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Zika Virus and the 2016 Olympic Games - Evidence-based Projections derived from Dengue do not Support Cancellation

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From August 5-21 more than 10,000 athletes from about 200 countries will gather in Rio de Janeiro (RJ), Brazil, for the 2016 Summer Olympics. Thousands of domestic and international tourists are expected to attend the games. From Sep 7-18, RJ will also host the Paralympic Games. Concern has been raised around the public health consequences of the Games, given the Zika virus (ZIKV) situation in Brazil. Calls for cancelling, transferring, or postponing the games have been made,[1,2] including an open letter (https://rioolympicslater.org/) sent to the World Health Organization (WHO). The fear is mainly twofold: (i) infection of athletes and visitors, and (ii) the potential to speed up the spread of ZIKV worldwide. However, what is missing from that discussion is solid evidence to support the arguments.

Here, historical and current publicly available data are analyzed to promote an evidence-based discussion. Three types of data were reviewed. First, considering that dengue and ZIKV are transmitted by *Aedes aegypti* mosquitoes, and do have a similar epidemiological curve,[3] a time series of dengue cases recorded in RJ State by epidemiological week was assembled for the years 2001 to 2015.[4] Second, a time series of dengue cases by year, as well as data by epidemiological week for 2015 and 2016, was assembled in order to assess if/how the epidemiological pattern in RJ is different from that recorded for Brazil.[4,5] Third, information on ZIKV infections in RJ was gathered by epidemiological week for 2015 and 2016.[6]

Figure 1 shows a heat map with the percentage distribution of annual dengue cases by epidemiological week in RJ state. Both the Olympic and Paralympic Games will take place during the period of low transmission. While there is small variability across the years, the winter months are consistently periods of low transmission, and thus the best time to hold mass gathering events. Recommendations to postpone the games fail to recognize this epidemiological pattern, and would put athletes and visitors under a much higher risk of infection.

This pattern is not unique to RJ. Figure 2 shows that annual and weekly variation in recorded dengue cases is similar for RJ and Brazil. Most importantly, Figure 3 clearly shows that the transmission in 2016 started early and at higher levels, resulting in incidence rates in the first 13 weeks of the year that were 89% higher than the same period in the previous year [5]. Yet, transmission in 2016 is on a steady downward trend that is unlikely to revert to earlier patterns (a

sudden change in this trend during winter months would go against available evidence regarding vector biology and behavior, and its relationship with weather patterns).[7]

Regarding ZIKV, although 1.3 million infections in Brazil are commonly cited,[8] this figure refers to a rough estimate produced by the Brazilian Ministry of Health in Jan/2016, combining data of discarded dengue cases in Brazil, and proportion of ZIKV cases in French Polynesia.[9] Mandatory notification of ZIKV cases in Brazil only started on February 17, 2016. Until April 23, 120,161 probable ZIKV cases were reported,[5] but many cases reported are not yet confirmed. Thus, the best proxy is to analyze cases among pregnant women, which are more closely investigated. Since 2015, there have been 9,944 ZIKV cases among pregnant women in RJ, with peaks during 3-9/Jan and 7-13/Feb.[6] However, since late March cases have been steadily declining, following the same epidemiological pattern as dengue.

Also important is the intensification of vector control activities that RJ has started, and will be conducting throughout the duration of the games. More than 5.6 million private and public housing units have been inspected and treated, mobilizing health personnel, troops, and fire fighters.[6] Daily sweeps will be conducted in all Olympic facilities and areas where sport events will take place. Cellular apps will be available in multiple languages to facilitate messaging and surveillance (leveraging successful efforts done during the 2014 World Cup). Lastly, approximately 2,500 health professionals will be added to the current staff to intensify the health care network during the Games.

Based on the available evidence, calls for cancelling the games because of ZIKV are not justified.[10,11] The most important words in the current debate about ZIKV and the Olympics should not be cancelling and postponing, but preparedness and surveillance. Besides the preparedness policies put forth by RJ, recommendations for visitors, athletes, and the local population should follow WHO recommendations and suggestions of preventive measures,[12] but add a few others. There should be clear messages distributed at airports and bus stations, at hotels, at the Olympic village, in the public transportation system, and at the entrance of each game. Messages should appear at video boards of stadiums during all sport events. The private sector could take action and sponsor, for example, the distribution of a kit – containing preventative instructions against *Ae. aegypti*, a bottle of repellent, and condoms – to those attending sport events during the Games. South Korea set an example of preparedness, designing uniforms for the athletes that are treated with mosquito repellent, and that cover extremities of the body – long pants and long-sleeved shirts.

Yet, preparedness must be broad, recognizing that other diseases are likely to have a much higher risk than ZIKV, such as influenza and gastrointestinal illness. In that regard, the most detailed assessment of risks to public health associated with the Olympic Games have been produced by the European Centre for Disease Prevention and Control, and should be used as a reference.[13]

As for surveillance, policies must be in place in RJ to closely monitor the occurrence of unusual health conditions to minimize the risk of introduction of new pathogens in RJ and Brazil.[14,15] The current outbreak of yellow fever is just one example. Also, in anticipation of the possible return of infected individuals, policies should be implemented in countries sending athletes and visitors to Brazil.

Since ZIKV was officially reported in Brazil (May 2015), it spread to more than 20 countries in the Americas in nine months. Imported ZIKV cases have also been reported in many countries in

the Northern hemisphere, without triggering autochthonous transmission. All of this happened in a scenario where knowledge was for the most part limited (yet rapidly evolving). This is a much different situation than the present scenario; the reduced transmission and the accumulated knowledge produced in the last few months provide a clear advantage that has to be leveraged.

To suggest that the Olympics should be moved from Brazil, canceled or postponed because of ZIKV is not based on disease knowledge and on scientific assessment. Evidence shows that the epidemiological conditions in RJ in August and September will not pose a major risk for ZIKV transmission. Yet, the WHO recommendation[16] for pregnant women not to travel to areas with active ZIKV transmission must be followed, given the consequences of congenital ZIKV syndrome. Considering the current available knowledge, if ZIKV does spread much faster post-Olympics, it will be a result of lack of preparedness and inefficiencies in health systems and surveillance policies of individual countries.

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EW	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
1	0.40	1.12	1.40	6.17	2.50	0.60	1.21	0.62	3.09	1.21	0.47	1.52	0.76	2.53	0.97	
2	0.30	2.70	2.63	4.89	1.43	0.73	1.02	1.07	3.61	1.29	0.53	1.00	1.47	4.16	1.22	
3	0.59	6.02	4.00	6.60	1.07	1.37	1.46	1.44	2.74	1.39	0.67	0.97	1.70	3.83	1.84	
4	1.30	7.19	5.61	6.81	1.25	2.07	1.68	1.63	3.72	1.51	0.98	0.94	2.36	3.83	1.70	
5	1.85	8.04	6.45	4.04	1.25	2.39	2.66	1.09	5.21	1.67	1.52	0.98	2.60	2.71	1.69	
6	2.10	7.64	6.63	3.19	1.78	2.23	3.02	1.34	4.83	1.43	2.44	1.16	2.55	3.48	1.49	
7	1.79	7.56	6.84	2.98	1.60	2.70	3.04	1.88	3.26	1.72	2.86	1.22	3.61	3.18	1.59	
8	1.27	9.13	7.50	2.13	1.96	2.25	2.64	2.54	2.64	2.48	2.89	1.46	5.45	2.98	2.01	
9	1.73	8.77	6.35	3.19	0.71	2.62	3.80	3.78	3.26	2.48	2.77	1.96	6.82	2.03	3.24	
10	2.29	10.21	6.45	4.47	1.07	5.29	4.09	4.76	4.20	2.49	2.83	2.66	8.20	2.27	3.54	
11	2.50	9.26	7.22	2.77	1.07	6.58	4.97	5.67	5.63	2.66	4.30	3.04	9.41	2.86	4.26	
12	2.94	6.61	5.36	2.34	1.78	7.05	6.21	6.81	4.90	2.59	6.20	3.88	8.49	2.45	3.58	
13	3.54	4.36	4.28	2.77	0.89	6.52	5.72	11.18	4.24	3.31	6.44	4.53	7.41	2.74	3.58	
14	5.12	3.26	3.44	3.19	1.07	7.50	5.38	12.37	3.40	4.01	7.22	5.12	7.70	2.48	4.67	
15	4.74	2.23	2.35	1.70	1.96	6.72	5.60	9.99	3.09	3.77	6.53	6.40	7.64	2.56	4.53	
16	6.19	1.36	2.28	3.40	1.60	7.00	5.24	8.09	3.75	4.46	6.42	8.17	6.28	2.42	4.32	
17	7.49	0.92	1.72	1.49	2.67	5.56	4.16	6.74	2.88	5.73	7.60	8.11	4.42	2.33	4.73	
18	8.63	0.65	1.82	0.64	1.43	6.02	4.70	4.77	2.99	5.91	6.65	6.88	3.05	1.77	4.45	
19	7.29	0.57	1.33	0.64	1.43	4.10	5.00	3.99	2.40	5.85	5.87	7.23	2.31	2.53	4.32	
20	4.91	0.44	1.05	0.85	1.96	3.18	3.61	2.71	2.64	5.76	4.72	5.64	1.88	2.33	3.09	
21	3.89	0.25	1.16	1.70	0.89	2.52	3.27	1.69	2.26	4.35	3.59	4.44	1.32	1.44	2.62	
22	3.81	0.15	0.81	1.06	1.78	2.17	2.09	1.27	2.01	3.60	2.93	3.34	0.83	1.56	2.67	
23	3.67	0.13	0.74	0.21	2.14	1.58	1.71	0.74	2.05	2.84	1.97	2.92	0.62	1.83	2.33	
24	2.59	0.12	0.81	2.13	0.53	0.99	1.88	0.56	1.01	2.26	1.41	2.65	0.58	2.12	2.03	
25	2.49	0.09	0.39	1.91	1.43	0.90	1.61	0.44	0.56	1.81	1.02	2.29	0.40	1.74	1.49	
26	1.72	0.06	0.42	1.49	1.25	0.73	1.20	0.25	0.80	1.68	0.84	1.73	0.32	1.24	1.38	
27	1.37	0.05	0.46	1.28	1.07	0.43	1.01	0.27	0.94	1.68	0.58	1.11	0.21	1.00	1.26	
28	0.96	0.04	0.11	0.21	0.36	0.52	0.94	0.15	0.56	1.30	0.47	0.65	0.16	1.00	1.29	
29	0.83	0.03	0.35	0.00	1.60	0.38	0.84	0.13	0.42	0.86	0.36	0.54	0.14	1.33	1.28	
30	0.54	0.03	0.28	0.43	1.60	0.24	0.57	0.22	0.35	1.17	0.29	0.29	0.09	0.91	1.07	
31	0.44	0.03	0.21	0.64	1.78	0.42	0.41	0.15	0.31	1.00	0.20	0.45	0.10	0.94	1.05	Olympic
32	0.38	0.02	0.25	1.28	2.50	0.13	0.43	0.14	0.17	1.07	0.18	0.45	0.08	0.74	0.87	Games
33	0.31	0.04	0.35	1.28	0.71	0.22	0.33	0.10	0.21	0.74	0.18	0.35	0.07	1.27	0.66	August
34	0.35	0.03	0.14	0.43	1.25	0.24	0.26	0.07	0.03	0.60	0.14	0.36	0.06	1.15	0.65	5-21
35	0.26	0.01	0.32	1.28	1.07	0.15	0.35	0.06	0.28	0.52	0.11	0.27	0.05	1.21	0.58	
36	0.21	0.01	0.07	0.21	1.25	0.07	0.16	0.06	0.14	0.47	0.14	0.20	0.04	1.18	0.57	Paralympic
37	0.24	0.02	0.21	1.28	0.89	0.10	0.30	0.08	0.10	0.46	0.14	0.24	0.05	0.91	0.52	Games
38	0.14	0.01	0.14	0.64	1.43	0.14	0.23	0.05	0.17	0.36	0.18	0.21	0.04	0.97	0.52	Sep 7-18
39	0.18	0.01	0.11	0.21	0.53	0.13	0.16	0.05	0.14	0.51	0.20	0.18	0.05	1.39	0.54	
40	0.31	0.02	0.21	0.43	1.43	0.10	0.11	0.04	0.14	0.36	0.21	0.14	0.04	1.41	0.43	
41	0.30	0.03	0.14	0.85	1.60	0.15	0.20	0.04	0.03	0.24	0.23	0.12	0.03	0.77	0.41	
42	0.42	0.02	0.14	1.06	1.25	0.25	0.26	0.08	0.31	0.21	0.20	0.14	0.04	0.91	0.51	
43	0.24	0.04	0.46	1.06	1.96	0.22	0.24	0.08	0.17	0.28	0.29	0.16	0.06	0.77	0.42	
44	0.23	0.04	0.46	2.13	1.60	0.14	0.27	0.08	0.42	0.34	0.26	0.24	0.06	1.06	0.62	
45	0.32	0.03	0.39	0.64	3.39	0.20	0.39	0.08	0.56	0.48	0.31	0.28	0.05	0.77	0.83	
46	0.30	0.10	0.74	1.28	2.14	0.17	0.38	0.09	0.76	0.52	0.30	0.21	0.05	1.24	0.88	
47	0.36	0.10	0.95	1.28	3.92	0.25	0.63	0.11	0.90	0.72	0.46	0.28	0.04	1.03	1.23	
48	0.56	0.13	0.91	2.13	4.10	0.36	0.65	0.09	1.60	0.98	0.44	0.32	0.04	1.41	1.51	
49	0.75	0.16	0.95	1.70	6.06	0.43	0.75	0.09	1.49	1.67	0.57	0.50	0.10	1.21	2.13	
50	1.18	0.07	1.26	1.06	6.60	0.67	0.93	0.10	1.91	1.84	0.69	0.60	0.06	2.12	2.51	
51	1.11	0.06	0.70	1.28	4.46	0.85	1.09	0.07	2.60	1.61	0.57	0.57	0.05	3.30	2.25	
52	2.52	0.04	0.46	1.28	6.95	1.67	1.16	0.07	2.50	1.73	0.62	0.92	0.04	2.92	1.73	
53	0.00	0.00	0.25	1.91	0.00	0.00	0.00	0.03	1.63	0.00	0.00	0.00	0.00	1.68	0.29	

Figure 1. Heat map of the percentage of reported dengue cases by epidemiological week (EW), Rio de Janeiro State, 2001-15. Heat map colors range from red (high percentages) to blue (low percentages). The epidemiological weeks corresponding to the period of the Olympic and Paralympic Games are highlighted in the heat map.

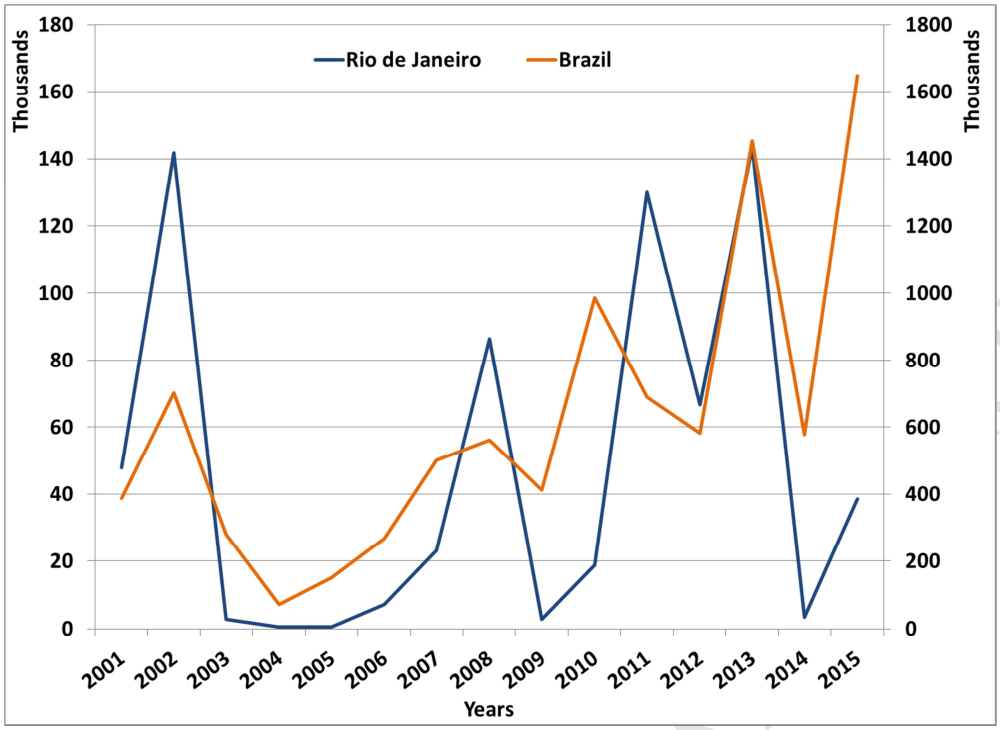

Figure 2. Annual curves of dengue cases in Rio de Janeiro State and Brazil. Total number of dengue cases recorded in Rio de Janeiro and Brazil, for the years 2001 to 2015. The right Y-axis refers to Brazil, and left Y-axis refers to Rio de Janeiro.

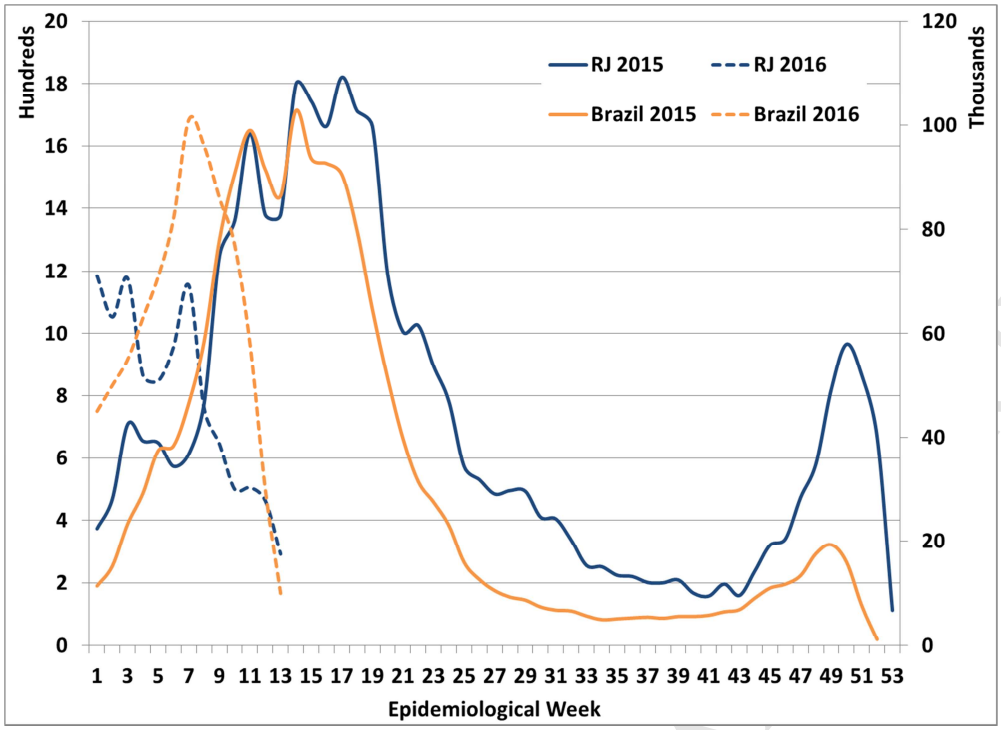

Figure 3. Epidemiological curves of weekly dengue cases in Rio de Janeiro State and Brazil. Dengue cases by epidemiological week recorded in Rio de Janeiro and Brazil in 2015 and 2016. The right Y-axis refers to Brazil, and left Y-axis refers to Rio de Janeiro.