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Letter to the editor

## Probability of Mpox importation during the FIFA World Cup 2022 in Qatar



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Amid the multinational mpox/monkeypox virus (MPXV) outbreaks, Qatar is hosting the FIFA World Cup from November 20 to December 18, 2022. Qatar is one of the six Gulf Cooperation Council (GCC) states with a population of about 3 million, of which 0.4 million citizens hold Qatari nationality. Qatar expects to receive 1.2 million international visitors [1], and many World Cup visitors will travel to, and stay overnight at other GCC states [2]. Mass gatherings like this magnificent sporting event inevitably pose risks of mpox importation not only to Qatar but also to the neighboring countries [3]. Major challenges with MPXV transmission are the difficulties in rapidly detecting suspected cases, and managing contact tracing especially in large uncontrolled crowds [4].

The volume of population inflow and MPXV transmission dynamics of the countries of origin are the two key factors determining the risk of case importation. Thus, the probable number of mpox cases introduced from particular foreign countries during FIFA World Cup could be estimated through the following two steps. Firstly, the inflow of visitors to Qatar from different countries during the tournament was interpreted from the structure and volume of FIFA ticket sales [5]. We estimated the structure of population inflow by proportionately analyzing data of ticket sales for the top-nine countries (Fig. 1A and B) [5]. Secondly, we modelled the transmission dynamics of the individual countries during the World Cup period (Supplementary Methods and Table S1). The respective number of infections in the top-nine countries of ticket sales was simulated by incorporating the estimated reproduction number of late-October in the Susceptible-Exposed-Infected-Recovered-Dead (SEIRD) model (Fig. 1C and D). The other countries were regarded as a whole and assumed with a same reproduction number.

Herewith, the probability of mpox importation from a particular country was calculated based on the estimated population

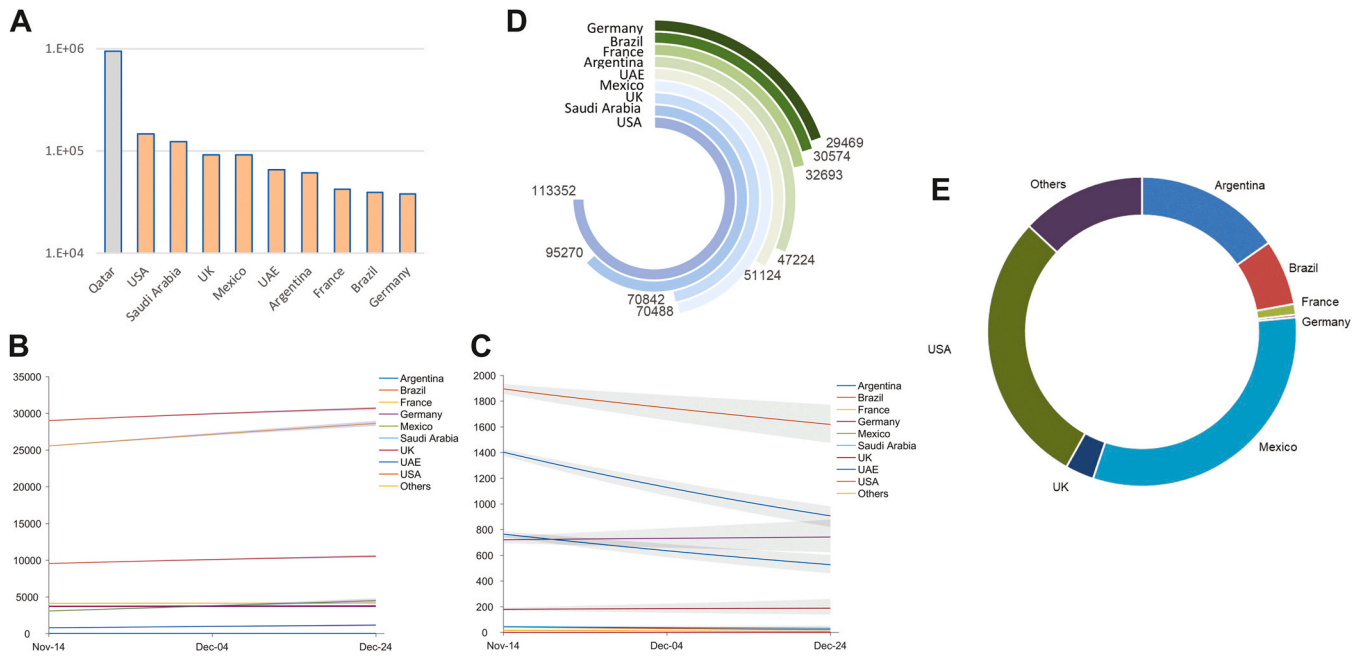
inflow from this country and the simulated number of infections in this country. For example, about 113,000 visitors from the USA are expected to enter Qatar, and the number of active mpox cases among the US population is estimated to be 3085 (95 % CI 2880–3257) during the World Cup period. Thus, it is estimated that one case would be imported from the USA. Overall, a total number of 3.6 (95 % CI 3.2–4.1) mpox cases may flow into Qatar and the surrounding Gulf countries during the World Cup. Of the countries with the most ticket sales, several countries including the USA, Mexico, Argentina and Brazil are in the epicenter of the current mpox outbreak [6]. The countries with the highest risk of exporting cases include Mexico (31.5 %), the USA (28.8 %), and Argentina (15.3 %) (Fig. 1E).

The popularity of the FIFA World Cup is such that 3 million tickets were snapped up. Such mass gathering attracting younger people who have passion and fun will certainly create a breeding ground for MPXV spread, as it is primarily transmitted through close and sex-related intimate contacts. Considering our estimated risk of mpox importation, infection control policies should be implemented for preventing MPXV spread, and the local authorities shall be prepared for rapidly responding to potential outbreaks during the 2022 FIFA World Cup. Fortunately, Qatar in particular the healthcare sector is highly responsible, capable and vigilant in well-preparing and safely hosting this magnificent event [7].

In summary, this study estimated the probability of mpox importation by assessing the pattern of population mobility and the epidemic situation of the country-of-origin, whereas the FIFA World Cup in Qatar serves as a unique setting for studying such public health questions. This approach bears broad implications for organizing future mass gatherings amid epidemics/pandemics, regarding how to assess the risk of case importation and subsequent development of measures to ensure the safety of the events.

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**Fig. 1.** Estimating the risk of monkeypox importation during the FIFA World Cup 2022 in Qatar. (A). The number of FIFA tickets sold to the top-ten countries. (B). The structure of population inflow estimated by proportionately analyzing data of FIFA ticket sales to the top-nine foreign countries. The estimated numbers of cumulative (C) and active monkeypox cases for the respective countries during the World Cup period. (D). The relative contribution of case importation by different countries. USA: United States of America; UK: United Kingdom; UAE: United Arab Emirates.

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Q.Z. literature search, figure, study design, data collection, analysis and/or interpretation, writing; C.B. literature search, figure, study design, data collection, analysis and/or interpretation; Z.A.M. analysis and/or interpretation, editing; J.A.A. analysis and/or interpretation, editing; Q.P. figure, study design, data collection, analysis and/or interpretation, writing; Q.Z. and C.B. contributed equally.

**Conflict of interest disclosures**

None reported.

**Appendix A. Supporting information**

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.jiph.2023.01.001](https://doi.org/10.1016/j.jiph.2023.01.001).

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