

Spatial distribution of Zika in Honduras during 2016–2017 using geographic information systems (GIS) – Implications for public health and travel medicine[☆]

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ABSTRACT

Background: Zika virus (ZIKV) infection has significantly affected Latin America in 2015–2017. Most studies have been reported from Brazil and Colombia, and only a few from Central America. For these reasons, we analyzed the incidence, incidence rates and evolution of cases in Honduras from 2016 to 2017.

Methods: Using epidemiological weeks (EW) surveillance data on the ZIKV epidemics in Honduras, we estimated incidence rates (cases/100,000 population), and developed maps at national, departmental and municipal levels.

Results: From 1 January 2016 to 31 December 2017, a total of 32,607 cases of ZIKV were reported (98.5% in 2016 for an incidence rate of 36.85 cases/100,000 pop; 1% confirmed by RT-PCR). The highest peak was reached on the EW 6°, 2016 (2559 cases; 29.34 cases/100,000 pop). The department with the highest number of cases and incidence rate was Cortés (13,128 cases, 791.08 cases/100,000 pop in 2016).

Discussion: The pattern and evolution of ZIKV infection in Honduras have been similar to that which occurred for chikungunya in 2015. As previously reported, infection with chikungunya involved predominantly the central and capital area of the country, reaching incidences there > 750 cases/100,000 pop. Studies using geographical information systems linked with clinical disease characteristics are necessary to attain accurate epidemiological data for public health systems. Such information is also useful for assessment of risk for travelers who visit specific areas in a destination country.

1. Introduction

During the past several years, a significant number of tropical and

subtropical geographic areas have been threatened by an unprecedented occurrence of emerging arboviral outbreaks [1]. Factors such as climate change [2,3], international travel, foreign trade [4,5],

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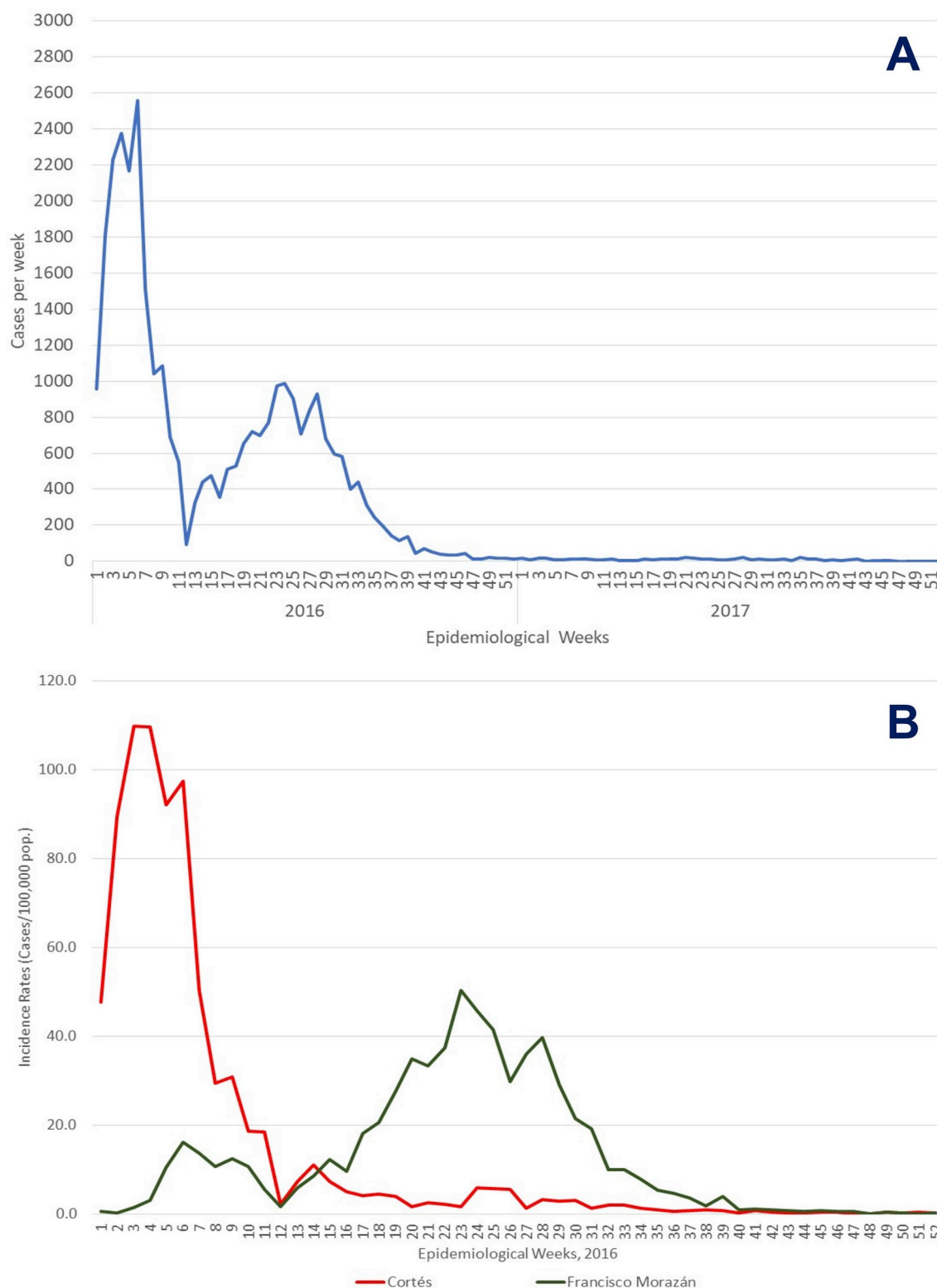


Fig. 1. Temporal distribution by epidemiological weeks of the number of cases of Zika in Honduras, 2015–2016 (A), and the comparison between the evolution during 2016 at Cortés and Francisco Morazán departments (B).

geographical susceptibility, and other factors are associated with these outbreaks [6–10]. In December 2013, chikungunya virus (CHIKV) arrived in the Americas [11], and this was followed shortly by Zika virus (ZIKV) in 2013–2015 [12]. These viruses spread within a population that had already experienced previous endemo-epidemic seasons of urban dengue virus (DENV) and sylvatic yellow fever virus (YFV)

[2,4,5,13,14].

According to the Pan-American Health Organization (PAHO) [15], in Central America 71,316 cases of ZIKV were reported between 2015 and 2017 (11% confirmed by RT-PCR), with > 45% of them occurring within Honduras (Fig. 1), making it the country with the highest number of cases in the region. In general, there are not many other

studies about ZIKV in Honduras [16–20]. Previous publications worth mentioning are multi-country surveillance from 1 April 2015 to 31 March 2016 of ZIKV-associated Guillain-Barre Syndrome (GBS) [21] and case reports about neurological complications of ZIKV such as sensory polyneuropathy [22]. Other publications have highlighted Honduras as a potential point source of ZIKV cases to other countries given the attraction of tourist destinations such as Roatán and the Bay Islands [17–19].

ZIKV was first detected in Honduras in late December 2015 [23,24]. After that, mandatory reporting surveillance of ZIKV cases was established in the country, and the World Federation of Neurology (WFN) established a Zika Working Group to help understand the ZIKV epidemic [25]. Coinciding with the beginning of the epidemics in the country (Fig. 1), the World Health Organization (WHO) declared a Public Health Emergency of International Concern (PHEIC) in February 2016. As of this time, ZIKV has spread to more than 148 countries around the world, mostly in Latin America, and its complications have challenged the existing response capacities of local health systems [5,7,16,26].

The ZIKV epidemics in countries such as Brazil and Colombia stimulated multiple studies, including entomological assessments since the control of the *Aedes aegypti* mosquito, is critical to curbing the spread of the virus [18,24,26,27]. Previous assessments for DENV and CHIKV in Honduras performed by our group demonstrated the importance of *A. aegypti* populations for informing public health decisions and travel advice [6]. This has also been shown in other Latin American countries [6,8,9,13,28,29]. In addition to *A. aegypti*, the presence of *A. albopictus* was confirmed in the Mountain Park Juana Lainez at Tegucigalpa in 2013 [30].

In the past decade, the near real-time availability of novel and disparate internet-based data sources has motivated the development of complementary methodologies to track the incidence and spread of disease. PAHO currently streamlines reports from ministries of health and reports weekly confirmed and suspected cases of ZIKV by country [26,29,31–35]. These reports provide up-to-date data about the epidemiology of ZIKV in affected global regions [6]. However, there is no detailed information about specific places, departments or municipalities, which is necessary to make more specific recommendations to travelers as well for public health prioritization and policies [31,33,36,37].

Understanding the impact of arboviruses, especially ZIKV, in terms of clinical complications, disability and costs to health systems require a greater number of investigations involving multiple medical specialties, mainly in susceptible countries such as Honduras. This information is essential to develop and prepare for possible future epidemics of new arboviruses [10,13].

As part of the enhanced efforts in control and risk assessment for ZIKV in Latin America, the Universidad Tecnológica de Pereira, the Ministry of Health of Honduras and the Universidad Nacional Autónoma de Honduras, are working together in the analysis of epidemiological information of infectious diseases in regional and national scales [6,38], including diseases such as ZIKV, DENV and CHIKV [3,6,29,31–33,36]. In this setting, this study aimed to estimate incidence rates of ZIKV in 2016–2017 for Honduras and its departments and municipalities and to develop GIS-based epidemiological maps for this arboviral disease.

2. Methods

Honduras is a Central American country constituted by 18 departments (main administrative level) (Fig. 2) and 298 municipalities (second administrative level) (Figs. 3 and 4). The Honduran territory presents climatic, geographic and epidemiological conditions suitable for the transmission of many vector-borne diseases. *Aedes aegypti*, the main vector of ZIKV, is widely distributed over all the territories [6,39], constituting large areas where environmental factors such as

temperature, humidity, precipitation, latitude, and altitude, as well as social, cultural, economic and political factors are suitable for sustained vector-transmission [6].

For this observational, retrospective and cross-sectional study, the epidemiological data were collected from the national surveillance system, obtaining the number of cases for each department and each municipality of the country by the years 2016–2017 (detailed by weeks). Data were constituted from clinically confirmed cases (suspected cases by clinical criteria definition) and confirmed by RT-PCR, which have been revised in terms of data quality. Data analyzed for this study came from 298 primary municipal notification units, collected at the 18 department notification units, and consolidated in Tegucigalpa (Francisco Morazán department, Capital District, CD) [6]. Determination of ZIKV infection included syndromic and/or laboratory surveillance (clinical definition of fever, rash, conjunctivitis, and arthralgias in a place with previously ZIKV circulation; at least one case confirmed by RT-PCR). This clinical definition has been recommended by the WHO, PAHO, and the US Centers for Disease Control (CDC).

Using official reference population data (National Institute of Statistics, INE), estimates of the annual incidence rates for all the departments and municipalities of the country were calculated (cases/100,000 pop) to provide estimates of ZIKV incidence by department and municipalities [6].

In addition, national GIS-based maps, by departments and municipalities with the distribution of ZIKV were generated. Microsoft Access® was used to design the spatial databases to import incidence rates by departments, municipalities, and disease to the GIS software. The Client GIS software Open source used was Kosmo Desktop 3.0 RC1®. The shapefiles of departments (.shp) were linked to data table database through spatial join operation, in order to produce digital maps of annual incidence rates by departments and municipalities [6,31,34].

3. Results

From 1 January 2016 to 31 December 2017, a total of 32,607 cases of ZIKV were reported (1% confirmed by RT-PCR for ZIKV), 98.5% of them in 2016, for an incidence rate of 36.85 cases/100,000 pop.

The highest peak was reached on the epidemiological week (EW) 6°, 2016 (2559 cases; 29.34 cases/100,000 pop) (Fig. 1). During the first 10 EW, a total of 16,415 cases were reported (50% of the 2016–2017 period). The number of cases decreased at EW 12° to 93 cases (1.07 cases/100,000 pop). A second peak of cases occurred during EW 24° reaching 988 cases (11.33 cases/100,000 pop) (Fig. 1). By EW 35° more than 95% of the cases of the period were reported.

Of the 18 departments of Honduras, all except Gracias a Dios reported cases during the study period. Rates ranged from 0 to 791.08 cases/100,000 (Cortés, 2016), followed by Francisco Morazán (663.53 cases/100,000, 2016) and Yoro (350.93 cases/100,000, 2016), Santa Barbara (308.64 cases/100,000, 2016), and Olancho (265.65 cases/100,000, 2016) (Fig. 2, Table 1). These 5 departments, which are located in the central and northwestern areas of Honduras (Fig. 2), reported more than 88% of the ZIKV cases of the country (Table 1).

When comparing Cortés and Francisco Morazán incidence over time, clear differences were evident. At Cortés a high number of cases was reported during the first 12 EWs of 2016 reaching up to 109.8 cases/100,000 pop (1815 cases) during that week, for a total of 11,514 cases in the three first months (35% of the cases reported in Honduras during 2016–2017) (Fig. 1). In contrast, there was a low incidence in Francisco Morazán (below 20 cases/100,000 or < 300 cases per week) during the same period. Thereafter, there was a low reported number of cases in Cortés (< 10 cases/100,000 pop) and a significant increase in Francisco Morazán, which reached its peak during the EW 23° with 50.3 cases/100,000 (793 cases that week) for a total of 5453 cases (17% of the cases reported in Honduras during 2016–2017) (Fig. 1). Until EW 23° more than 52% of the cases of the 2016–2017 epidemic were reported from these two departments, documenting a concentrated

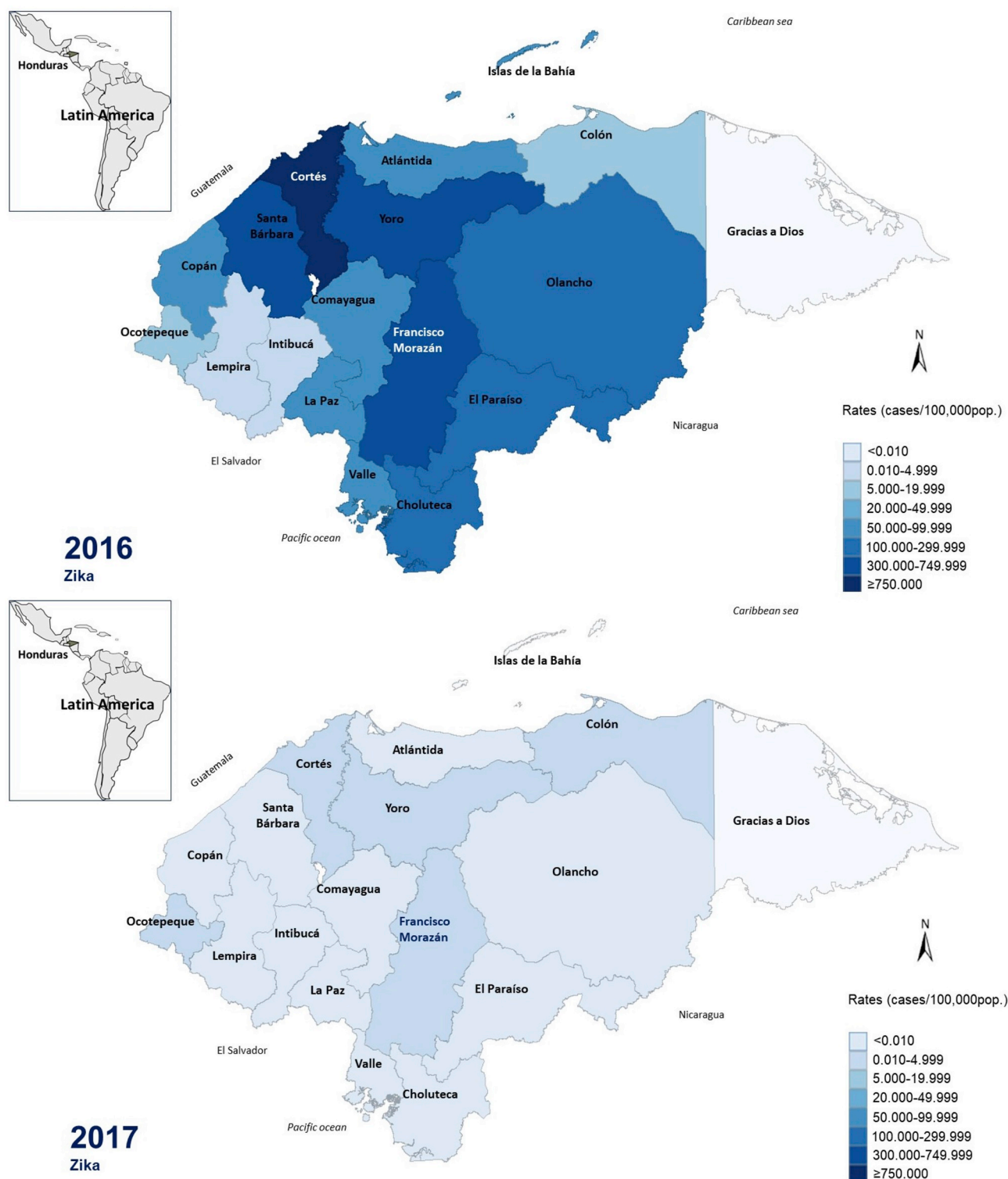


Fig. 2. Geographic distribution by GIS-based map of the calculated incidence rates for Zika in Honduras, 2016–2017 by departments.

occurrence in the most populated departments containing the capital (Tegucigalpa, Francisco Morazán) and second largest city of the country (San Pedro Sula, Cortés) (Table 1).

From the total number of municipalities (298) of Honduras, 69.4% of them reported cases of ZIKV (Table 2). Rates ranged from 0 to 2495.79 cases/100,000 (Ceguapa, Santa Barbara department, 2016), followed by Cane (La Paz department, 1648.91 cases/100,000, 2016) and San Vicente Centenario (Santa Bárbara department, 1,565.18 cases/100,000, 2016) (Fig. 3, Table 2). Tegucigalpa, at the Capital

District, reported 10,386 cases in 2016 for a rate of 860.03 cases/100,000 pop. (Fig. 3).

At Francisco Morazán department, areas closer to Tegucigalpa presented high incidence numbers. For instance, Santa Lucia reported 193.13 cases/100,000 pop and San Buenaventura reported 101.25 cases/100,000 pop (Fig. 4). Similarly, at Cortés department, municipalities such as Villanueva, Choloma, Puerto Cortes, San Manuel, which surround the department capital of San Pedro Sula, demonstrated incidence rates > 100 cases/100,000 pop (Fig. 4) (Table 2)

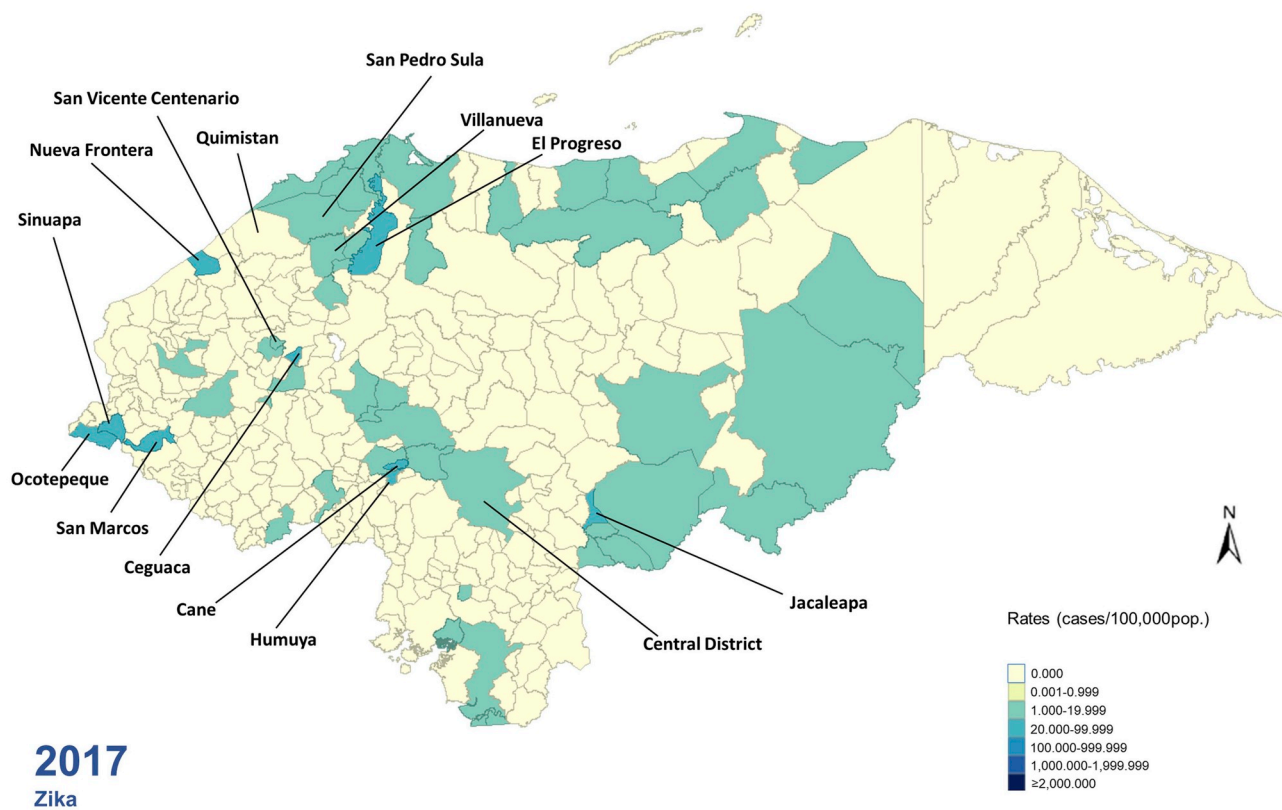
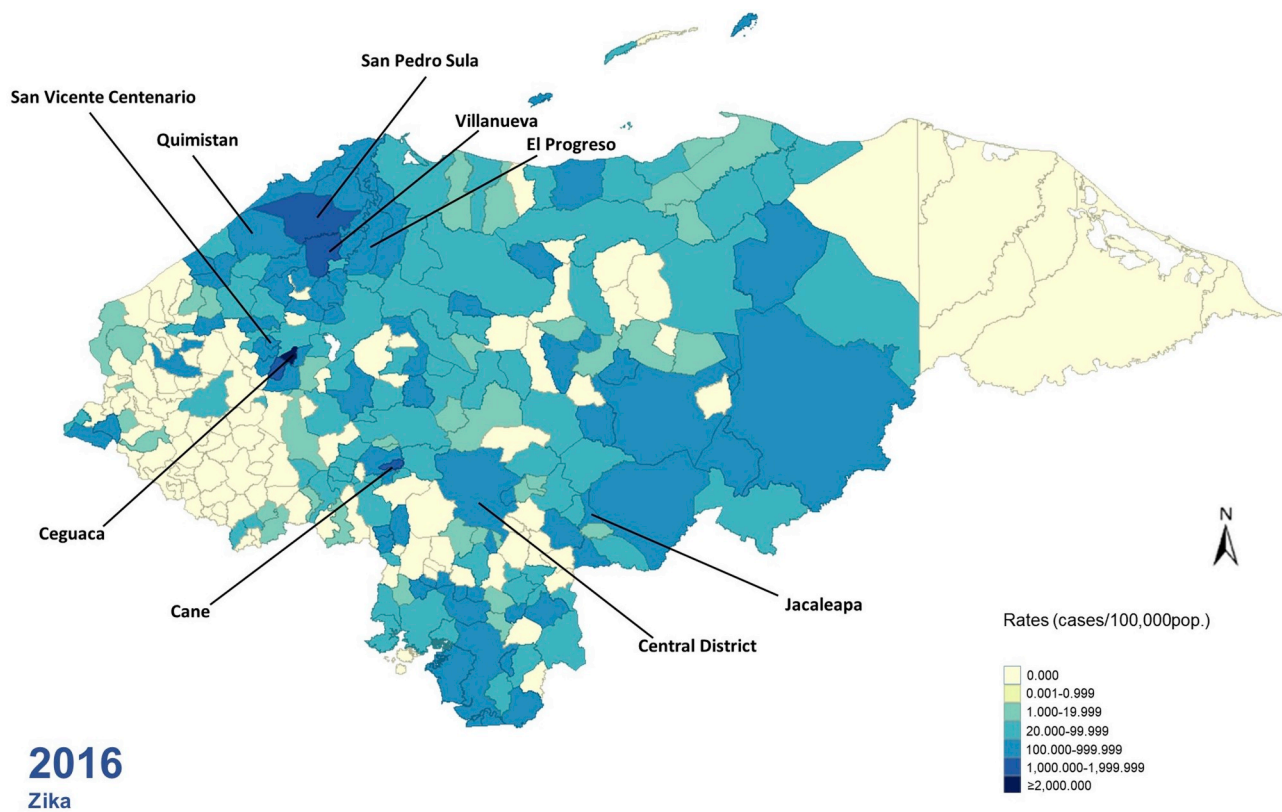


Fig. 3. Geographic distribution by GIS-based map of the calculated incidence rates for Zika in Honduras, 2016–2017 by municipalities.

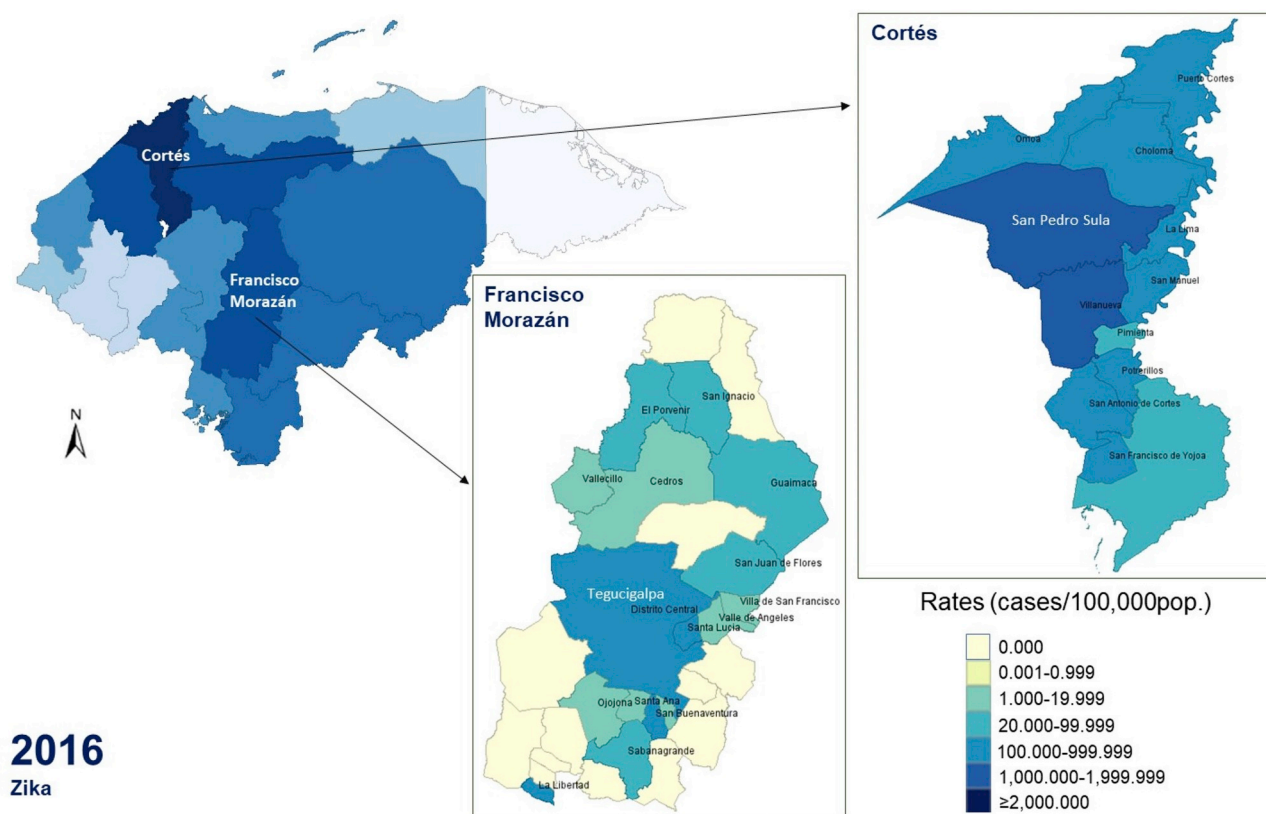


Fig. 4. Geographic distribution by GIS-based map of the calculated incidence rates for Zika in municipalities of Cortés and Francisco Morazán departments, Honduras, 2016.

Table 1

ZIKV incidence rates (cases/100,000 pop) by departments, Honduras, 2016–2017.

Department	Cases		Population		Rates ^a	
	2016	2017	2016	2017	2016	2017
Cortés	13,082	90	1,653,699	1,686,094	791.08	5.34
Francisco Morazán	10,465	189	1,577,178	1,601,291	663.53	11.80
Yoro	2092	58	596,138	604,844	350.93	9.59
Santa Bárbara	1364	13	441,939	448,942	308.64	2.90
Olancho	1450	12	545,835	554,282	265.65	2.16
Choluteca	1037	3	453,360	458,871	228.74	0.65
El Paraíso	905	13	465,864	473,277	194.26	2.75
Copán	361	6	388,810	394,890	92.85	1.52
La Paz	181	3	209,783	213,499	86.28	1.41
Atlántida	373	19	457,031	464,288	81.61	4.09
Islas de la Bahía	51	0	67,704	69,493	75.33	0.00
Comayagua	392	22	521,748	531,676	75.13	4.14
Valle	101	1	180,772	182,996	55.87	0.55
Colón	154	19	324,950	330,105	47.39	5.76
Ocatepeque	58	25	154,251	157,018	37.60	15.92
Intibucá	45	1	246,258	250,959	18.27	0.40
Lempira	21	1	339,310	345,489	6.19	0.29
Gracias a Dios	0	0	96,384	98,337	0.00	0.00
Total	32,132	475	8,721,014	8,866,351	368.44	0.54

^a Cases per 100,000 pop.

(Supplemental Table 1 shows all the municipalities of Honduras by incidence rates).

4. Discussion

As expected, after the arrival of ZIKV to Brazil and other countries in Latin America [12,31], Honduras was significantly affected by ZIKV

cases. As occurred with DENV and CHIKV in 2015 [6], Francisco Morazán and Cortés, the most populated departments, were the most affected. ZIKV has followed the path of dengue and chikungunya in Honduras. Those areas with high incidence rates of these infections also exhibited the highest risk for ZIKV [6]. Although more than 32,000 cases were reported in the country, only 1% of cases have been confirmed by RT-PCR. This is directly related to the financial limitations that preclude assessment of all patients by laboratory confirmation and to a lack of readily available and reliable serological tests. Nonetheless, we used the PAHO case definition which is based upon a clinical definition of ZIKV infection for surveillance data.

Social and eco-epidemiological conditions in Honduras make the whole country susceptible to spread of arboviral diseases such as DENV, CHIKV, and ZIKV [3,6]; therefore, analyses such as the one presented herein are relevant for understanding future emerging arboviral diseases in the region and the country. Other relevant viral diseases to consider include Mayaro (MAYV), Oropouche (OROV), Venezuelan Equine Encephalitis (VEEV), West Nile virus (WNV), among others [1,13,40,41]. Recent social and political movements such as migration of large numbers of people from Central America through Mexico toward the United States of America present the potential for spread of ZIKV and other arboviruses into other regions and countries. Although the last case of ZIKV in Honduras was officially reported in mid-December 2017, transmission is still occurring, albeit with a lower number of incident cases (between 0 and 13 cases/week during first 38 EW of 2018). However, as seen in other countries [7,31–34], marked variation occurred in reported incidence in areas within countries and between 2016 and 2017. This can be explained in part due to previous high attack rates and a decrease in the number of susceptible populations due to herd immunity. As has been recently hypothesized for dengue [42], but also for Zika and chikungunya, this decline is unlikely due to changes in epidemiological surveillance systems, as similar designs of surveillance systems exist across the region. However, future studies

Table 2

Top ten risky municipalities by ZIKV incidence rates (cases/100,000 pop), Honduras, 2016–2017.

Departments	Municipalities	Cases		Population		Rates ^a	
		2016	2017	2016	2017	2016	2017
Santa Bárbara	Ceguapa	131	5	5249	5353	2495.79	93.41
La Paz	Cáne	66	1	4003	4150	1648.91	24.10
Santa Bárbara	San Vicente Centenario	58	0	3706	3736	1565.18	0.00
Cortés	Villanueva	1765	14	161,609	165,602	1092.14	8.45
Copán	San Pedro Sula	8022	29	754,061	765,999	1063.84	3.79
Santa Bárbara	Quimistan	474	0	52,884	54,638	896.30	0.00
El Paraíso	Jacaleapa	36	1	4126	4186	872.55	23.89
Yoro	El Progreso	1678	52	193,567	195,247	866.88	26.63
Francisco Morazán	Tegucigalpa M.D.C.	10,386	189	1,207,635	1,225,043	860.03	15.43
Cortés	Choloma	2100	14	249,217	255,625	842.64	5.48
Olancho	Silca	65	0	8087	8135	803.73	0.00
Santa Bárbara	La Arada	79	1	10,220	10,433	773.00	9.58
Olancho	Juticalpa	821	9	132,484	135,076	619.70	6.66
Santa Bárbara	Nuevo Celilac	49	0	8166	8185	600.04	0.00
Islas de la Bahía	Utila	24	0	4277	4400	561.08	0.00
Copán	Santa Rosa	354	6	65,233	66,629	542.67	9.01
Santa Bárbara	San José de Colinas	104	2	19,266	19,407	539.82	10.31
Santa Bárbara	Trinidad	101	0	20,325	20,563	496.93	0.00
Choluteca	San Antonio de Flores	27	1	5463	5470	494.25	18.28
Olancho	Guayape	60	0	13,027	13,152	460.60	0.00

^a Cases per 100,000 pop.

should address the effect of prior DENV infection on ZIKV incidence and severity, the epidemiological effect of prior ZIKV infection on dengue incidence and severity, immune correlates based on new-generation ELISA assays, and the impact of prior DENV/other arbovirus infection on ZIKV immune response in relation to number of infections and the duration of antibodies in relation to interval of protection [42]. Also, in 2015–2016, environmental conditions in the Americas were ripe for ZIKV transmission [43].

As mentioned previously, in Central America Honduras was the country with the highest number of ZIKV cases [15]. But, some small countries such as Belize actually had a higher incidence rate (636 cases/100,000 pop), with more than 2,000 cases during 2015–2017 [44–46]. One also has to keep in mind that exact numbers of ZIKV cases are difficult to obtain from many of the other countries in Central America [47,48]. Adding the ZIKV cases from Central America which are known to the rest of the continent, more than 800,000 cases have been reported [15].

So far, in Honduras, only 8 cases of congenital Zika syndrome (CSZ) have been reported. But, this figure may not be accurate and may be an underestimate. Further studies are necessary to determine the true frequency of ZIKV infection during pregnancy in Honduras and the association of microcephaly and other birth defects with ZIKV infection [20], as has been reported in Brazil and Colombia, among other countries in Latin America [49–52]. Abortion is currently illegal under any circumstances in Honduras.

In this setting, public health tools for detailed analyses, such as the use of GIS-epidemiological maps [6,34,36], are of high relevance for any affected country. In the case of Central American territories, there is a clear lack of studies developing such maps for arboviral and other infectious diseases. In Honduras, a previous assessment using GIS mapped DENV and CHIKV during 2015 found a similar spatial distribution as has been found for ZIKV in 2016. In 2016, according to the Ministry of Health of Honduras, 22,961 cases of DENV and 15,896 cases of CHIKV were reported. Combining the three arboviral diseases, almost 71,000 cases were reported. In spite of the fact that Honduras has been especially affected by DENV, CHIKV and ZIKV, there is a great lack of scientific and public health studies dealing with these arboviruses [53].

In this study, we estimated the incidence rates of ZIKV and generated epidemiological maps in two geographical levels (departments and municipalities). ZIKV appears to follow the patterns of other arboviral

diseases in the country [6]. Further studies are clearly essential to understand the epidemiological and medical characteristics of this and other arboviruses in Honduras. Although this may not provide all the answers, such information is particularly useful for public health evidenced-based decisions [54]. Developed maps would provide baseline epidemiological information for assessment of the differentiated risk related to acquiring such diseases in certain areas (departments and municipalities) of Honduras. Similar recommendations have previously been made for DENV and CHIKV [3,6].

Use of GIS-based epidemiological maps is very useful to develop preventative/control strategies and public health policies for joint control of these vector-borne diseases in Honduras [6,31–33,36,37], as well as other countries in Central America. These tools such as GIS-based maps can also be developed and used for making public health decisions about other emerging diseases in Honduras.

These maps can also provide relevant information concerning the risk to individuals travelling to specific regions of the world [6,31–33,36,37,55]. A correlated and very important role is using the data to help prevent further spread of viruses such as DENV, CHIKV and ZIKV from other countries (imported cases) to Honduras and other countries in Latin America. According to the Secretary of Tourism of Honduras (*Instituto Hondureño de Turismo*), just in 2014, the country received 1.133 million international tourists (51.3% from Europe and 23.2% from Asia-Pacific region); 107,710 visited the archaeological site of Copán, and 20,118 the fortress of Santa Barbara, both located in Zika-endemic areas).

In the case of ZIKV, previous studies at the department of Islas de la Bahía (Bay Islands), which include Roatan, indicate that this is a highly visited tourist destination during all seasons. This area has a considerable occurrence of DENV and CHIKV [6], highlighting the need for increased measures to prevent arbovirus infection in these areas. A recent study specifically at Roatán found by molecular diagnosis the co-circulation of ZIKV, DENV and CHIKV [18].

Roatan is constantly receiving international cruise ships, with the consequent epidemiological implications, as described [6]. Now, in the department of Colon (with 47.39 cases/100,000 pop of ZIKV in 2016), which includes Trujillo (3.14 cases/100,000 pop of ZIKV in 2016) with its port Puerto Castilla, there is large industrial development and an international hub for cruise ships. This area should also be a focus of concern for travel medicine and public health for ZIKV and other arboviral diseases in Honduras. Such tourist destinations are

epidemiologically suitable for acquisition of ZIKV by international travelers in Honduras. In fact, such acquisition of infection with both ZIKV and CHIKV has been reported in a young woman who returned to Madrid, Spain after visiting Tegucigalpa and Choluteca [19].

In the near future, other eco-epidemiological assessments should be performed in Honduras for these arboviral diseases. With warm temperatures during the whole year, susceptible individuals, and high density of mosquito vectors, many municipalities have become endemic regions for ZIKV in addition to CHIKV and DENV [6].

5. Limitations

Only 1% of cases of ZIKV infection were laboratory confirmed. We used the PAHO case definition in surveillance to be as accurate as possible in obtaining the epidemiological data [37]. This situation is similar to other countries and published reports about GIS-mapping of Zika and other arboviral diseases in the Americas [31–34,36]. But certainly, in Honduras, as in other areas of the tropical Americas, DENV and CHIKV also circulate with ZIKV, and there is overlap in their clinical features. All three viruses have similar clinical presentations, and coinfections may be more common than previously known [4,5,40,56–59]. In addition, there is probably under-reporting of cases in certain areas as compared with more accurate reporting in certain municipalities.

6. Conclusions

GIS-based maps provide relevant information to assess the risk to individuals traveling to specific destinations in endemo-epidemic areas allowing detailed prevention advice [37]. Such maps allow integration of prevention and control strategies, as well as public health policies, for joint control of this vector-borne disease in this and other countries of the region [60]. Simultaneous or sequential arboviral infections occur and should be assessed and mapped as a subject of surveillance [57–59]. Preparedness in this setting should also consider the potential arrival of Mayaro [13,41], Oropouche and yellow fever viruses in *Aedes* infested areas [61].

Ethical approval

Not required.

Conflicts of interest

The authors have no conflict of interest to disclose.

Data availability

Raw data for is available and will be provided on request.

Study design

AJRM, Data collection: LIZ, WOVB, ICFB, JAVR, Data analysis: AJRM, JASD, JCDS, MTM, JDE, Writing: All authors. All authors contributed to and approved of the final version submitted.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.tmaid.2019.01.017>.

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Supplemental Table 1. ZIKV incidence rates (cases/100,000pop) by municipalities, Honduras, 2016-2017.

Departments	Municipalities	Cases		Population		Rates*		Departments	Municipalities	Cases		Population		Rates*	
		2016	2017	2016	2017	2016	2017			2016	2017	2016	2017	2016	2017
Santa Bárbara	Ceguapa	131	5	5,249	5,353	2,495.79	93.41	El Paraíso	San Matías	1	1	5,250	5,321	19.05	18.79
La Paz	Cáne	66	1	4,003	4,150	1,648.91	24.10	Colón	Santa Fé	1	0	5,390	5,376	18.55	0.00
Santa Bárbara	San Vicente Centenario	58	0	3,706	3,736	1,565.18	0.00	Santa Bárbara	San Pedro de Zacapa	2	0	10,790	10,868	18.54	0.00
Cortés	Villanueva	1,765	14	161,609	165,602	1,092.14	8.45	Colón	Santa Rosa de Aguan	1	0	5,463	5,498	18.30	0.00
Copán	San Pedro Sula	8,022	29	754,061	765,999	1,063.84	3.79	Comayagua	Ajuterique	2	0	11,579	11,655	17.27	0.00
Santa Bárbara	Quimistan	474	0	52,884	54,638	896.30	0.00	Comayagua	Lejamani	1	0	5,831	5,883	17.15	0.00
El Paraíso	Jacaleapa	36	1	4,126	4,186	872.55	23.89	Atlántida	Lamasica	5	2	30,619	31,034	16.33	6.44
Yoro	El Progreso	1,678	52	193,567	195,247	866.88	26.63	Olancho	Yocon	2	0	12,375	12,566	16.16	0.00
Francisco Morazán	Tegucigalpa M.D.C.	10,386	189	1,207,635	1,225,043	860.03	15.43	Intibucá	Intibuca	9	0	60,264	61,695	14.93	0.00
Cortés	Choloma	2,100	14	249,217	255,625	842.64	5.48	Comayagua	San José del Potrero	1	0	7,018	7,125	14.25	0.00
Olancho	Silca	65	0	8,087	8,135	803.73	0.00	Ocatepeque	San Marcos	3	7	21,068	21,448	14.24	32.64
Santa Bárbara	La Arada	79	1	10,220	10,433	773.00	9.58	Olancho	Salamá	1	0	7,778	7,859	12.86	0.00
Olancho	Juticalpa	821	9	132,484	135,076	619.70	6.66	Francisco Morazán	Villa de San Francisco	1	0	8,641	8,755	11.57	0.00
Santa Bárbara	Nuevo Celilac	49	0	8,166	8,185	600.04	0.00	Choluteca	Orocuína	2	0	18,578	18,676	10.77	0.00
Islas de la Bahía	Utila	24	0	4,277	4,400	561.08	0.00	Intibucá	Colomoncagua	2	1	18,613	18,737	10.75	5.34
Copán	Santa Rosa	354	6	65,233	66,629	542.67	9.01	El Paraíso	Soledad	1	0	9,352	9,352	10.69	0.00
Santa Bárbara	San Jose de Colinas	104	2	19,266	19,407	539.82	10.31	La Paz	Yarula	1	0	9,356	9,522	10.69	0.00
Santa Bárbara	Trinidad	101	0	20,325	20,563	496.93	0.00	Olancho	San Francisco de La Paz	2	0	19,937	20,183	10.03	0.00
Choluteca	San Antonio de Flores	27	1	5,463	5,470	494.25	18.28	Ocatepeque	La Labor	1	0	10,012	10,188	9.99	0.00
Olancho	Guayape	60	0	13,027	13,152	460.60	0.00	Valle	Langue	2	0	21,275	21,387	9.40	0.00
Santa Bárbara	Concepción del Sur	25	0	5,514	5,517	453.42	0.00	Francisco Morazán	Ojona	1	0	10,872	11,017	9.20	0.00
Choluteca	Pespire	106	0	24,024	24,063	441.22	0.00	Francisco Morazán	Vallecillos	1	0	10,981	11,147	9.11	0.00
Olancho	Santa María del Real	47	0	10,823	10,875	434.25	0.00	Colón	Sonagera	4	1	44,574	45,073	8.97	2.22
Cortés	Puerto Cortes	538	25	127,968	129,961	420.42	19.24	Olancho	Manto	1	0	11,697	11,748	8.55	0.00
Cortés	San Manuel	241	1	58,927	61,159	408.98	1.64	La Paz	Santa Ana	1	0	12,304	12,486	8.13	0.00
Choluteca	San Isidro	14	0	3,765	3,793	371.81	0.00	Francisco Morazán	Santa Ana	1	0	16,661	16,889	6.00	0.00
Yoro	El Negrito	170	0	47,104	47,663	360.91	0.00	Santa Bárbara	Protección	1	0	17,013	17,220	5.88	0.00
Valle	San Francisco de Coray	35	0	9,859	9,910	355.00	0.00	Francisco Morazán	Valle de Angeles	1	0	18,189	18,747	5.50	0.00
Choluteca	Choluteca	549	2	159,739	162,125	343.69	1.23	Atlántida	Arizona	1	0	24,345	24,578	4.11	0.00
El Paraíso	Danlí	688	8	206,922	210,742	332.49	3.80	Copán	Santa Rita	1	0	31,072	31,455	3.22	0.00
La Paz	San Antonio del Norte	9	0	2,817	2,851	319.49	0.00	Colón	Trujillo	2	6	63,622	64,688	3.14	9.28
La Paz	San Juan	8	0	2,539	2,571	315.03	0.00	Copán	Copan Ruinas	1	0	40,219	40,952	2.49	0.00
Santa Bárbara	Santa Barbara	123	2	44,182	45,002	278.40	4.44	Copán	Nueva Arcadia	1	0	42,590	43,346	2.35	0.00
Choluteca	Marcóvia	121	0	46,725	47,113	258.96	0.00	Atlántida	San Francisco	0	0	15,277	15,531	0.00	0.00
Olancho	Catacámas	318	2	124,599	126,982	255.22	1.58	Colón	Iriona	0	0	21,461	21,716	0.00	0.00
Comayagua	San Jerónimo	53	0	22,064	22,441	240.21	0.00	Comayagua	Lajas	0	0	15,038	15,284	0.00	0.00
Islas de la Bahía	Guanaja	13	0	5,595	5,663	232.34	0.00	Comayagua	La Trinidad	0	0	4,694	4,755	0.00	0.00
Cortés	La Lima	177	0	76,823	78,596	230.40	0.00	Comayagua	Meambar	0	0	13,092	13,287	0.00	0.00
Santa Bárbara	Nueva Frontera	29	3	13,395	13,504	216.49	22.22	Comayagua	San José de Comayagua	0	0	7,882	7,909	0.00	0.00
Choluteca	El Triunfo	99	0	45,741	46,490	216.44	0.00	Comayagua	Lamani	0	0	7,176	7,239	0.00	0.00
Choluteca	Santa Ana de Yusguare	30	0	14,717	14,813	203.84	0.00	Copán	Cabañas	0	0	14,725	15,082	0.00	0.00
El Paraíso	Yuscaran	30	0	14,974	15,271	200.34	0.00	Copán	Concepción	0	0	8,311	8,524	0.00	0.00
Santa Bárbara	Pettoa	25	0	12,501	12,617	199.98	0.00	Copán	Corquin	0	0	17,542	17,940	0.00	0.00
Choluteca	Morolica	10	0	5,007	5,012	199.70	0.00	Copán	Cucuyagua	0	0	17,042	17,379	0.00	0.00
Francisco Morazán	Santa Lucía	26	0	13,463	14,065	193.13	0.00	Copán	Dolores	0	0	6,777	6,902	0.00	0.00
El Paraíso	Alauca	18	1	9,354	9,433	192.43	10.60	Copán	Dulce Nombre	0	0	6,116	6,273	0.00	0.00
Cortés	San Francisco de Yojoa	42	0	23,097	23,499	181.84	0.00	Copán	El Paraíso	0	0	20,053	20,104	0.00	0.00
El Paraíso	Liure	19	0	10,808	10,852	175.80	0.00	Copán	Florida	0	0	29,134	29,400	0.00	0.00
Francisco Morazán	La Libertad	5	0	2,869	2,900	174.25	0.00	Copán	La Jigua	0	0	9,579	9,677	0.00	0.00
Santa Bárbara	Concepción del Norte	16	0	9,303	9,405	171.98	0.00	Copán	La Union	0	0	16,463	16,612	0.00	0.00
Ocatepeque	Nueva Ocatepeque	38	12	24,337	24,770	156.14	48.45	Copán	San Agustín	0	0	5,721	5,801	0.00	0.00
Santa Bárbara	El Nispero	13	0	8,580	8,745	151.52	0.00	Copán	San Antonio	0	0	10,064	10,185	0.00	0.00
Olancho	Patuca	40	0	27,433	27,671	145.81	0.00	Copán	San Jeronimo	0	0	5,097	5,120	0.00	0.00
Comayagua	Humuya	2	1	1,378	1,399	145.10	71.49	Copán	San José	0	0	7,152	7,218	0.00	0.00
Santa Bárbara	Ilama	13	0	9,137	9,160	142.28	0.00	Copán	San Juan de Opoa	0	0	9,750	9,788	0.00	0.00
Ocatepeque	Sinuapa	13	6	9,371	9,601	138.73	62.49	Copán	San Nicolas	0	0	7,932	8,068	0.00	0.00
Atlántida	La Ceiba	285	11	207,733	211,327	137.20	5.21	Copán	San Pedro	0	0	7,716	7,772	0.00	0.00
Santa Bárbara	Macuelizo	49	0	36,058	36,607	135.89	0.00	Copán	Veracruz	0	0	3,399	3,447	0.00	0.00
Yoro	Jocom	13	0	9,687	9,710	134.20	0.00	Choluteca	Apacilagua	0	0	9,084	9,093	0.00	0.00
Choluteca	San José	6	0	4,543	4,633	132.08	0.00	Choluteca	Concepción de Maria	0	0	27,469	27,687	0.00	0.00
Cortés	Omóa	63	5	48,495	49,749	129.91	10.05	El Paraíso	Guinópe	0	0	8,949	9,107	0.00	0.00
Cortés	San Antonio de Cortes	29	1	22,386	22,498	129.54	4.44	El Paraíso	Oropolí	0	0	6,053	6,090	0.00	0.00
Olancho	Campamento	27	0	21,283	21,814	126.86	0.00	El Paraíso	San Antonio de Flores	0	0	5,729	5,783	0.00	0.00
Olancho	El Rosário	5	0	4,282	4,298	116.76	0.00	Francisco Morazán	Alubaren	0	0	5,566	5,576	0.00	0.00
Olancho	San Esteban	30	0	26,488	26,781	113.26	0.00	Francisco Morazán	Curaren	0	0	20,775	20,924	0.00	0.00
Comayagua	Siguastepeque	114	12	101,316	103,506	112.52	11.59	Francisco Morazán	La Venta	0	0	6,353	6,421	0.00	0.00
La Paz	La Paz	52	1	47,452	48,640	109.58	2.06	Francisco Morazán	Lepaterique	0	0	21,245	21,767	0.00	0.00
Cortés	Potrerrillos	26	0	24,626	24,958	105.58	0.00	Francisco Morazán	Maraita	0	0	6,867	6,927	0.00	0.00
Santa Bárbara	Naranjito	13	0	12,447	12,637	104.45	0.00	Francisco Morazán	Marale	0	0	9,183	9,199	0.00	0.00
La Paz	Aguanqueterique	5	0	4,846	4,888	103.17	0.00	Francisco Morazán	Nueva Armenia	0	0	3,782	3,880	0.00	0.00
Yoro	Yorito	21	0	20,372	20,926	103.09	0.00	Francisco Morazán	Orica	0	0	14,398	14,604	0.00	0.00
Comayagua	La Libertad	28	0	27,652	28,275	101.26	0.00	Francisco Morazán	Reitoca	0	0	10,735	10,761	0.00	0.00
Francisco Morazán	San Buenaventura	3	0	2,963	3,029	101.25	0.00	Francisco Morazán	San Antonio De Oriente	0	0	15,446	15,598	0.00	0.00
Colón	Balfate	13	0	13,273	13,326	97.95	0.00	Francisco Morazán	San Miguelito	0	0	1,943	1,957	0.00	0.00
Yoro	Olanchito	105	5	110,437	112,444	95.08	4.45	Francisco Morazán	Talanga	0	0	36,285	36,733	0.00	0.00
El Paraíso	El Paraíso	43	1	45,638	45,920	94.22	2.18	Francisco Morazán	Tatumbla	0	0	7,799	8,018	0.00	0.00
Colón	Sava	29	0	30,949	31,402	93.70	0.00	Gracias a Dios	Puerto Lempira	0	0	51,702	53,131	0.00	0.00
Choluteca	San Marcos de Colon	26	0	28,102	28,679	92.52	0.00	Gracias a Dios	Brus Laguna	0	0	13,505	13,801	0.00	0.00
El Paraíso	Moroceli	16	0	17,458	17,764	91.65	0.00	Gracias a Dios	Ahuas	0	0	8,539	8,694	0.00	0.00
Colón	Tocóa	87	10	96,360	98,602	90.29	10.14	Gracias a Dios	Juan Francisco Bulnes	0	0	6,417	6,428	0.00	0.00
Comayagua	Comayagua	139	6	155,948	159,904	89.13	3.75	Gracias a Dios	Ramón Villeda Morales	0	0	10,348	10,365	0.00	0.00
Choluteca	Duyure	3	0	3,529	3,537	85.01	0.00	Gracias a Dios	Wampusirpe	0	0	5,873	5,919	0.00	0.00
Santa Bárbara	San Luis	21	0	25,033	25,166	83.89	0.00	Intibucá	Dólores	0	0	5,434	5,537	0.00	0.00
Yoro	Victória	29	0	34,848	35,475	83.22</									

Cortés	Santa Cruz de Yojoa	70	0	86,590	88,054	80.84	0.00	Intibucá	San Isidro	0	0	4,701	4,812	0.00	0.00
Valle	San Lorenzo	34	1	43,977	44,917	77.31	2.23	Intibucá	San Juan	0	0	14,138	14,390	0.00	0.00
Valle	Caridad	3	0	3,980	4,000	75.37	0.00	Intibucá	San Marcos de La Sierra	0	0	9,123	9,285	0.00	0.00
Intibucá	Jesus de Otoro	22	0	30,073	30,663	73.15	0.00	Intibucá	San Miguelito	0	0	8,006	8,236	0.00	0.00
El Paraíso	Yauyupe	1	0	1,378	1,394	72.57	0.00	Intibucá	Santa Lucía	0	0	5,382	5,434	0.00	0.00
Choluteca	El Corpus	18	0	25,337	25,591	71.04	0.00	Intibucá	Yamarangila	0	0	21,946	22,258	0.00	0.00
Olancho	Gualaco	16	0	22,552	22,769	70.95	0.00	Intibucá	San Francisco de Opalaca	0	0	11,685	12,024	0.00	0.00
El Paraíso	Potrerrillos	3	0	4,553	4,663	65.89	0.00	Islas de la Bahía	Jose Santos Guardiola	0	0	11,698	11,823	0.00	0.00
Yoro	Santa Rita	13	0	20,710	20,841	62.77	0.00	La Paz	Cabañas	0	0	3,492	3,579	0.00	0.00
Comayagua	San Luis	7	0	11,561	11,718	60.55	0.00	La Paz	Lauterique	0	0	3,040	3,060	0.00	0.00
Comayagua	Villa de San Antonio	15	1	24,824	25,234	60.43	3.96	La Paz	Mercedes de Oriente	0	0	1,124	1,138	0.00	0.00
Yoro	Morazán	26	1	43,163	44,188	60.24	2.26	La Paz	Opatoro	0	0	7,662	7,754	0.00	0.00
La Paz	Santiago de Puringla	10	0	16,782	16,978	59.59	0.00	La Paz	San Pedro de Tutule	0	0	7,290	7,421	0.00	0.00
Intibucá	Camasca	4	0	6,924	6,977	57.77	0.00	La Paz	Santa Elena	0	0	12,904	13,139	0.00	0.00
Francisco Morazán	El Porvenir	13	0	22,611	23,655	57.49	0.00	Lempira	Belen	0	0	7,477	7,720	0.00	0.00
El Paraíso	Texiguat	5	0	8,817	8,841	56.71	0.00	Lempira	Candelaria	0	0	6,896	6,931	0.00	0.00
El Paraíso	Teupasénti	25	0	44,442	45,417	56.25	0.00	Lempira	Cololaca	0	0	9,401	9,715	0.00	0.00
Copán	Trinidad	4	0	7,122	7,215	56.17	0.00	Lempira	Erandique	0	0	15,823	16,009	0.00	0.00
Atlántida	Jutiápa	20	1	35,690	36,207	56.04	2.76	Lempira	Gualcince	0	0	11,697	11,826	0.00	0.00
Comayagua	Ojos de Agua	6	0	10,739	10,873	55.87	0.00	Lempira	Guarita	0	0	8,577	8,646	0.00	0.00
Valle	Guascoran	8	0	14,441	14,489	55.40	0.00	Lempira	La Campa	0	0	7,172	7,408	0.00	0.00
Santa Bárbara	Azacualpa	11	0	21,693	22,240	50.71	0.00	Lempira	La Iguala	0	0	27,508	28,219	0.00	0.00
Atlántida	Téla	51	5	100,650	102,018	50.67	4.90	Lempira	Las Flores	0	0	6,662	6,682	0.00	0.00
Santa Bárbara	Santa Rita	2	0	4,020	4,036	49.75	0.00	Lempira	La Unión	0	0	10,005	10,172	0.00	0.00
El Paraíso	Vado Ancho	2	0	4,050	4,071	49.38	0.00	Lempira	La Virtud	0	0	13,463	13,791	0.00	0.00
Yoro	Sulaco	9	0	18,517	18,866	48.60	0.00	Lempira	Lepaera	0	0	38,445	39,004	0.00	0.00
La Paz	Chinacla	4	0	8,232	8,366	48.59	0.00	Lempira	Mapulaca	0	0	4,338	4,360	0.00	0.00
Santa Bárbara	Las Vegas	12	0	25,196	25,596	47.63	0.00	Lempira	Piraera	0	0	14,306	14,485	0.00	0.00
La Paz	Guajiquiro	7	0	15,138	15,317	46.24	0.00	Lempira	San Andres	0	0	13,807	14,028	0.00	0.00
Cortés	Pimienta	9	1	19,899	20,394	45.23	4.90	Lempira	San Francisco	0	0	9,205	9,260	0.00	0.00
La Paz	Marcala	13	1	30,504	31,148	42.62	3.21	Lempira	San Juan de Guarita	0	0	2,693	2,710	0.00	0.00
Francisco Morazán	Sabana Grande	9	0	21,445	21,781	41.97	0.00	Lempira	San Manuel de Colohete	0	0	14,854	15,123	0.00	0.00
Colón	Bonito Oriental	12	0	29,087	29,313	41.25	0.00	Lempira	San Rafael	0	0	13,938	14,109	0.00	0.00
Lempira	Gracias	21	1	51,635	53,018	40.67	1.89	Lempira	San Sebastian	0	0	11,069	11,279	0.00	0.00
Valle	Alianza	3	0	7,544	7,562	39.77	0.00	Lempira	Santa Cruz	0	0	7,258	7,429	0.00	0.00
Ocotepeque	Santa Fe	2	0	5,090	5,174	39.30	0.00	Lempira	Talgua	0	0	10,908	11,071	0.00	0.00
Olancho	Dulce Nombre del Culmi	12	1	30,836	31,118	38.92	3.21	Lempira	Tambla	0	0	3,291	3,360	0.00	0.00
Santa Bárbara	San Marcos	6	0	15,709	15,857	38.20	0.00	Lempira	Tomalá	0	0	6,574	6,652	0.00	0.00
Olancho	La Unión	3	0	7,949	8,038	37.74	0.00	Lempira	Valladolid	0	0	3,774	3,802	0.00	0.00
Intibucá	San Antonio	2	0	5,614	5,658	35.62	0.00	Lempira	Virginia	0	0	2,588	2,605	0.00	0.00
Colón	Limón	5	2	14,770	15,112	33.85	13.23	Lempira	San Marcops de Caiquin	0	0	5,946	6,076	0.00	0.00
Santa Bárbara	San Nicolas	5	0	15,112	15,360	33.09	0.00	Ocotepeque	Belen Gualcho	0	0	16,276	16,568	0.00	0.00
Intibucá	La Esperanza	4	0	12,955	13,413	30.88	0.00	Ocotepeque	Concepción	0	0	5,344	5,439	0.00	0.00
Yoro	Yoro	28	0	91,751	93,489	30.52	0.00	Ocotepeque	Dolores Merendon	0	0	4,140	4,287	0.00	0.00
Islas de la Bahía	Roatan	14	0	46,133	47,608	30.35	0.00	Ocotepeque	Fraternidad	0	0	5,769	6,111	0.00	0.00
El Paraíso	Las Trojes	15	1	50,047	51,011	29.97	1.96	Ocotepeque	Lucerna	0	0	6,083	6,157	0.00	0.00
Comayagua	El Rosario	9	2	30,687	31,339	29.33	6.38	Ocotepeque	Mercedes	0	0	7,423	7,491	0.00	0.00
Comayagua	Esquiás	6	0	21,262	21,514	28.22	0.00	Ocotepeque	San Fernando	0	0	7,126	7,184	0.00	0.00
Comayagua	San Sebastian	1	0	3,631	3,629	27.54	0.00	Ocotepeque	San Francisco del Valle	0	0	9,946	10,051	0.00	0.00
Valle	Nacaome	16	0	59,291	59,970	26.99	0.00	Ocotepeque	San Jorge	0	0	5,258	5,336	0.00	0.00
Santa Bárbara	San Francisco de Ojuera	2	0	7,441	7,595	26.88	0.00	Ocotepeque	Sesenti	0	0	11,776	11,881	0.00	0.00
La Paz	Santa María	3	0	11,250	11,404	26.67	0.00	Olancho	Concordia	0	0	8,418	8,498	0.00	0.00
Atlántida	Esparta	5	0	19,125	19,364	26.14	0.00	Olancho	Esquipulas del Norte	0	0	11,135	11,496	0.00	0.00
Atlántida	El Porvenir	6	0	23,592	24,228	25.43	0.00	Olancho	Guarizama	0	0	7,896	7,942	0.00	0.00
El Paraíso	San Lucas	2	0	7,963	8,057	25.12	0.00	Olancho	Guata	0	0	12,236	12,385	0.00	0.00
Francisco Morazán	San Juan de Flores	4	0	16,457	16,857	24.31	0.00	Olancho	Jano	0	0	4,943	5,083	0.00	0.00
Francisco Morazán	Guaimáca	7	0	29,438	29,923	23.78	0.00	Olancho	Mangulile	0	0	9,481	9,495	0.00	0.00
Comayagua	Minas de Oro	3	0	13,445	13,548	22.31	0.00	Olancho	San Francisco de Becerra	0	0	10,096	10,318	0.00	0.00
Francisco Morazán	San Ignacio	2	0	9,036	9,119	22.13	0.00	Santa Bárbara	Atima	0	0	18,752	19,132	0.00	0.00
La Paz	San José	2	0	9,047	9,086	22.11	0.00	Santa Bárbara	Chinda	0	0	4,886	4,947	0.00	0.00
Comayagua	Taulabe	5	0	24,930	25,158	20.06	0.00	Santa Bárbara	Gualala	0	0	5,361	5,416	0.00	0.00
Francisco Morazán	Cedros	5	0	25,539	26,003	19.58	0.00	Valle	Amapala	0	0	13,020	13,302	0.00	0.00
Intibucá	Concepción	2	0	10,379	10,557	19.27	0.00	Valle	Aramecina	0	0	7,384	7,460	0.00	0.00
Ocotepeque	La Encarnación	1	0	5,232	5,330	19.11	0.00	Yoro	Arenal	0	0	5,983	5,995	0.00	0.00
Total										32,132	475	8,721,014	8,866,351	368.44	5.36

*Cases per 100,000 pop.