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The influence of intra- and inter-annual meteorological variability on dengue transmission: a multi-level modeling analysis

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Dengue fever is one of potentially life-threatening mosquito-borne diseases and IPCC Fifth Assessment Report (AR5) has confirmed that dengue incidence is sensitive to the critical weather conditions, such as effects of temperature. However, previous literature focused on the effects of monthly or weekly average temperature or accumulative precipitation on dengue incidence. The influence of intra- and inter-annual meteorological variability on dengue outbreak is under investigated. The purpose of the study focuses on measuring the effect of the intra- and inter-annual variations of temperature and precipitation on dengue outbreaks. We developed the indices of intra-annual temperature variability are maximum continuity, intermittent, and accumulation of most suitable temperature (MST) for dengue vectors; and also the indices of intra-annual precipitation variability, including the measure of continuity of wetness or dryness during a pre-epidemic period; and rainfall intensity during an epidemic period. We used multi-level modeling to investigate the intra- and inter-annual meteorological variations on dengue outbreaks in southern Taiwan from 1998-2015. Our results indicate that accumulation and maximum continuity of MST are more significant than average temperature on dengue outbreaks. The effect of continuity of wetness during the pre-epidemic period is significantly more positive on promoting dengue outbreaks than the rainfall effect during the epidemic period. Meanwhile, extremely high or low rainfall density during an epidemic period do not promote the spread of dengue epidemics. Our study differentiates the effects of intra- and inter-annual meteorological variations on dengue outbreaks and also provides policy implications for further dengue control under the threats of climate change.

Keywords: dengue fever, meteorological variations, multi-level model