

1 **Title:** International risk of SARS-CoV-2 Omicron variant importations originating in South
2 Africa

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21 Abstract

22 Omicron, a fast-spreading SARS-CoV-2 variant of concern reported to the World
23 Health Organization on November 24, 2021, has raised international alarm. We estimated
24 there is at least 50% chance that Omicron had been introduced by travelers from South Africa
25 into all of the 30 countries studied by November 27, 2021.

26 **Keywords:** Omicron, SARS-CoV-2 variant, spreading, importations

27 South Africa (SA) first detected the B.1.1.529 SARS-CoV-2 variant from a specimen
28 collected on November 9, 2021 and reported the variant to the World Health Organization
29 (WHO) on November 24, 2021 (1). Two days later, the WHO named the variant Omicron
30 and classified it as a Variant of Concern (VOC), because of increasing detections in South
31 Africa and large number of mutations in immunogenic regions of the spike protein (1). In
32 addition to increasing cases in South Africa, the new variant may have been prevalent in
33 other locations in southern Africa. By November 30, 2021, over 11 countries had reported
34 detections of the Omicron variant, with the first reports of international importations coming
35 from Hong Kong, Israel, Japan, and France (2). Three days later, it was reported in 29
36 additional countries (2). As of December 2, 2021, more than 50 countries had enacted border
37 controls to slow the global spread of Omicron (3). For example, Japan and Israel closed their
38 borders to all foreign travelers (4). The Omicron variant might have been spreading
39 cryptically in these and other countries before the WHO declaration, undetected because of
40 limited viral sequencing capacity.

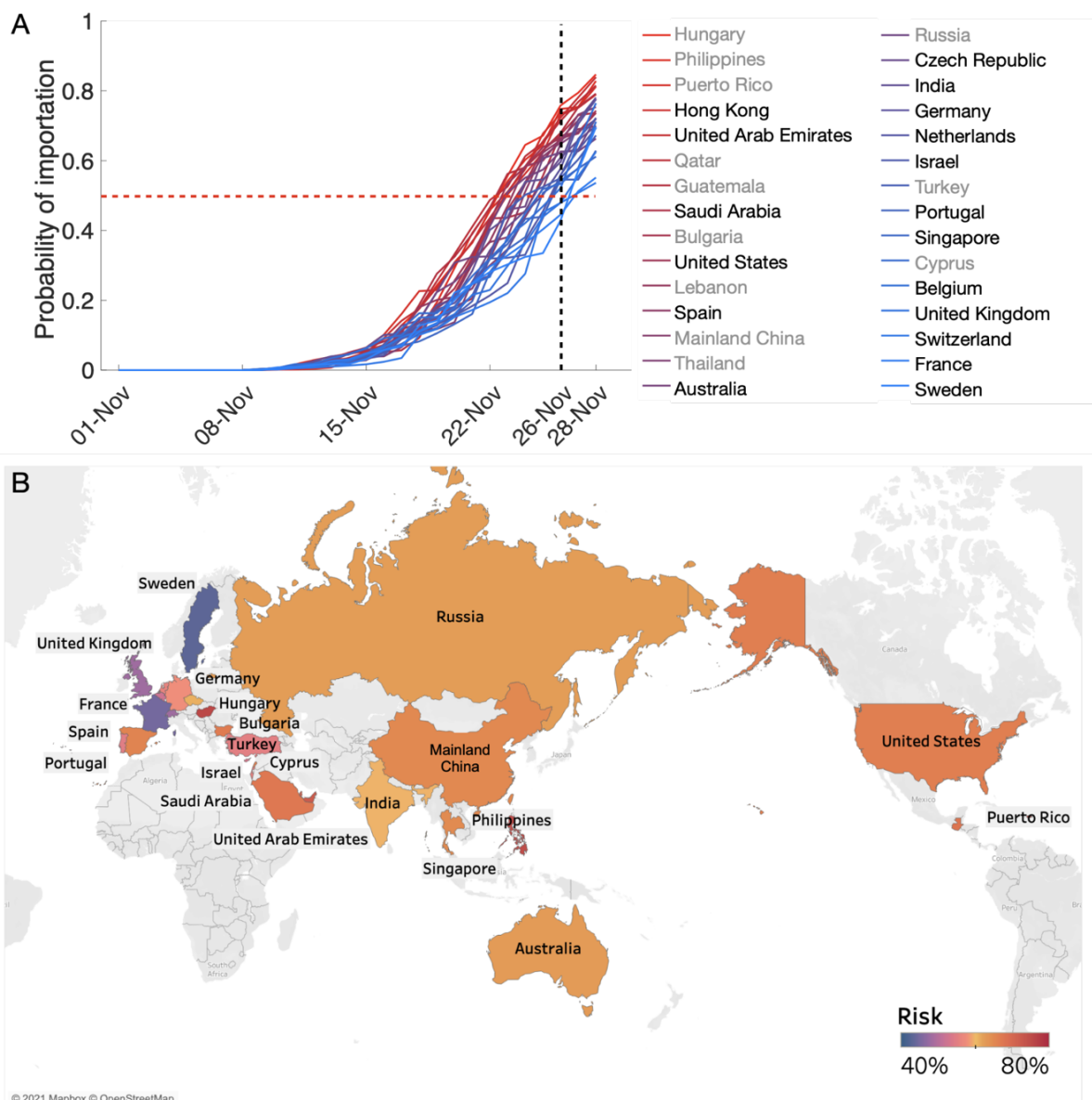
41 Since South Africa has strong travel links with the rest of the world and was known to
42 have early cases of the Omicron variant, we analyzed population mobility data from SA to 30
43 non-African countries with direct flights in the study period, available through Facebook
44 Data for Good and OpenSky (**Table S1**), as well as Omicron case report data from SA (2).

45 We estimated the probability that the Omicron variant was introduced into each country via
46 travelers from SA and the extent of local transmission prior to November 28, 2021 (detailed
47 in Appendix). Hungary has the highest expected importation risk between November 1 and
48 November 28, 2021, with a date of introduction of November 23 exceeding a 50% chance.
49 By the time Omicron was classified as a VOC (November 26), we estimated that 26 of the 30
50 non-African regions had over a 50% chance of having received at least one travel-based
51 importation from SA (**Figure 1**). The remaining four countries—United Kingdom (UK),
52 Switzerland, France, and Sweden—exceeded this risk threshold on November 27. By
53 December 3, 18 of the 30 regions had confirmed Omicron cases (2). If Omicron was also
54 prevalent in other countries in southern Africa the above estimates would be underestimates
55 of the probability of importation in other parts of the world.

56 Regions that receive a substantial number of travelers from South Africa were likely
57 to harbor cases of the Omicron variant by late November 2021. Although the UK has lower
58 estimated importation risks than many of the other regions considered, it has reported the
59 largest number of Omicron cases outside Africa, as of November 29 (2). This reflects the
60 UK's strong genomic surveillance program, which has contributed nearly 25% of all SARS-
61 CoV-2 sequences globally (5), and suggests that Omicron may be spreading undetected in
62 countries with similar or higher importation risks but perhaps less sequencing capacity.

63 Our estimates rest on several simplifying assumptions. The Facebook mobility data,
64 which included ~93 thousand trips from SA to the 30 non-African regions, reflects the
65 demographic makeup of the user base, with ~2.9 billion monthly active users in the third
66 quarter of 2021 (6). The Facebook data exclude date-destination combinations for which the
67 total number of travelers from SA is less than 1000. We fill in those missing data assuming a
68 constant ratio between the number of travelers and the number of available seats on flights,
69 which we estimate from a combination of the Facebook and OpenSky data (detailed in

70 Appendix). We assumed that all introductions during this early period occurred via pre-
71 symptomatic and asymptomatic travelers from SA and ignored possible importations from
72 other countries or by symptomatic cases. Thus, we may underestimate the risks. Furthermore,
73 we assumed a 10-day lag between infection and hospitalization based on estimates from the
74 United States (7) and Europe (8), under the assumption that the wildtype and Omicron
75 variants share the same natural history of infection and symptomatic proportion. Should
76 future studies reveal significant epidemiological differences between the Omicron variant and
77 the wildtype, then these estimates can be readily updated.



79 **Figure 1. Estimated risks of SARS-CoV-2 Omicron variant introductions from South**
80 **Africa to 30 non-African regions on or before November 28, 2021.** (A) The probability
81 that at least one person infected with the Omicron variant arrived in a given country from
82 South Africa by the date indicated on the x-axis, based on Facebook mobility and OpenSky
83 data. The black dashed vertical line indicates November 26, 2021, when the WHO classified
84 Omicron as a VOC (1); the red dashed horizontal line indicates an importation probability of
85 50%; line colors correspond to the relative risk of importations as of November 26. Regions
86 that confirmed Omicron cases by December 3, 2021 are listed in black (2). (B) Probability of
87 at least one Omicron variant importation from SA by November 28, 2021. Regions in grey
88 were not analyzed because mobility data were not available.

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