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Letter to the Editor

Mapping Zika in municipalities of one coastal department of Colombia (Sucre) using geographic information systems during the 2015–2016 outbreak: implications for public health and travel advice

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Zika virus (ZIKV) infection emerged in 2015 as one of the most significant tropical infectious diseases in Latin America,[1] following the geographical distribution of chikungunya virus (CHIKV).[2] These viruses share high transmissibility due to the extended presence of the main vector mosquito *Aedes aegypti* in the region.[3] Travelers to endemic areas in Latin American countries should be aware of the risk of exposure to infection through mosquito bites when visiting these areas.[4]

In order to provide useful advice for travelers, epidemiological information is of the utmost importance. Such advice includes the availability of detailed maps in order to assess the risk when visiting a specific destination.[4,5] We have developed among the first published epidemiological maps for ZIKV in Colombia using geographical information systems (GIS) in the department of Sucre, which is located in one of the main tourist regions of the country (Caribbean coast region). We have previously provided GIS-based epidemiological maps for CHIKV for this region.[5]

Scientific reports in which GIS has been used for the development of epidemiological maps for ZIKV are not yet available for Colombia and Latin America, particularly the north Caribbean coastal areas of Colombia (including the department of Sucre), which have been affected significantly by the 2015–2016 Americas outbreak.

Surveillance case data (2015–2016; officially reported by the National Institute of Health of Colombia)[6] were used to estimate the cumulative incidence rates using reference population data (2016) of ZIKV infections (cases/100 000 population) and to develop the first maps for the municipalities of Sucre. The GIS used was Kosmo 3.1.

Up to February 13, 2016 (epidemiological week 6), 1253 cases of ZIKV were reported in Sucre, for a cumulative rate of 145.71 cases/100 000 population (3.4%). Rates at the municipality level ranged from 0 to 405.9 cases/100 000 population. The rate in cases per 100 000 population was 405.9 in Buenavista municipality (3.11% of the department cases), 248.36 in Sincelejo (capital of the department; 55.3%), 240.01 in Morroa (2.8%), 230.29 in Tolú (Santiago de Tolú) (6.2%), 224.02 in Colosó (1.0%), 216.99 in Tolú Viejo (3.3%), and 207.06 in San Juan de Betulia (2.1%) (Figure 1).

Up to April 23, 2016 (epidemiological week 16), 305 additional cases were recorded for a total of 1558, with a cumulative rate of 181.18 cases/100 000 population (2.1%) (Table 1). The previously mentioned seven municipalities (out of 26) reported 72.08% of the cases in the department (Table 1). The greatest change during these 10 epidemiological weeks occurred in San Marcos, with an increase from 15.58 to 136.74 cases/100 000 population. This was followed by San Juan de Betulia, where the rate increased to 310.58 cases/100 000 population (Table 1). Buenavista remained the municipality with the highest rate (426.28 cases/100 000 population). At epidemiological week 16, 25 out of the 26 municipalities reached rates of >10 cases/100 000 population.

Colombia officially reported a total of 87 355 cases in the first 41 epidemiological weeks of the epidemic (21 weeks in 2015 and 20 weeks in 2016); 1.8% were from Sucre department. This department is included among the seven with the highest incidence rates of ZIKV; the first is Norte de Santander (678.21 cases/100 000 population). Sucre is the second in the Caribbean region; the first is Atlántico (250.51 cases/100 000 population). In Sucre, the burden of ZIKV infection was initially concentrated in the north of the department, with the main ecological hotspot in the north-west (up to February 13, 2016), including the municipalities of Tolú, Tolú Viejo, Colosó, Morroa, and Sincelejo (high incidence rates of ≥200 cases/100 000 population) (Figure 1). High rates were also found in two municipalities that do not directly neighbor the north-west municipalities – San Juan de Betulia and Buenavista; however, later (up to April 23, 2016), a high incidence was reported in Corozal, a municipality located between San Juan de Betulia and the north-west municipalities (Figure 1). Given the eco-epidemiological conditions in the department, and particularly in these municipalities, these regions are now becoming endemic for ZIKV. The municipalities of Sucre are also endemic for dengue and CHIKV.[5]

Among cases in Sucre, 403 (25.9%) were in pregnant women (35 confirmed by RT-PCR for ZIKV).[7] Public health policies and strategies for the integrated control of ZIKV in people living in these areas, and also in travelers, should be developed and implemented as a matter of urgency. There has been a very recent report of ZIKV cases imported into Europe in travelers returning from Colombia during the current ZIKV epidemics.[8] This reaffirms the relevance of epidemiological maps for risk assessment. Furthermore, a detailed evaluation of morbidity due to this arbovirus in pregnant women, and mapping of this, should be performed, given the fact that more than a quarter of cases have occurred in this population group.

Although ZIKV was first isolated in 1947,[1] significant related research has been done only since 2013, and particularly since 2014.[9] There has been a sharp increase in research in Latin America and in Colombia, with a particular focus on the association with

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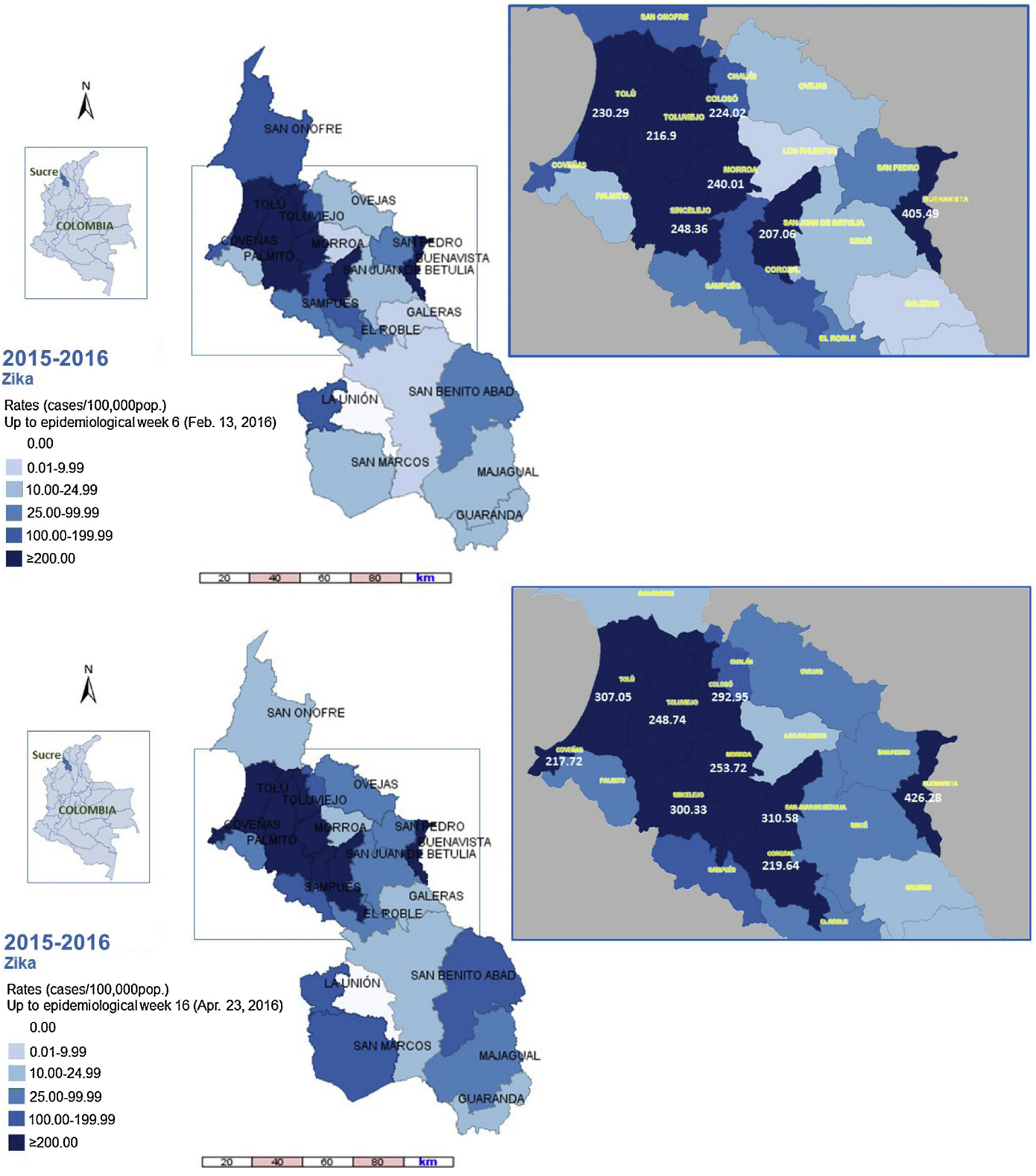

Figure 1. Geographic distribution of ZIKV incidence rates (cases/100 000 population) in Sucre department, Colombia, 2015–2016, at week 6 (February 13, 2016) and at week 16 (April 23, 2016).

microcephaly and other birth defects (congenital Zika syndrome), as well with the Guillain–Barré syndrome.

The use of GIS-based epidemiological maps will allow the integration of prevention and control strategies, as well public health policies, for the joint control of this vector-borne disease in this area of the country.[4,5] As dengue, CHIKV, and ZIKV are transmitted primarily by *A. aegypti* mosquitoes, maps of these infections, as well as co-infections, will also be needed. The simultaneous or subsequent occurrence of arboviral infections should also be assessed. Finally, relevant information should also be provided to assess the risk to travelers with a specific destination in a high transmission area. This is necessary to

Table 1
ZIKV incidence rates (cases/100 000 population) by municipality in Sucre department, Colombia, 2015–2016, at week 6 (February 13, 2016) and at week 16 (April 23, 2016)

Municipality	Cases (2015–2016)		Population (2016)	Rate (cases/100 000 population)		% Cumulative at EW-16
	Up to EW-6	Up to EW-16		Up to EW-6	Up to EW-16	
Whole department	1253	1558	859 909	145.71	181.18	100.00
Buenavista	39	41	9618	405.49	426.28	2.63
San Juan de Betulia	26	39	12 557	207.06	310.58	5.13
Tolú	78	104	33 871	230.29	307.05	11.81
Sincelejo	693	838	279 027	248.36	300.33	65.60
Colosó	13	17	5803	224.02	292.95	66.69
Morroa	35	37	14 583	240.01	253.72	69.06
Tolú Viejo	41	47	18 895	216.99	248.74	72.08
Corozal	116	138	62 830	184.63	219.64	80.94
Coveñas	20	30	13 779	145.15	217.72	82.86
La Unión	20	21	11 262	177.59	186.47	84.21
San Marcos	9	79	57 775	15.58	136.74	89.28
Chalán	5	5	4367	114.50	114.50	89.60
Sampués	24	41	38 067	63.05	107.70	92.23
Sucre municipality	21	24	22 403	93.74	107.13	93.77
El Roble	5	8	10 670	46.86	74.98	94.29
Palmito	3	8	13 953	21.50	57.34	94.80
San Pedro	8	9	16 005	49.98	56.23	95.38
Majagual	8	18	33 438	23.92	53.83	96.53
Sincé	8	16	34 016	23.52	47.04	97.56
Ovejas	5	6	21 030	23.78	28.53	97.95
San Onofre	63	11	50 647	124.39	21.72	98.65
Galeras	1	4	20 515	4.87	19.50	98.91
San Benito Abad	2	5	25 723	7.78	19.44	99.23
Guaranda	3	3	17 646	17.00	17.00	99.42
Los Palmitos	1	2	19 245	5.20	10.39	99.55
Caimito	0	0	12 184	0.00	0.00	99.55
Unknown	6	7	-	-	-	100.00

ZIKV, Zika virus; EW, epidemiological week.

provide advice on prevention, particularly because such travelers play an important role in the spread of the virus,[4,5,8] as occurred in Colombia and Sucre department in 2015–2016.

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Alfonso J. Rodriguez-Morales[a,b,c,*]
Leidy Jhoana Patiño-Cadavid[a]
Carlos O. Lozada-Riascos[c,d]
Wilmer E. Villamil-Gómez[c,e,f]

[a]*Public Health and Infection Research Group, Faculty of Health Sciences, Universidad Tecnologica de Pereira, Pereira, Risaralda, Colombia*
[b]*Organización Latinoamericana para el Fomento de la Investigación en Salud (OLFIS), Bucaramanga, Santander, Colombia*
[c]*Colombian Collaborative Network on Zika (RECOLZIKA), Pereira, Risaralda, Colombia*
[d]*Regional Information System, Universidad Tecnológica de Pereira, Pereira, Risaralda, Colombia*
[e]*Infectious Diseases and Infection Control Research Group, Hospital Universitario de Sincelejo, Sincelejo, Sucre, Colombia*
[f]*SUE Caribe Programa del Doctorado de Medicina Tropical, Universidad del Atlántico, Barranquilla, Colombia*

Corresponding Editor: Eskild Petersen, Aarhus, Denmark.

*Corresponding author.
E-mail address: arodriguezm@utp.edu.co (A.J. Rodriguez-Morales).

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