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Modelling of canine rabies transmission and vaccination in five villages of Cambodia using agent-base models

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Background and objectives:
Rabies is endemic in Cambodia where the transmission chained is maintained in free-roaming owned dogs. Due to the current lack of national vaccination program, there is a need to inform authorities on the best strategies for implementation. Recent pilot vaccination campaigns have surveyed the canine population of several Cambodian villages and collected detailed demographic information. We aimed to model the impact of population turnover on vaccination coverage and the effectiveness of different levels of annual vaccination drives on rabies transmission using locally specific dog demography data.

Methods:
We used demographic and spatial data from pilot dog vaccination campaigns to parametrize and construct a spatially explicit agent-based model in five villages of Kandal Province, Cambodia. Infection parameters were sourced from the literature, with reported basic reproduction number (R0) values used to calibrate key transmission parameters, including probability and distance of infectious contact. Calibration was accomplished through 48,000 simulations testing a range of parameter values with a target R0 between 1 and 2. Another 75,000 simulations were used to test various vaccination coverage scenarios within this R0 range.

Results:
We observed a 40% reduction in vaccination coverage one year after vaccination. Annual vaccination with a target coverage of 70% maintained the average coverage over six years at 65% and reduced the mean R0 under one in every infection scenario. However, 8% of simulations led to outbreaks of 10 dogs or more in higher R0 scenarios. A target coverage of 90% reduced the number of outbreaks of 10 dogs or more to below 1% of simulations with the same scenarios.

Conclusion:
We provide evidence that dogs need to be vaccinated annually due to the impact of rapid population turnover, and that annual vaccination coverage should be at least 70% of the whole dog population to control rabies in this setting.