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CORRESPONDENCE

Using geographic information system (GIS) to mapping and assess changes in transmission patterns of chikungunya fever in municipalities of the Coffee-Triangle region of Colombia during 2014–2015 outbreak: Implications for travel advice

KEYWORDS
Chikungunya;
Epidemiology;
Travelers;
Colombia;
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Chikungunya (CHIKV) fever arrived to Latin America to stay. Rapidly, during 2014, transmission was established in places where dengue and its main vector, *Aedes aegypti*, were present in the region [1]. However, the 2014 outbreak was the beginning of a new endemic disease, meaning that in the countries facing this new arboviral disease, some areas will see stabilization of its transmission with decrease in its incidence, whilst in others a significant increase during 2015 is now being observed [2]. This is the case of the Coffee-Triangle region in Colombia.

In this setting, travelers to endemic areas in Latin American countries should be aware about the risk of infective biting exposure when visiting for different purposes these areas, as we have reported it for other areas of Colombia [3]. In order to help in the advice to travelers, epidemiological information is of utmost importance [4,5], including the availability of detailed maps in order to assess the risk when visiting specific destinations [5]. For these reasons, we have developed epidemiological maps for CHIKV in Colombia using geographical information systems (GIS) [3], now in the Coffee-Triangle region, which is a touristic area constituted by three departments (Caldas, Quindío and Risaralda) and 53 municipalities (Fig. 1).

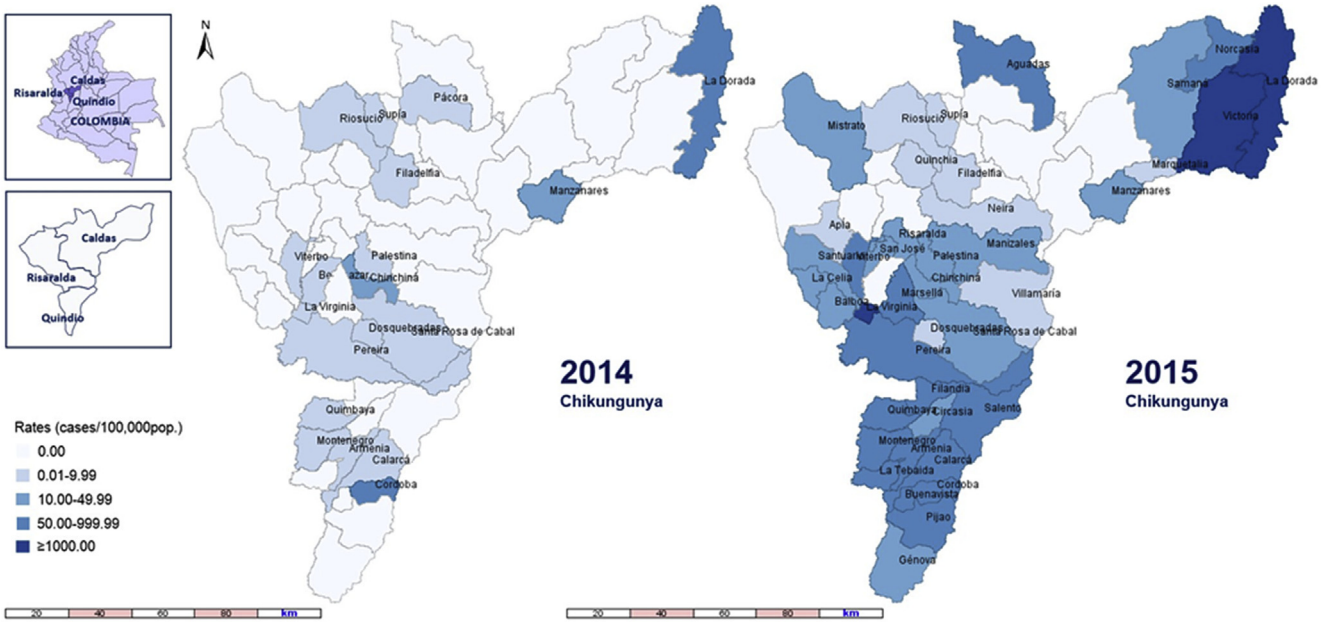

Fig. 1 Geographic distribution of CHIKV incidence rates (cases/100,000pop) in the Coffee-Triangle region, Colombia, 2014 and 2015 (up to epidemiological week 20).

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Table 1 CHIKV incidence rates (cases/100,000pop) by municipalities in the departments of the Coffee-Triangle region, Colombia, 2014 and 2015 (up to epidemiological week 20).

Department	Municipality	2014			2015		
		Cases	Population	Rates (cases/100,000pop)	Cases	Population	Rates (cases/100,000pop)
Region	Total region	118	2,494,774	13.5	4459	2,505,196	530.4
Caldas	Total department	82	986,061	8.3	2542	988,003	257.3
Quindio	Total department	19	562,087	3.4	998	565,248	176.6
Risaralda	Total department	17	946,626	1.8	919	951,945	96.5
Caldas	La Dorada	60	76,574	78.4	2000	76,963	2598.7
Risaralda	La Virginia	2	31,959	6.3	489	32,039	1526.3
Caldas	Victoria	0	8505	0.0	108	8415	1283.4
Quindio	La Tebaida	0	41,169	0.0	335	42,141	795.0
Caldas	Norcasia	0	6430	0.0	46	6374	721.7
Caldas	Viterbo	1	12,506	8.0	69	12,469	553.4
Caldas	Aguadas	0	22,293	0.0	80	22,081	362.3
Quindio	Buenavista	0	2860	0.0	9	2834	317.6
Quindio	Quimbaya	2	34,859	5.7	95	34,945	271.9
Quindio	Filandia	0	13,355	0.0	21	13,414	156.6
Quindio	Calarca	2	77,198	2.6	104	77,598	134.0
Quindio	Armenia	11	295,149	3.7	376	296,691	126.7
Quindio	Montenegro	1	41,146	2.4	37	41,268	89.7
Risaralda	Pereira	12	467,209	2.6	384	469,644	81.8
Quindio	Cordoba	3	5320	56.4	4	5305	75.4
Quindio	Salento	0	7118	0.0	5	7111	70.3
Quindio	Pijao	0	6203	0.0	4	6139	65.2
Risaralda	Marsella	0	23,107	0.0	13	23,299	55.8
Risaralda	Balboa	0	6332	0.0	3	6331	47.4
Caldas	Samana	0	25,769	0.0	12	25,777	46.6
Caldas	Manizales	0	394,655	0.0	182	396,102	45.9
Caldas	Chinchina	7	51,696	13.5	15	51,492	29.1
Caldas	Palestina	1	17,795	5.6	5	17,760	28.2
Caldas	Risaralda	0	9693	0.0	2	9583	20.9
Risaralda	Santa Rosa de Cabal	2	72,028	2.8	15	72,228	20.8
Quindio	Circasia	0	29,642	0.0	5	29,886	16.7
Caldas	San Jose	0	7595	0.0	1	7588	13.2
Caldas	Manzanares	5	23,447	21.3	3	23,274	12.9
Risaralda	Santuario	0	15,681	0.0	2	15,715	12.7
Quindio	Genova	0	8068	0.0	1	7916	12.6
Risaralda	Mistrató	0	16,049	0.0	2	16,177	12.4
Risaralda	La Celia	0	8616	0.0	1	8598	11.6
Caldas	Filadelfia	1	11,200	8.9	1	11,034	9.1
Risaralda	Quinchía	0	33,695	0.0	3	33,754	8.9
Caldas	Supia	2	26,542	7.5	2	26,728	7.5
Caldas	Marquetalia	0	14,982	0.0	1	14,992	6.7
Caldas	Neira	0	30,285	0.0	2	30,513	6.6
Risaralda	Apia	0	18,833	0.0	1	18,976	5.3
Risaralda	Dosquebradas	1	196,925	0.5	6	198,874	3.0
Caldas	Villamaria	0	55,219	0.0	1	56,288	1.8
Caldas	Riosucio	3	60,798	4.9	1	61,535	1.6
Risaralda	Belén de Umbría	0	27,721	0.0	0	27,721	0.0
Risaralda	Guatica	0	15,350	0.0	0	15,306	0.0
Risaralda	Pueblo Rico	0	13,121	0.0	0	13,283	0.0
Caldas	Anserma	0	33,920	0.0	0	33,792	0.0
Caldas	Aranzazu	0	11,566	0.0	0	11,422	0.0
Caldas	Belalcazar	1	10,960	9.1	0	10,863	0.0
Caldas	La Merced	0	5623	0.0	0	5508	0.0
Caldas	Marmato	0	9026	0.0	0	9096	0.0
Caldas	Marulanda	0	3410	0.0	0	3406	0.0
Caldas	Pacora	1	12,244	8.2	0	11,952	0.0

(*continued on next page*)

Table 1 (*continued*)

Department	Municipality	2014			2015		
		Cases	Population	Rates (cases/100,000pop)	Cases	Population	Rates (cases/100,000pop)
Caldas	Pensilvania	0	26,360	0.0	0	26,361	0.0
Caldas	Salamina	0	16,968	0.0	0	16,635	0.0
Caldas	Unknown municipality	0	–	–	11	–	–
Quindio	Unknown municipality	0	–	–	2	–	–

There has been a lack of reports using of GIS for development of epidemiological maps in chikungunya (CHIKV) in Colombia and Latin America [3]. We previously develop it for Sucre department, at the north Caribbean coastal area of Colombia [3].

Surveillance cases data (of the year 2014 and of the first 20 epidemiological weeks of 2015) (official reported by the National Institute of Health of Colombia) were used to estimate annual incidence rates using reference population data (of 2014 and 2015), on CHIKV infections (cases/100,000pop) and to develop the first map in the 53 municipalities of Coffee-Triangles region. GIS used was Kosmo® 3.1.

During 2014, 118 cases of CHIKV were reported in the Coffee-Triangles region, for a cumulated rate of 13.5 cases/100,000pop. Rates ranged from 0 to 78.4 cases/100,000pop (Table 1). Highest incidence was reported at La Dorada municipality, Caldas department (78.4 cases/100,000pop), followed by Córdoba, Quindío (56.4 cases/100,000pop) and Manzanares (21.3 cases/100,000pop) (Fig. 1). In 2014 just 23 out of the 53 municipalities (43%) reported cases of CHIKV. In 2015 there has been a significant increase. During the first 20 epidemiological weeks of the year, 4459 cases have been reported (38 times more than in the whole 2014 year), 57% in Caldas, 22% in Quindío and 20% in Risaralda, for cumulated rate in the region of 530.4 cases/100,000pop (39 times higher). Highest incidence has been reported at La Dorada (2598.7 cases/100,000pop), followed by La Virginia, Risaralda department (1526.3 cases/100,000pop) and Victoria, Caldas (1283.4 cases/100,000pop) (Fig. 1). Until now, 45 out of the 53 municipalities (85%) reported cases of CHIKV. Just in three municipalities of Risaralda (out of 14) and nine of Caldas (out of 27) no cases have been reported yet.

Up to the epidemiological week 20 (January–May 2015) Colombia reported so far 247,599 cases (during 2014 were 106,592; an increase of 2.3 times more cases). At the Coffee-Triangle region, 10 municipalities concentrate 92% of the cases (Table 1). All the municipalities of Quindío department have reported cases, with rates ranging 12.6 (Genova) up to 795.0 cases/100,000pop (La Tebaida, where the international airport of Armenia is located) (Fig. 1). Pereira, the most populated city of the region (469,644 in 2015), have reported 384 cases (81.8 cases/100,000pop) in 2015 (Fig. 1). Not been yet at the half of year, twice number of cases and rates would be expect for the ending of it if no interventions are made. Just during 2014, 585,586 passengers arrived by the Matecaña International Airport of Pereira, then, CHIKV exposure in travelers is highly expectable.

Preparedness on CHIKV for healthcare workers and students in the region have been under intense continuing education activities, but more interventions, including community participation on vector control will be necessary to control and mitigate the effects of *Aedes* transmission on CHIKV, but also on dengue, and the potentially arriving Zika virus.

Use of GIS-based epidemiological maps allow to integrate preventive and control strategies, as well public health policies, for joint control of this vector-borne disease in this and other areas of the country [3]. As CHIKV is transmitted primarily by *A. aegypti*, the dengue virus vector, maps of both infections as well for coinfections will be also needed. Finally also providing relevant information in order to assess the risk of travelers with specific destination in highly transmission areas with the idea of giving prevention advice, even more because they play also an important role in the virus spread, as occurs in Colombia and many of its departments [3].

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Conflicts of interests

The authors state that they have no conflicts of interest.

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