

# Terrestrial rabies incursions in the 21st century

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## INTRODUCTION

*Animal rabies incursions occur globally and can lead to outbreaks or even establish endemic circulation, thereby threatening progress towards elimination. This review aims to explore variation in identified incursions and subsequent responses around the world, to investigate how such occurrences can be reduced and their impacts mitigated when they occur.*

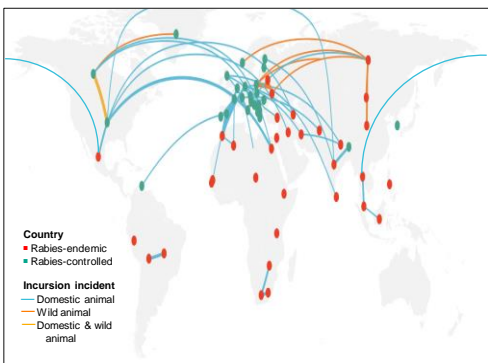
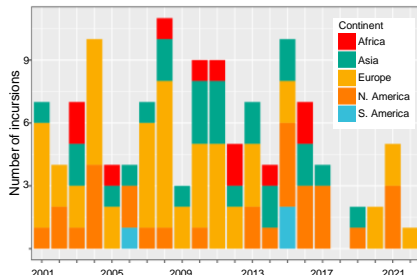
## METHODS

We compiled documented incursions from online research databases from 2001 to 2022, and examined host characteristics, incursion outcomes and public health responses (**Fig. 1**, below).



## RESULTS

We identified 160 studies describing 123 incursions; 54% resulted from human-mediated transportation, primarily rehoming dogs. Incursions were most frequently reported by the US. 57% originated from Africa (mostly Morocco and Egypt) or Asia (mostly Indonesia and India) (**Fig. 2** right, **Fig. 3** below).



Incursions were generally caused by: 1) insufficient control measures to interrupt rabies circulation in wild and domestic animals, 2) failure of border control measures to prevent rabid animal movement, and 3) weak surveillance enabling escalation of undetected local transmission into outbreaks. Outbreak escalation was often associated with insufficient dog or fox mass vaccination.

## CONCLUSION

Reported incursions underscore a critical need for rabies-endemic countries to improve surveillance and implement more comprehensive control. While responses vary between countries, in high-income countries, these have mostly been effective at averting outbreaks, but fail in low-income countries. We speculate this is because border control measures are poorly maintained and/or incursions are more frequent.