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2 **Title:** Potential Zika virus spread within and beyond India

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35 As of 28 October 2018, 147 cases of zika virus disease (ZVD) have been reported in
36 Jaipur, the capital of Rajasthan state, India¹. Subsequently, as of 2 November 2018, a single case
37 was reported in the neighbouring state of Gujarat and three additional cases were reported in the
38 state of Madhya Pradesh, demonstrating national spread of ZVD and marking the largest
39 reported outbreak of ZVD in Indian history¹. State health departments in India have mobilized
40 hundreds of medical personnel to perform emergency screenings for ZVD¹. As a major tourist
41 attraction for domestic and foreign visitors, the outbreak in Jaipur presents a high risk of Zika
42 virus exportation. To anticipate the potential spread of ZVD in the face of an ongoing outbreak
43 in Jaipur, we determined temporally-explicit air travel connectivity with Jaipur, and
44 corresponding seasonal environmental suitability for Zika virus transmission in domestic and
45 international destination cities.

46 We ranked destination cities based on their arriving volume of travellers on commercial
47 flights from Rajasthan for November, December, and January using passenger-level, full-route,
48 flight itinerary data from the International Air Transport Association (IATA) for the year 2017.
49 We delineated suitability for transmission of Zika virus in India and Southeast Asia using
50 distribution models of the virus's primary mosquito vector *Aedes aegypti* and secondary vector
51 *Aedes albopictus* limited by the well-characterized temperature thresholds for the genetically
52 similar dengue virus for November, December, and January². Each month, top ranking domestic
53 and international cities by connectivity were subsequently filtered to include only those cities
54 located within 200 km of areas suitable for Zika virus transmission.

55 Over this 3-month period 326 cities that were within 200 km of areas suitable for Zika
56 virus transmission received a total of 740,232 passengers from Rajasthan (summarized for
57 December in Figure 1). Of these passengers, approximately 94% travelled to cities within India
58 ($n = 696,753$). Mumbai received the most passengers (>24%), with Delhi, Bengaluru and
59 Kolkata ranking second, third, and fourth respectively across all three months. Bangkok, Muscat,
60 and Singapore were the only international cities ranked in the top twenty destinations.

61 Given the abundance of regions that are predicted to support Zika virus transmission and
62 have large populations with limited previous exposure, and thus limited immunity, to Zika virus,
63 Indian cities and countries with close international connections to Jaipur should prepare for
64 potential importations of Zika virus. Our results suggest a greater risk of domestic spread from
65 Jaipur within India in upcoming months but relatively lower potential for international
66 exportation and spread. Notably, the city of Chennai may be especially vulnerable given
67 relatively high connectivity to Rajasthan, a large urban population (> 7 million), and conditions
68 conducive to year-round transmission of Zika virus via *Ae. aegypti*. If not controlled, the ZVD

69 outbreak in Jaipur could have far-reaching consequences and public health and clinical personnel
70 in domestic and global areas connected to the current epidemic should remain vigilant for
71 possible importation of ZVD cases.

72

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77

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91 evidence of possible Zika virus infection during pregnancy. *JAMA*, *317*(1), 59-68.

92 **Figure Captions**

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94 Figure 1. Number of passengers arriving from Rajasthan state (highlighted in red) by air for
95 cities within 200 km of any Zika suitable area estimated for December. Proportion of total
96 outbound passengers from Rajasthan provided in parentheses. Case counts for Jaipur are reported
97 as of 2 November 2018¹.

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