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Perspective

Paris 2024 Olympic Games: A risk enhancer for autochthonous arboviral diseases epidemics?

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ABSTRACT

Objectives: The anticipated increase in international tourist flows and the first locally acquired dengue cases in the Paris region in October 2023 have raised concerns about potential arbovirus outbreaks during the 2024 Olympics. Unlike previous mass sporting events at risk of arbovirus outbreaks, Paris is a nonendemic arbovirus area, requiring a unique investigation.

Methods: Therefore, we analyzed factors conducive to possible arbovirus epidemics in temperate regions: vector distribution in the Paris area, seasonal global arboviral disease patterns, projected visitor demographics, and international flight bookings.

Results and conclusion: Our results suggest that the expected visitors' profile for the summer of 2024 should not increase the risk of arbovirus importation into the Paris region compared to a typical year. Conversely, the primary risk of arbovirus outbreaks is likely to come from within France, particularly from the French West Indies, where a notable, albeit declining, dengue outbreak is underway. Vigilant surveillance by French health authorities will ensure that this trend continues.

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Manuscript

The Ile-de-France Region (IDFR), which is set to host the Paris 2024 Olympics, is experiencing a concerning rise in imported cases of chikungunya, Zika, and dengue arboviral diseases [1]. The escalating presence of the *Aedes albopictus* mosquito, a competent vector for these diseases in temperate climates, is a significant threat [1]. The first dengue outbreak in the IDFR last fall underscored the local vulnerability to this risk [1].

In light of these circumstances, there is a growing apprehension, as conveyed by the media, that the Olympics could trigger autochthonous arboviral disease outbreaks in Paris this summer. This reflects previous concerns surrounding the risk of arboviral transmission during large-scale sporting events. However, a crucial distinction arises this time: the risk to the Paris 2024

Olympics lies in the importation of arboviral disease cases to a nonendemic area hosting both a nonimmune human population and a competent vector for arbovirus transmission, with the potential of sparking outbreaks in the IDFR. In contrast, the primary concern for the Rio 2016 Olympics was the potential for the ongoing Zika epidemic to be disseminated from Brazil, through Olympic visitors to the entire world [2]. Consequently, a distinctive investigation is required for the Paris 2024 scenario. The following section presents a pragmatic assessment of the hypothetical alignment of factors conducive to arboviral disease epidemics in temperate regions. Initially, we examine the geographical distribution of *A. albopictus* in the IDFR. Subsequently, we review the risks associated with the importation of arboviral diseases, considering their global distribution and seasonal patterns. Finally, we analyze projections for visitor demographics and air traffic book-

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ings between Paris and endemic regions in order to formulate our conclusions.

The competent-vector geographical distribution in the IDFR

Recent data indicate that by late 2023, *A. albopictus* had colonized western peripheral areas of Paris, including notable Olympic sites such as Le Trocadéro, Le Parc des Princes, Le Stade Roland Garros, l’Arena Paris Sud, and l’Arena Bercy [1]. Central Paris remained unaffected, but numerous competition venues situated outside Paris, with the exception of those in Seine-Saint-Denis, where the Olympic Village will be located, fall within *A. albopictus*-colonized areas [1]. However, the anticipated presence of the vector at Olympic venues is mitigated by the ongoing vector control measures, which have been meticulously planned and implemented by public health agencies in the IDFR [3].

Global arboviral geographical and seasonal distribution

Endemic areas are characterized by sustained arbovirus circulation, yet arboviral diseases exhibit both regional and seasonal variations [4-6]. Over the past 5 years, peak transmission periods in endemic areas for dengue—the most prevalent arboviral disease globally and the primary imported disease in the IDFR [1]—have typically occurred between June 15 and August 15 in Southeast Asia, the Caribbean, and most African countries [7-9]. In South America, the peak transmission period has been observed between January and July [7]. Hence, regions experiencing peak dengue transmission coinciding with the 2024 Summer Olympics include Southeast Asia, the Caribbean, and most African nations. The French Overseas Territories, particularly the French West Indies, have consistently served as the primary source of arboviral disease importation to the IDFR during summers since 2019 [10]. It is anticipated that this trend will persist, given the ongoing dengue outbreak in these areas, which has already resulted in a notable increase in imported dengue cases in the IDFR. Between May and July 2024, there were 131 imported cases compared to 65 in the same period in 2023 [11]. Fortunately, the outbreak in the French West Indies is currently declining, which should substantially mitigate the importation risk during the Olympics [12].

Projections for tourist and aerial traffic projections during the 2024 Olympics

The latest forecasts indicate a significant influx of visitors during the Olympics, with a notable shift toward domestic tourism. It is anticipated that French tourists will account for approximately 85% of the visitors from July 26 to September 8 (13 out of 15 million visitors), with the majority arriving from the IDFR [13]. Among international visitors, the top three nations are expected to be the United Kingdom, the United States of America, and Germany [13]. Compared to the same period in 2023, flight bookings to the IDFR have decreased for Southern Europe visitors [13]. This reduces the already low risk of transporting autochthonous cases to Paris from Southern Europe regions, such as the south of France, Italy, and Spain, where autochthonous outbreaks are relatively common [14]. These forecasts, presented by the Paris tourist office, are informed by a number of factors including the experience of previous Olympics in Rio and London, the results of surveys, and the sales of tickets for the 2024 Olympics. Updated data on air traffic bookings provided by the Paris tourist office are based on the country from which the booking was made (Figure 1). The data indicate a decline in international arrivals compared to the previous year, including from areas with sustained dengue, Zika, and

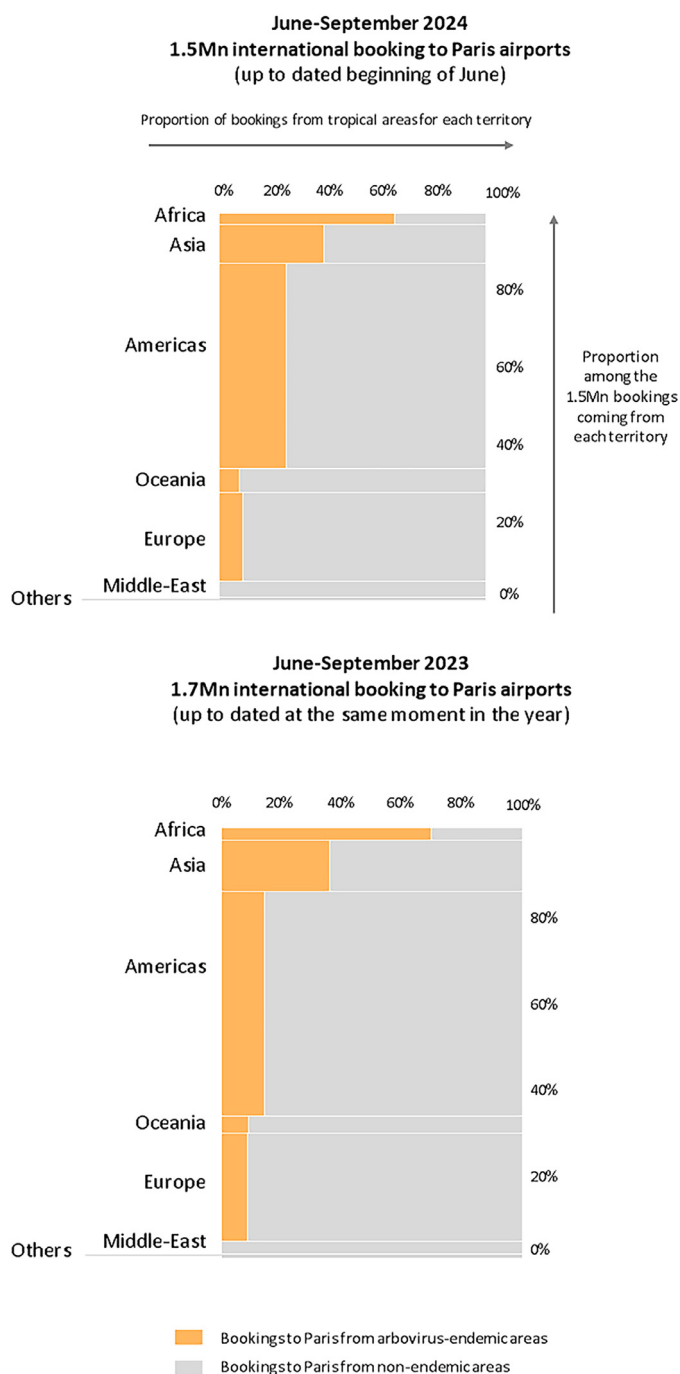


Figure 1. Marimekko chart of international flight bookings to Paris airports from arbovirus-endemic and nonendemic areas (June to September 2024 vs 2023). This Marimekko chart illustrates the proportion of international flight bookings to Paris airports from endemic areas (in orange) for the period from June to September 2024 (top) and the same period in 2023 (bottom). The x-axis represents the proportion of international bookings to Paris from endemic areas (orange) vs nonendemic areas (gray) for each geographical zone (Africa, Asia, Americas, Oceania, Europe, Middle East, and unclassified territories). The y-axis indicates the proportion of each geographical zone’s bookings among the total international bookings. Endemic areas for arbovirus were defined as those exhibiting sustained local circulation of dengue, Zika, and chikungunya [4-6]. These up-to-date air traffic booking data, based on the country of booking origin, were sourced from the Paris tourist office.

chikungunya circulation [4–6]. As of early June, a total of 250,000 flights had been booked, compared to 240,000, respectively, for the 2023 and 2024 periods, from endemic areas to Paris during the June to September period. This phenomenon is exemplified in the Caribbean, where an ongoing dengue outbreak has resulted in 22,600 flights being booked to Paris in 2023, compared to 20,500 in 2024. It is therefore unlikely that the number of arrivals from tropical areas to Paris will increase as a result of changes in population fluxes during the 2024 Olympics.

Conclusion

It is noteworthy that the Olympics will take place in a region with a well-documented presence of *A. albopictus*, and will occur shortly following the peak of a dengue outbreak in the Caribbean, a region with strong air travel connections to Paris. However, the influx of tourists to the IDFR in the months surrounding the Olympics is unlikely to involve as many visitors from arbovirus-endemic areas as might have been anticipated. Furthermore, validated arbovirus transmission models indicate that as the human (uninfected) population increases, the probability of a competent mosquito biting a viremic individual is diluted, assuming that all other variables remain constant [15]. The Ross-MacDonald equation used to calculate the basic reproductive number (R_0) of vector-borne diseases includes the ratio of female mosquitoes to the susceptible human population in its numerator [16]. Consequently, an increase in the size of the human population (with all other parameters remaining constant) would ultimately result in a reduction of R_0 . This dilution effect predicts that a mass event increasing the flow of uninfected hosts would serve to mitigate the risk of arboviral transmission. Additionally, the French Public Health Agencies have already initiated vector control strategies and are informing the relevant healthcare providers about the current surge in imported cases [3].

Moreover, numerous other factors influence the risk of autochthonous outbreaks. Favorable climatic conditions, delayed notification of imported cases, and compatibility between viral strains and local mosquito populations contribute to the risk [1,17,18]. Some of these factors can be favorably influenced by public health measures but some others are contingent upon the specific viral strain, thus presenting new challenges for temperate areas colonized by *A. albopictus*. The prediction of arbovirus epidemics in temperate areas is currently underdeveloped and requires further research.

In conclusion, after a comprehensive analysis of the major epidemic drivers, the likelihood of autochthonous outbreaks during the 2024 Paris Olympics is nuanced. The hosting of the Olympics itself does not appear to increase the risk; rather, the primary concern appears to be within France, particularly in the French West Indies, where a significant dengue outbreak is currently underway. Although the outbreak is currently in decline, it is important to maintain a high level of vigilance and continue monitoring the situation in the French West Indies in the coming weeks to ensure that this trend persists. Consequently, the most significant challenge currently facing the French public health authorities is ensuring organizational preparedness, particularly in relation to the management of the substantial increase in workload due to the surge in imported arboviral disease cases just months before the Olympics, in addition to the already higher than usual workload due to the logistical demands of this mass event management.

Ethical approval

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Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the author(s) used ChatGPT 3.5. and deepL (free version) in order to correct the syntax. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

Author contributions

LL, CGM, and CVT participated in the writing of the original draft. KJ and LT reviewed the manuscript critically. All authors reviewed and edited the article. All authors read and approved the final manuscript.

Declarations of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

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