The effects of geographical distributions of buildings and roads on the spatiotemporal spread of canine rabies: An individual-based modeling study

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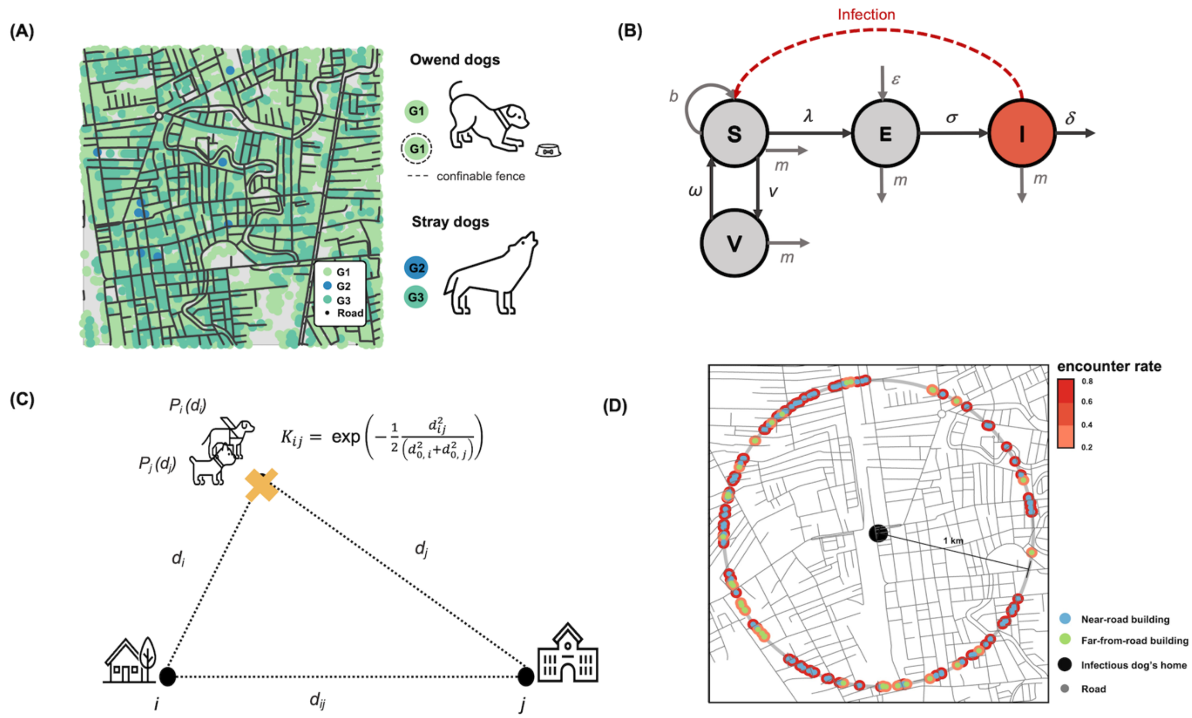
Rationale and objective: Although rabies is preventable by vaccination, the spread still occurs sporadically in many countries, including Thailand. As a directly transmitted disease, geographical distributions of buildings where dogs can live in, and road networks could inevitably influence the spatiotemporal spread of rabies. To investigate the role of these geographical structures on the transmission dynamics of canine rabies, we developed a stochastic individual-based model that integrates the exact geographical distributions of buildings and roads. The model was then applied to investigate rabies transmission in the low-risk and high-risk areas in Thailand.

Summary: Two contrasting areas with high- and low-risk of rabies transmission in Thailand, namely, Hatyai and Tepha districts, were chosen as study sites. Our modeling results indicated that the distinct geographical structures of buildings and roads in Hatyai and Tepha could contribute to the difference in the rabies transmission dynamics in these two areas. The high density of buildings and roads in Hatyai could facilitate more rabies transmission. We also investigated the impacts of rabies intervention, including reducing the dog population, restricting owned dog movement, and dog vaccination on the spread of canine rabies in these two areas. We found that reducing the dog population alone might not be sufficient for preventing rabies transmission in the high-risk area. Owned dog confinement could reduce more the likelihood of rabies transmission. Finally, a higher vaccination coverage may be required for controlling rabies transmission in the high-risk area compared to the low-risk area.



Graphical summary: (A) Example of the geographical distribution of buildings and roads in an area of 2x2 km^2. (B) Schematic of the transmission model. Based on the infection status, the model classifies each dog into susceptible (S), exposed (E), infectious (I), and vaccinated (V) classes. (C) Illustration of the probability of finding a dog at distance *d* from their home location, *P* (*d*). (D) An illustrative example of the unnormalized encountering rate between a rabid dog residing at the centered black point and susceptible dogs living one kilometer apart. The blue and green dots on the map represent the home locations of susceptible dogs that are located near roads and far from roads, respectively. The unnormalized encountering rates are indicated by the colors of the dot circumferences.

Outcome: Understanding of rabies transmission in Thailand and assessment on the effectiveness of rabies control measures.

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Related SDGs goal: 3. Good health and well-being.

Related publications:

Sararat C, Changruenngam S, Chumkaeo A, Wiratsudakul A, Pan-Ngum W, Modchang C. The effects of geographical distributions of buildings and roads on the spatiotemporal spread of canine rabies: An individual-based modeling study. PLOS Neglected Tropical Diseases. 2022;16(5):e0010397.

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