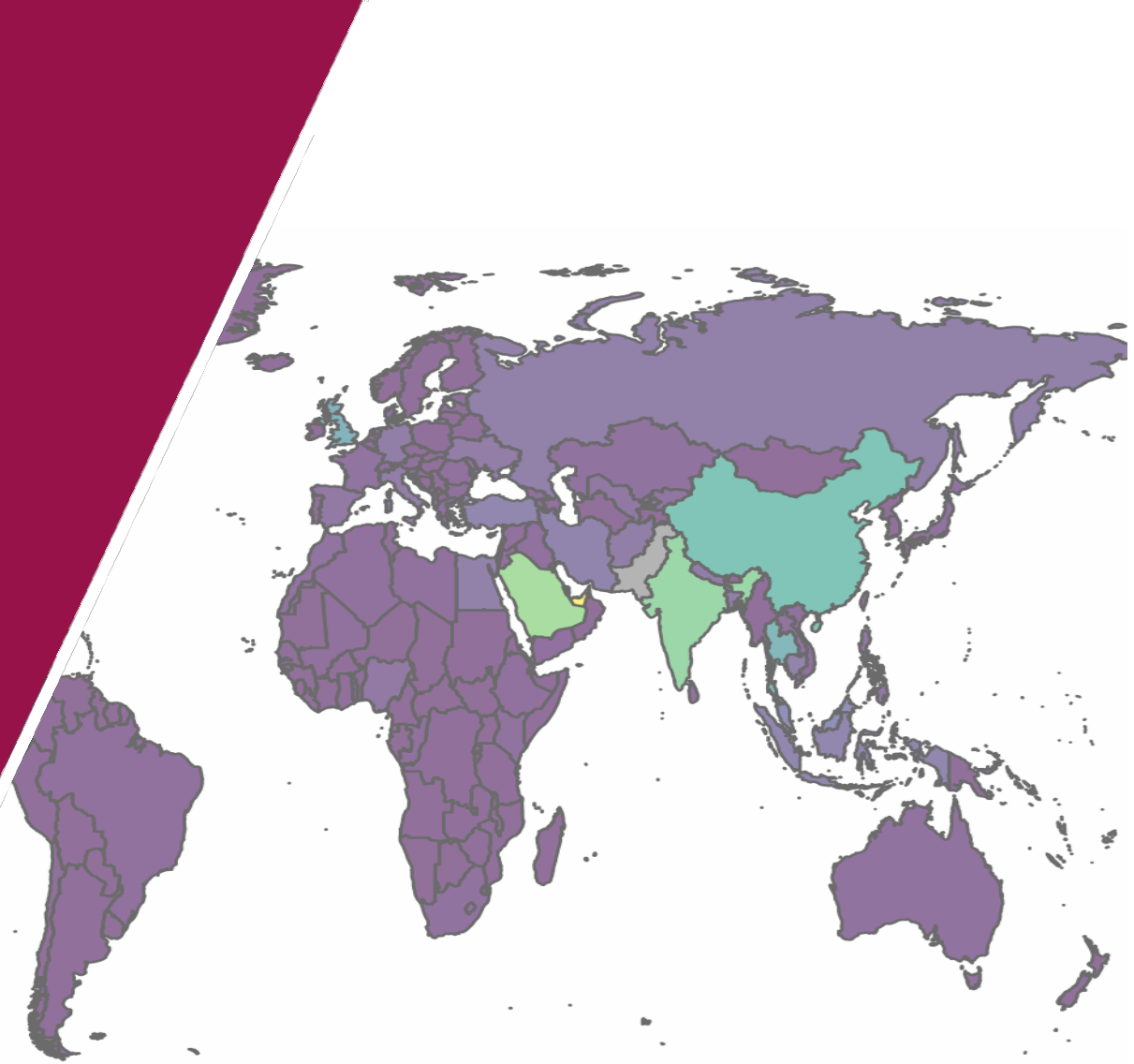
Assessing the Global Risk of Typhoid Outbreaks Caused by XDR Salmonella Typhi

Jo Walker
Yale School of Public Health

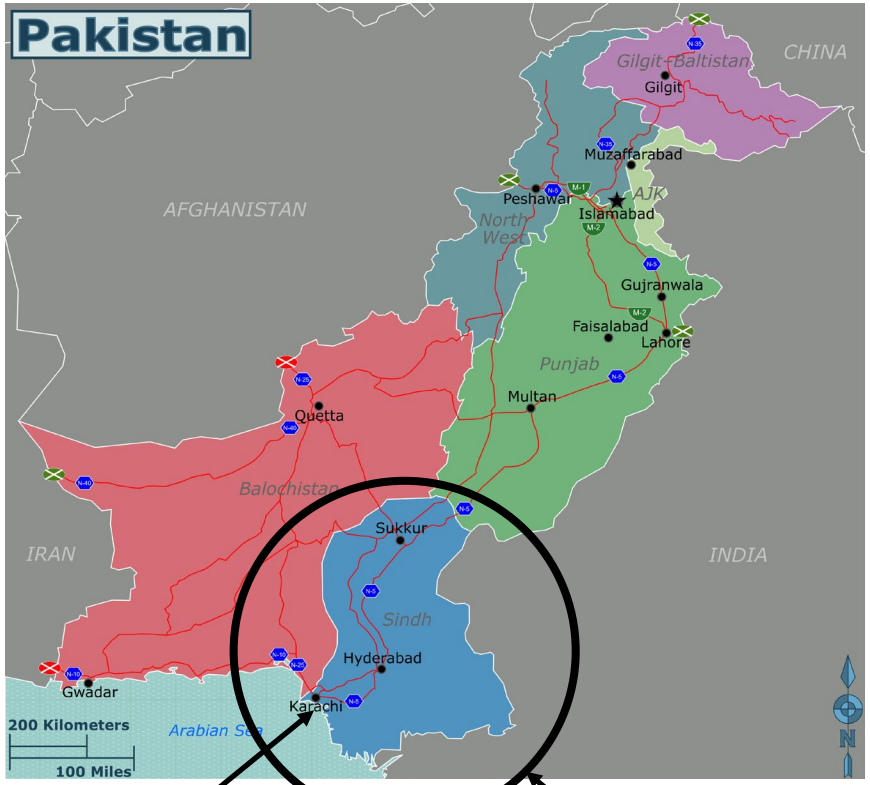


TyVAC Typhoid Vaccine Acceleration Consortium
CENTER FOR VACCINE DEVELOPMENT • OXFORD VACCINE GROUP • PATH

Photo: PATH/Asad Zaidi

Extensively Drug-Resistant (XDR) Typhoid Fever

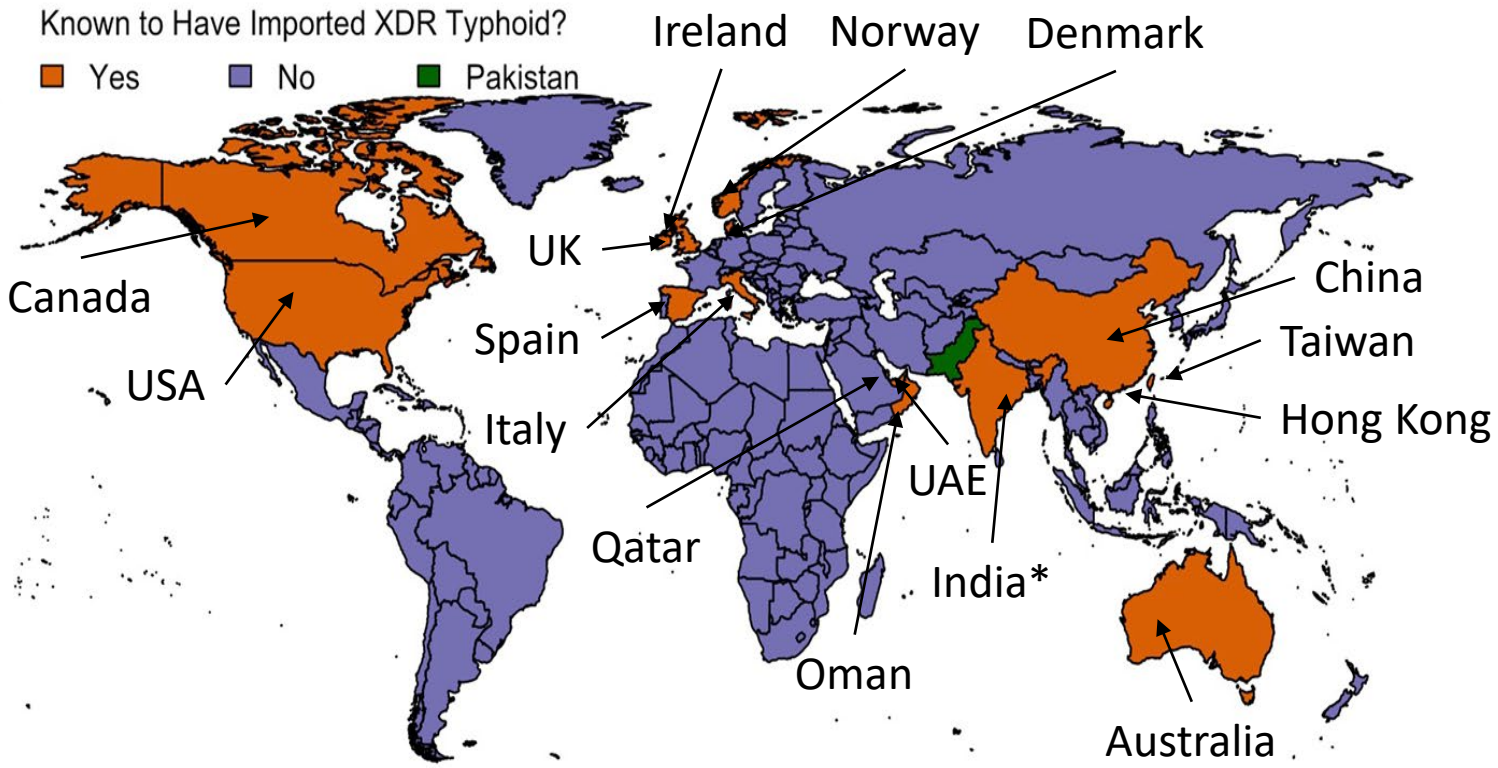
- Ongoing outbreak in Pakistan since 2016
  - First identified in Karachi, Sindh region
  - Now common nationwide
- XDR = MDR + fluoroquinolone and cephalosporin resistance
- Few remaining treatment options
  - Oral: azithromycin
  - Intravenous: carbapenems



Karachi

Sindh region

Travel-Associated XDR Cases Have Been Detected Worldwide



- 16 countries + Pakistan with confirmed XDR typhoid cases

*Traveler from India to UK (see *Nair* 2021)

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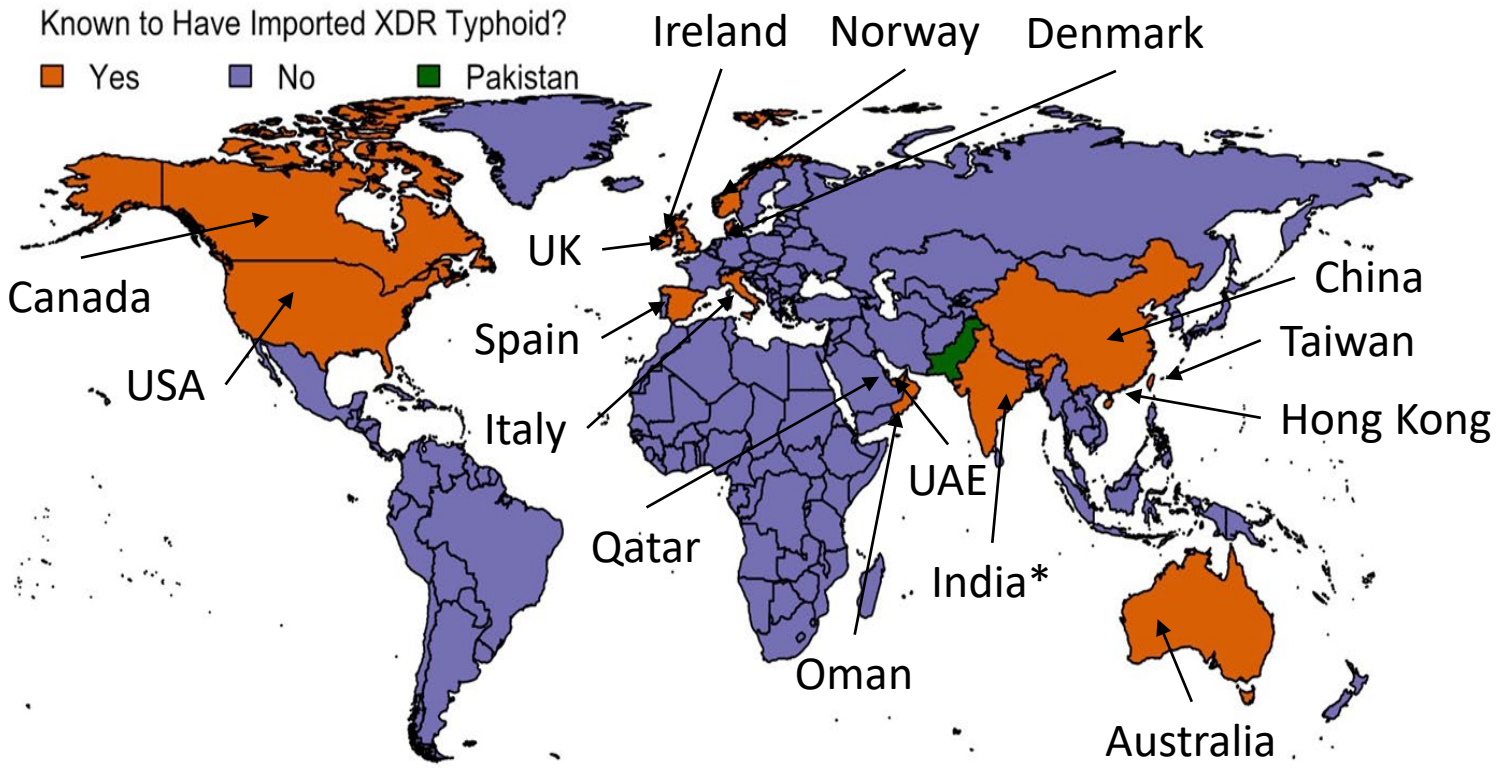

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- Some onward transmission from travelers, but no large outbreaks or sustained spread…..

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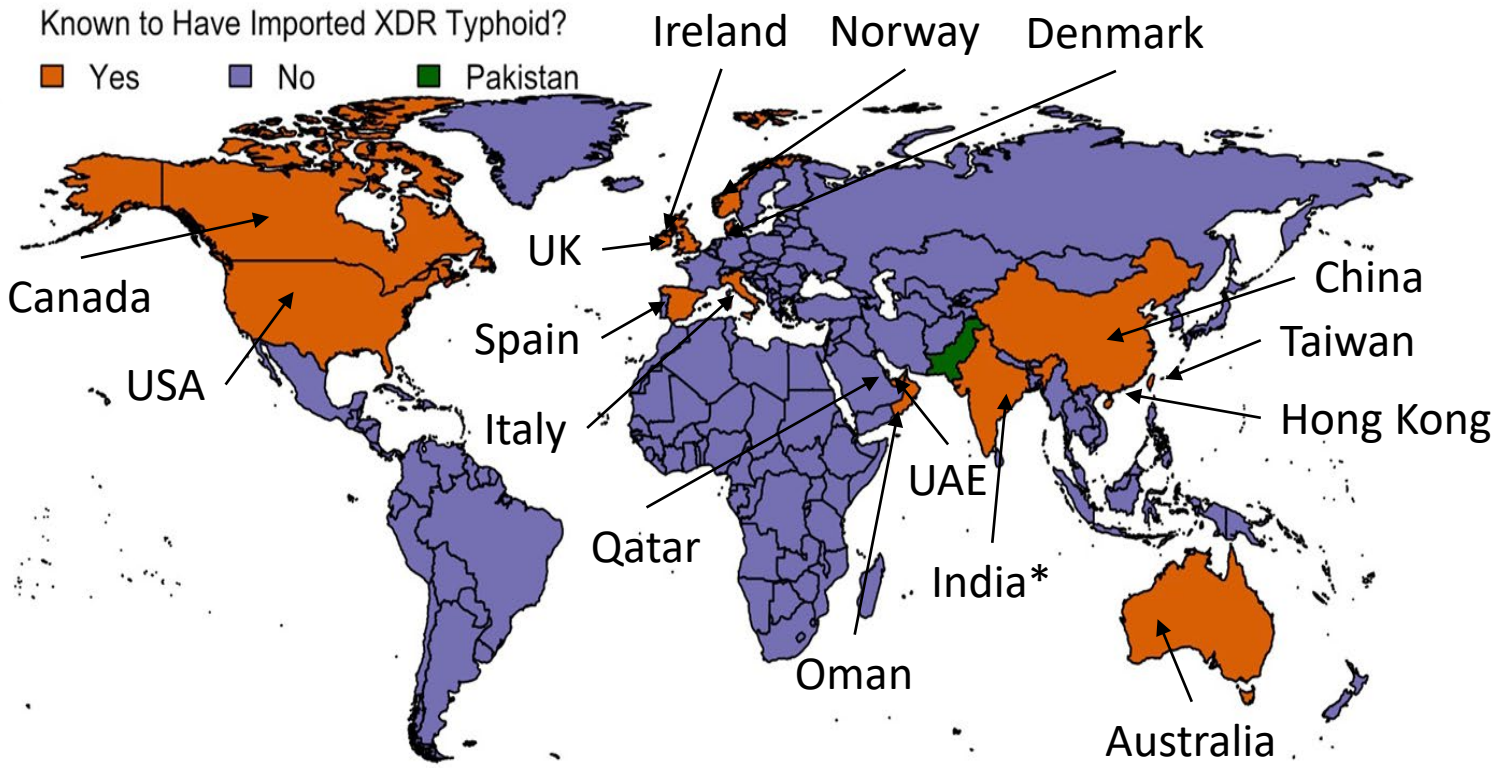

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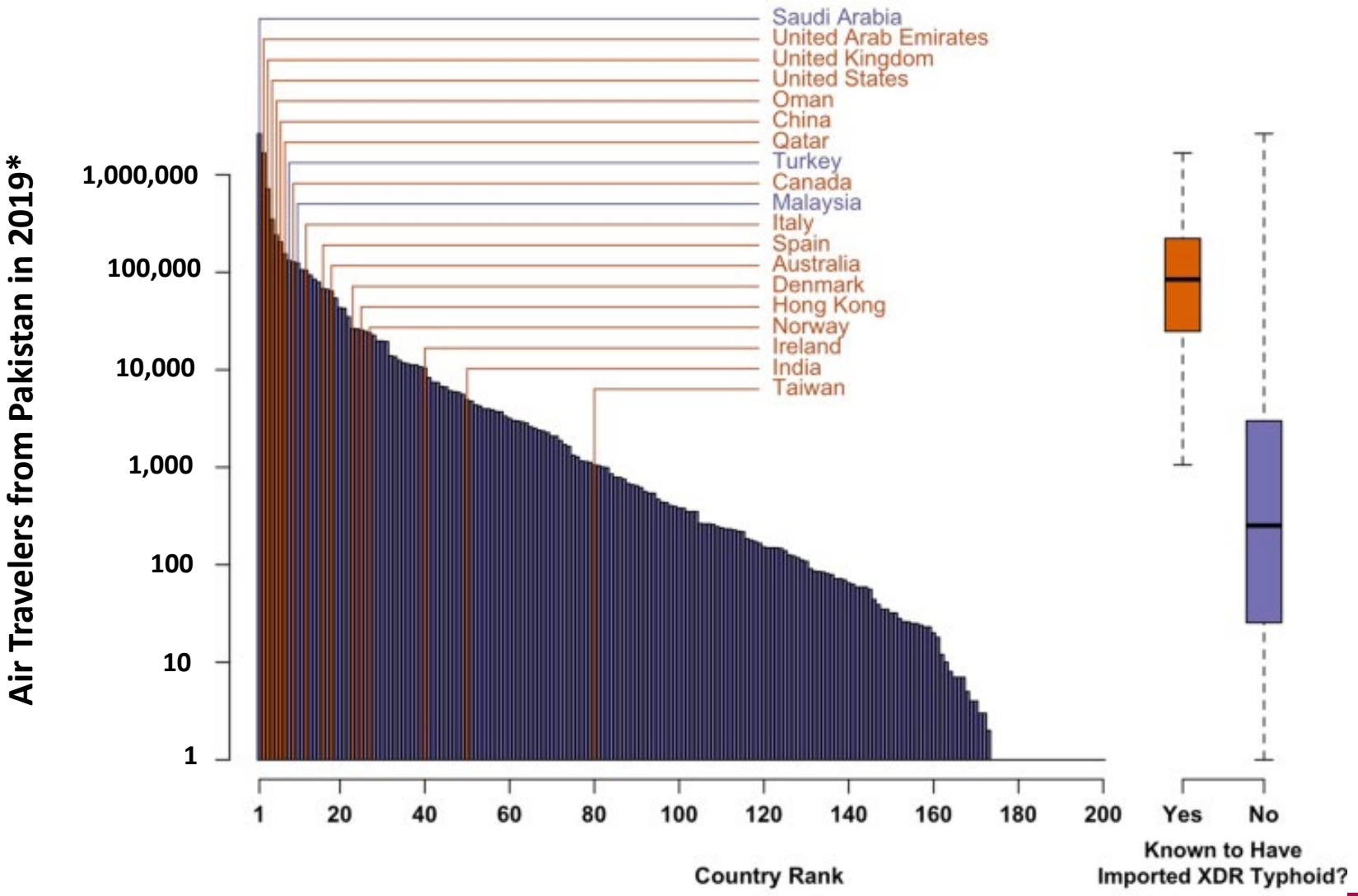
Which Countries are at Highest Risk for XDR Typhoid Outbreaks Going Forward?

XDR Introduction Associated with Air Travel from Pakistan

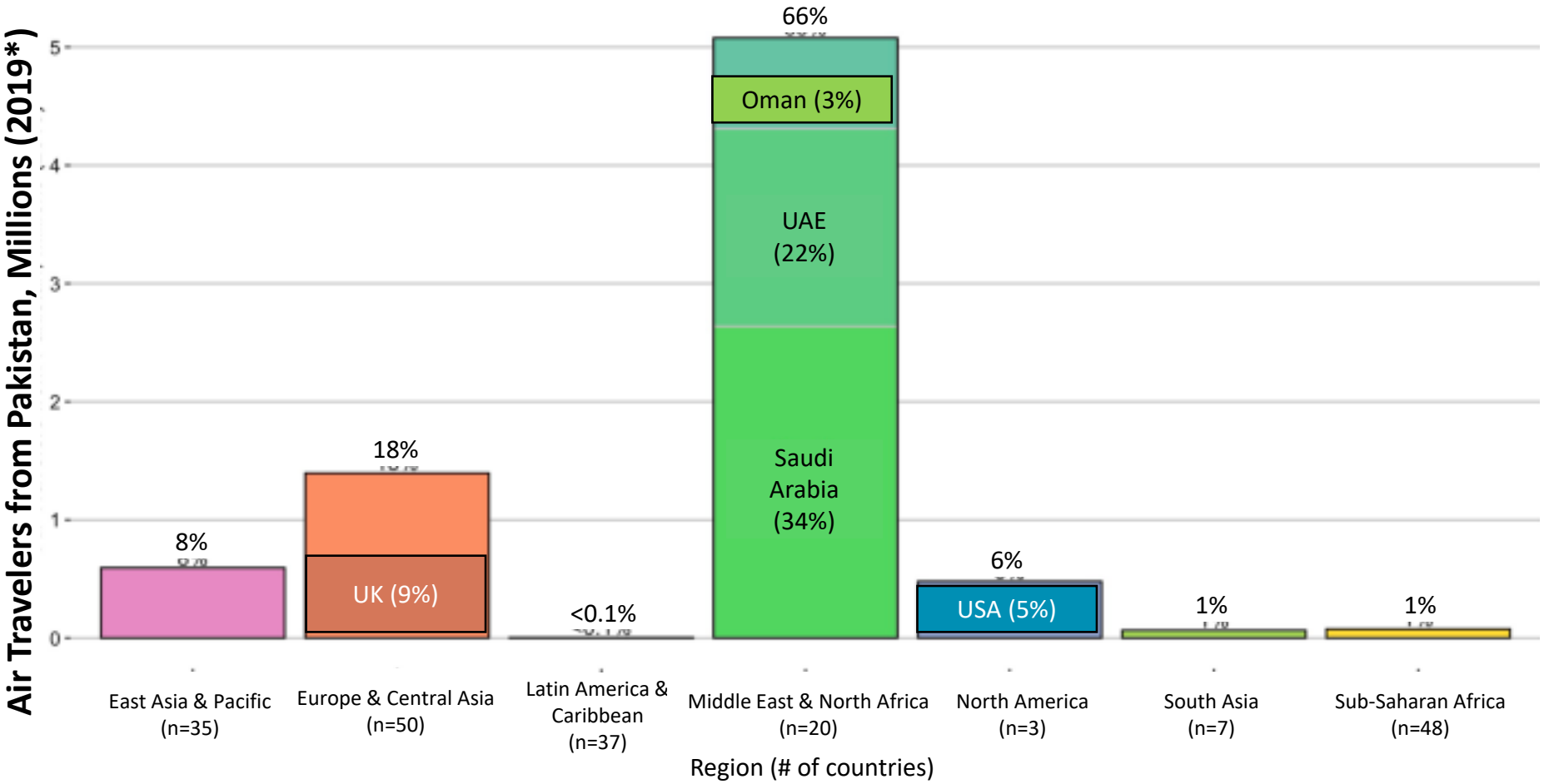


- XDR-detecting countries are among the most popular destinations for outgoing travel from Pakistan
  - 7 of the top 10 destinations have detected XDR cases

- Median Air Travelers from Pakistan (2019):
  - XDR Detected: ~85,000
  - XDR Not Detected: ~250

*Air Travel Data courtesy of the International Air Travel Association (IATA)

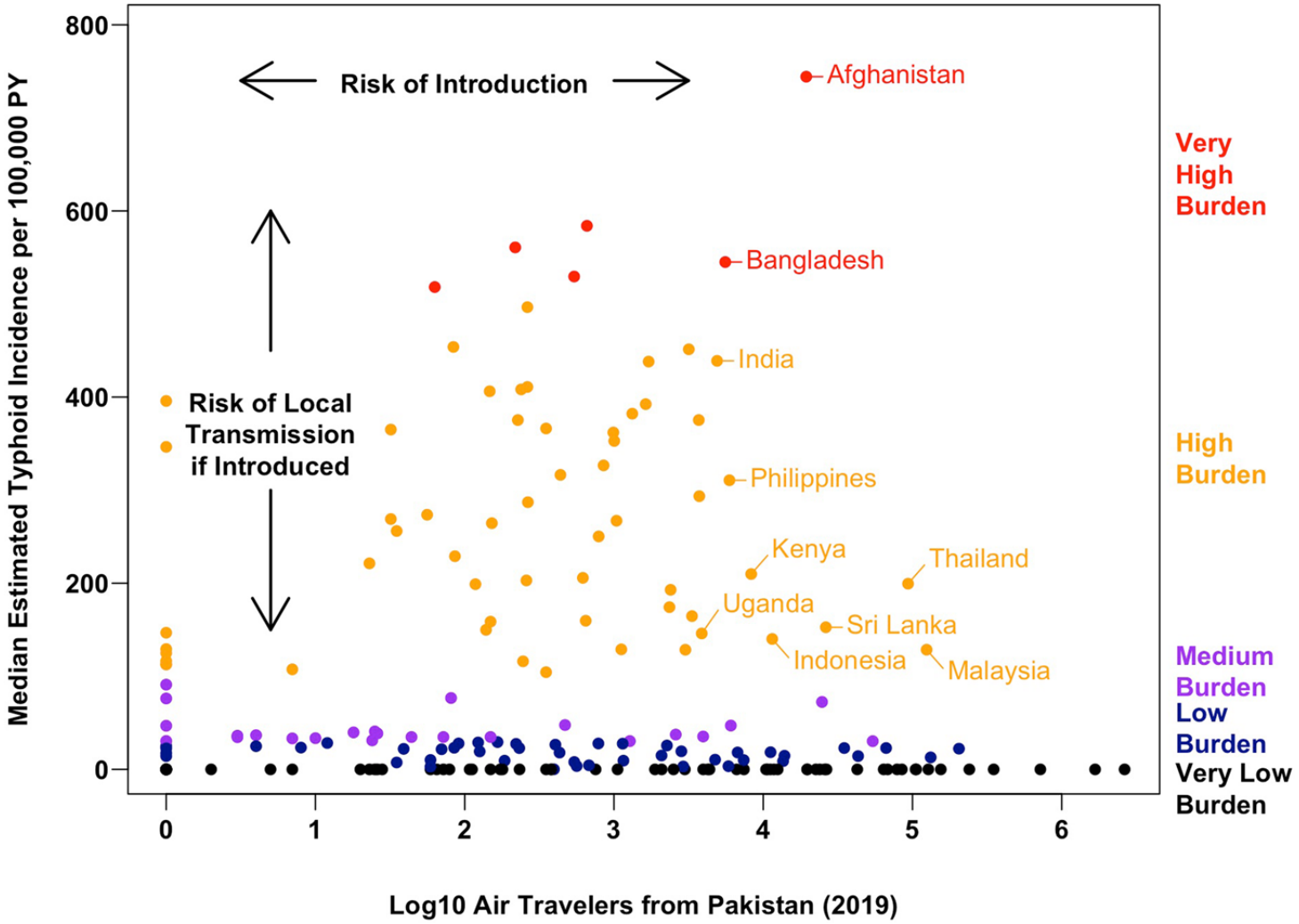
A Few Countries and Regions Account for Most of the International Air Travel from Pakistan



- ~3/4 trips bound for 5 countries: Saudi Arabia, UAE, Oman, UK, and US
- ~2/3 of trips bound for the Middle East, mostly Arab Gulf states
- Relatively little air travel from Pakistan to South Asia, Sub-Saharan Africa, and Latin America

*Air Travel Data courtesy of the International Air Travel Association (IATA)

Overlapping Risk: Countries with Significant Typhoid Transmission *and* Travel from Pakistan



X-axis: Air Travel from Pakistan

- IATA data (2019)
- Proxy for risk of introduction

Y-axis: Typhoid Burden

- Median of IHME, Antillon *et* al., and Kim *et al.* model output
- Proxy for risk of onward transmission if XDR is introduced

- 10 high-burden countries receiving the most travelers from Pakistan:
  - 4 in South Asia
  - 4 in Southeast Asia
  - 2 in Africa

Conclusions

- Travel-associated XDR typhoid detected in 16 countries
  - Possibility of undetected introduction/transmission in additional countries
- Countries with strong travel connections to Pakistan are more likely to have imported XDR typhoid
- Identified a number of countries with efficient typhoid transmission and a relatively high volume of incoming travel from Pakistan
  - Highest risk of XDR outbreaks and sustained transmission

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