and their potential magnitude. Monthly dengue counts from 114 districts in the Mekong Delta, Viet Nam (2012–2022) were modelled with an ensemble of probabilistic forecasts covering 1- to 3-month horizons. From each forecast distribution, we derived three decision metrics:
Absolute Risk Score –probability of exceeding a fixed case threshold multiplied by that threshold;Relative Risk Score –probability-weighted difference between the forecast and the historical mean Predicted Mean –forecast mean compared directly with the baseline threshold. We assessed the metrics, alone and in combination with the fixed rule, in a simulation study that triggered vector-control interventions and counted avoided cases. Integrating the three risk-based metrics with the conventional threshold reduced simulated annual dengue incidence by at least 16 % relative to reactive control, while lowering false-alert rates. Probabilistic, risk-weighted thresholds offer a transparent and reproducible alternative to fixed rules, enabling earlier and more targeted interventions. All code and processed data will be released to facilitate reuse in other settings and diseases.

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