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Clinical and Epidemiological Characterization of Dengue Outbreak in Cabo Verde in 2009-2010

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Abstract

Background: Dengue fever is one of the most significant public health problems as a vector-borne disease in tropical and subtropical countries. Cape Verde, a tropical country located in the Atlantic coast, has recorded cases of vector-borne diseases since the colonization of the islands, Cape Verde. In 2009, for the first time, an outbreak of dengue has been detected in Cabo Verde, namely in the Sotavento islands. In this study, we analyzed the clinical and epidemiological characteristics of dengue in Cape Verde during the outbreak in 2009-2010 and the next years, until 2016.

Methods: Based on officially reported dengue cases from Cabo Verde during the outbreak 2009-2010 and the others residual cases until 2016, epidemiological and clinical characteristics were analyzed.

Results: A total of 25.088 of cases of Dengue Fever (DF) were recorded, being mainly (more than 99%) during the outbreak in 2009-2010 and 174 Hemorrhagic Dengue Fever (HDF) cases in the same year. In the next years, imported cases were notified and in 2016, other 4 indigenous cases were notified in the country. The majority of cases were reported in Santiago, the main island, especially in Praia, the capital, São Filipe, in Fogo and Maio. The principal symptoms during the outbreak were retro-orbital pain, fever and headache and the principal clinic's forms were the classic dengue, viruses, and dengue with warning signs, with 15.577, 7.150 and 2.344 cases respectively.

Conclusion: For the first time, the country experienced the dengue virus in its territory, with greater weight in Barlavento Islands. Because of the ability to respond few cases of death were recorded during the outbreak. The lessons learned from this epidemic resulted in an investment in all areas regarding the prevention and control of dengue and other arboviruses.

Keywords: Epidemiology; Dengue fever; Outbreak; Cape Verde

List of Abbreviations HDC: Hot Desert Climate; DDT: Dichlorodiphenyltrichloroethane; GDP: Gross Domestic Product; IRS: Indoor Residual Spraying; MoH: Ministry of Health; NMCP: National Malaria Control Program; NOSI: Operational Nucleus of Information Society; WHO: World Health Organization

Introduction

Dengue is one of the most common vector-borne diseases in tropical and sub-tropical regions, transmitted by *Aedes aegypti* and *Aedes albopictus* mosquitoes [1-3]. According to the World Health Organization (WHO), 40%-60% of the world's population, approximately 2.5-4 billion persons live in areas at risk for dengue virus (DENV) infection [4,5], with an estimated annual total of 390 million infections. Dengue fever is a neglected tropical disease mainly in Africa [6].

Although the WHO estimates 50-100 million infections per year globally, other studies suggest much higher cases [2]. DENV affect especially the Southeast Asia and Western Pacific where it represents about 75% of the global dengue burden [3] and causing a substantial economic cost in these regions [1].

From the early 1460s, Cabo Verde report cases of vector-borne diseases, mainly malaria. With the first studies of medical entomology carried out in the country, *Aedes aegypti* was the second mosquito species recognized, firstly identified on the island of São Vicente in 1920. Years later, it was also identified in Sal, Boavista and São Nicolau islands. In 1950, its presence was confirmed in the island Brava [7]. Currently, the species is present at the national level, in all islands [8].

Despite the presence of the dengue major vector, *Aedes aegypti*, in the country, dengue has never been reported in Cape Verde until 2009.

In this year, the country started reporting cases, and the first outbreak of dengue was confirmed, in the same time that others Africa countries reported outbreaks, namely in Tanzania, Zanzibar, Comoros, and Benin [9-11]. Followed substantial numbers of cases in Angola [12], Kenya, and Somalia in 2011-2014 [13]. In view of the available data, all 4 DENV serotypes have now been documented to circulate in Africa, although DENV-2 has been reported most frequently [14]. During the outbreak in Cape Verde the serotypes DENV-3 was identified [15].

In this study, we analyze the variability of DF in Cape Verde from 2009-2016 through the epidemiological and clinical dynamics and provide proper information essential for planning and development of relevant control/preventive measures against dengue in the country.

Materials and Methods

Study area

Located on the Atlantic coast, in West Africa (latitude 17º 12 'and 14º 48 'north and longitude 22º 44' and 25º 22 'west), Cabo Verde is an archipelagic country, with a total area of 4033 Km^2, composed by ten islands, and 22 municipalities (Figure 1). According to the census report in 2010 and the 2030 demographic projection, the resident population in 2018 is estimated at 544.081 habitats, with 62% living in urban areas and 38% in rural areas. Around 48% of the population are concentred in Santiago, and the capital city, Praia, with 26.9% of the population.

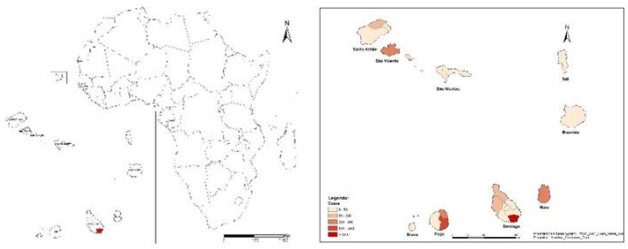

Figure 1: Location of the Cape Verde islands.

According to the 2010 Census (INE 2010), Cape Verde's population grew by 1.23% between 2000 and 2010, being 491,575 inhabitants in 2010, distributed in 62% in the urban environment and 38% in rural areas, with a slight predominance of (M/F ratio of 98%). Children younger than 15 years of age represent 32% of the general population and the average age was 22 years old. In fact, the country has also become, in recent decades, an area of attraction for immigrants, mainly from African countries, but also from Europe and Asia. The 2010 Census revealed that 14,373 of inhabitants were foreigners, corresponding to 2.9% of the country's total population.

This study used the dengue data reported by the health facilities (routine data) at the national level during the 2009/2010 outbreaks, as well as those of the following years up to 2016.

Case surveillance and data collection

Dengue fever is a legally notifiable infectious disease in Cabo Verde. Weakly, through the notification form, all health facilities notify the information about dengue in the country to the epidemiological surveillance service of the Ministry of Health.

A computerized database was developed, which allowed for the collection of patient information and the symptoms which allowed the national data to be available and analyzed daily.

The information required for each notification includes demographic data such as name, unique identification number, age, gender, residential area, dates of symptom onset and diagnosis, and whether the diagnosis was clinical or confirmed by laboratory tests. Only physician-diagnosed (clinical diagnosis) or laboratory-confirmed cases of dengue, according to the WHO's criteria, were included in this study during the outbreak. Data from the other years included imported cases was used in this study, to have an idea about the risk in the country.

Statistical analysis

To study the clinical and epidemiological dengue outbreak in Cape Verde was done a social-epidemiological characterization of dengue in the country, the prevalence by island and municipality to the outbreak cases, 2009/2010.

The clinical analyses were done seeing the 2009/2010 cases repartition by clinics forms, the main symptoms and the analyses of DHF. The incidence of cases was analyzed in the following years.

Population data from the National Institute of Statistics (INE) was used to calculate the prevalence, incidence and case attack rates for each municipality.

Results

Sociodemographic data

In October 2009, severe DEN-3 dengue outbreak hit the islands of Cape Verde and was responsible for 25.07 notified suspected cases with 4.92% of the general population, including 174 (0.69%) suspected hemorrhagic forms and 4 (0.02%) suspected deaths (Table 1).

Island	Municipalities	Pop. 2009/2010	Number of cases	Percentage (%)	DHF	%DHF	%DHF / Cases	Attack rate
Santo Antão	Ribeira Grande SA	21 729	2	0,01%	0			0,01%
	Paul	8 730	2	0,01%	0			0,02%
	Porto Novo	18 480	0		0			
São Vicente	São Vicente	79 681	18	0,07%	0			0,02%
São Nicolau	Ribeira Brava	7 946	6	0,02%	0			0,08%

	Tarrafal SN	4 864	2	0,01%	0			0,04%
Sal	Sal	20 041	25	0,10%	1	0,57%	3,85%	0,13%
Bavista	Boavista	6 007	10	0,04%	0			0,17%
Maio	Maio	8 132	585	2,33%	2	1,15%	0,34%	7,22%
Santiago	Ribeira Grande ST	9 628	168	0,67%	0			1,74%
	Praia	127 524	20067	80,04%	87	50,00%	0,43%	15,80%
	São Domingos	14 323	106	0,42%	0			0,74%
	São Lourenço dos Órgãos	9 120	29	0,12%	1	0,57%	3,33%	0,33%
	Sta Cruz	29 505	370	1,48%	8	4,60%	2,12%	1,28%
	São Salvador do Mundo	10 754	13	0,05%	0			0,12%
	São Miguel	17 449	29	0,12%	0			0,17%
	Sta Catarina ST	47 681	9	0,04%	3	1,72%	25,00%	0,03%
	Tarrafal Santiago	23 103	80	0,32%	6	3,45%	6,98%	0,37%
Fogo	São Filipe	23 176	2992	11,93%	64	36,78%	2,09%	13,19%
	Sta Catarina FG	4 811	87	0,35%	0			1,81%
	Mosteiros	9 817	456	1,82%	0			4,65%
Brava	Brava	6 141	15	0,06%	2	1,15%	11,76%	0,28%
	Total	**508 642**	**25 071**	**100,00%**	**174**	**100,00%**	**0,69%**	**4,96%**

Table 1: Number of dengue cases in Cabo Verde during the outbreak 2009/2010.

The major number of the case was on the island in the south of the country. Mainly in Santiago Island, especially in Praia, the capital of the country, where was reported 80% of cases, and Santa Cruz with 1.48% of cases. The other island with the high number of cases was Maio, with 2.d33% and Fogo (11.93% in São Filipe and 1.82% Mosteiros municipalities).

In the case of DHF, Praia in Santiago was responsible for 50% of the case, followed by Santa Cruz (4.60%) and Tarrafal on the same island. Fogo was the second island more affected by DHF with 36.77% cases in São Filipe and Maio with 1.15%. Other municipalities, as Santa Catarina de Santiago, Sal, Brava, and São Lourenço dos Órgãos had too DHF cases.

The percentage of DFH in relation to Dengue fever was analyzed. It was higher in Santa Catarina de Santiago (25%) and the low value in 0.34% in Maio islands.

The highest attack rate was in Praia (15.80%), followed by São Filipe in Fogo (13.19) and Maio islands (7.22%). The lowest value was observed Ribeira Grande de Santo Antão.

About the sex ratio, 10.66 male patients were affected against 14.40 female (male-female ratio is 0.70). Those most affected were in the age group range of 21 to 30 (Figure 2).

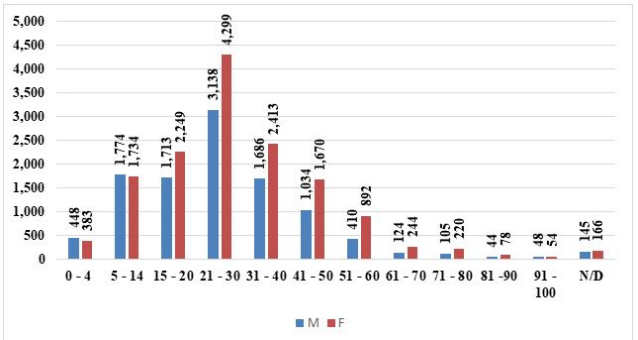

Figure 2: Socio-demographic data of dengue in Cape Verde, 2009/2010.

Analyzing the prevalence of the disease in the country by islands, during this epidemic, most cases were on the island of Santiago followed by the island of Fogo. In Santiago, the capital, Praia, was the most affected city with 3.95% while São-Filipe with 2.992 recorded cases was the city with the highest number of cases in the island of Fogo (Figure 3).

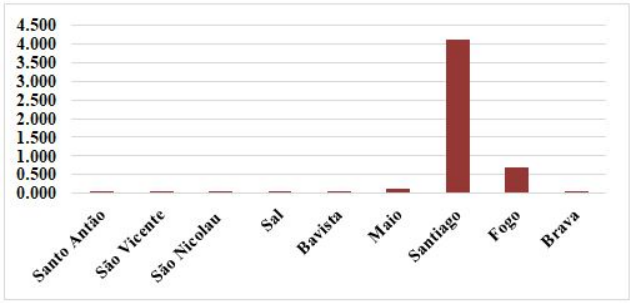

Figure 3: Prevalence of the dengue epidemic by the island.

The prevalence by municipalities, Praia was the more affected, followed by São Filipe in Fogo, in according with the Figure 4.

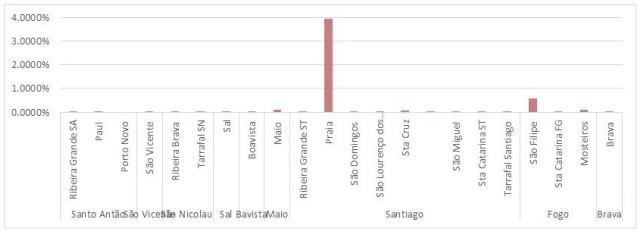

Figure 4: Prevalence of dengue in Cabo Verde by municipalities, during the outbreak 2009/2010.

Repartition of dengue by clinic forms

In this study, 62% of patients with dengue during the outbreak presented the clinical form, followed by 29% of gravity forms and 9% of viral cases (Figure 5).

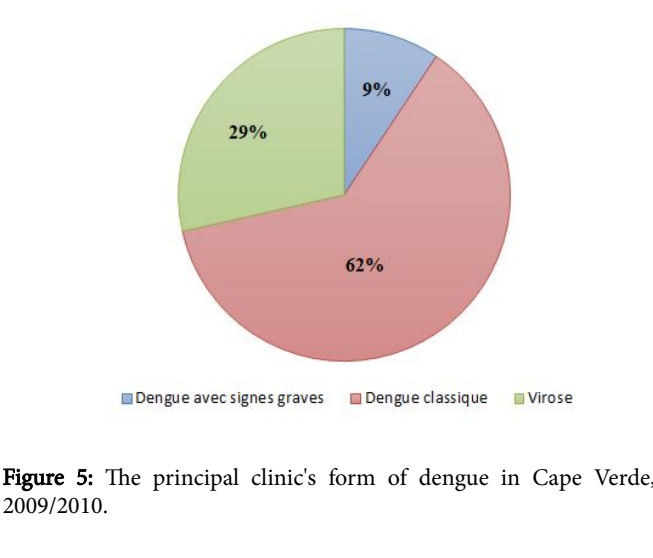

Figure 5: The principal clinic's form of dengue in Cape Verde, 2009/2010.

Hemorrhagic dengue fever cases

A total of 172 cases of HDF were reported during this outbreak, being 0.69% of people touched during the outbreak (Figure 6).

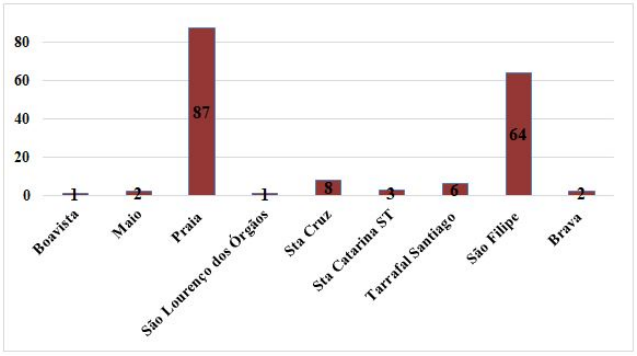

Figure 6: Number of HDF cases during the outbreak in Cabo Verde, 2009/2010.

The municipality with a high number of HDF cases was Praia, in Santiago, followed by São Filipe in Fogo, with the same tendency of DF cases. Santa Cruz and Tarrafal, both in Santiago Island, hade 8 and 6 HDF cases, respectively. Others municipalities had less than 03 cases, in Santiago, Boavista, Maio and Brava Islands.

Clinical signs

Dengue is characterized by clinical signs in which fever is the first line. During this outbreak, the two clinical signs more identified was the retro-orbital pain found in 75.76% of those affected and 58.46% presented fever. The other symptoms found were a headache, myalgia, arthralgia, exanthema, abdominal pain.

Other considerable symptoms were identified, namely the headache, in 49.2%, Myalgia in 36,9% or naughty Vomiting (13.8%) and Arthralgia. Others symptoms were identified in according with the Figure 7.

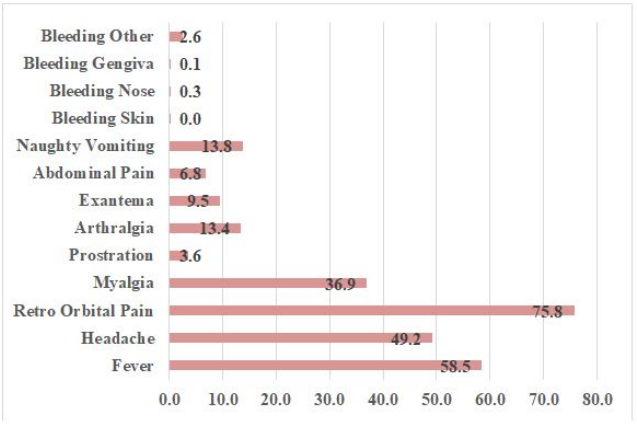

Figure 7: Principal symptoms of dengue during the dengue outbreak in Cape Verde, 2009/2010.

After the outbreak in 2009/2010, other 17 cases were notified in the country for 6 years (2011-2016). In 2011, 5 cases in Praia, 1 in Santa Catarina and 4 in São Filipe, both in Fogo Island. No cases were notified in 2012 and in 2013 and 2014, 2 and 1 imported cases respectively, in Praia. No case in 2015 and in 2016 was reported, other 4 indigenous cases were notified in Praia (Figure 8).

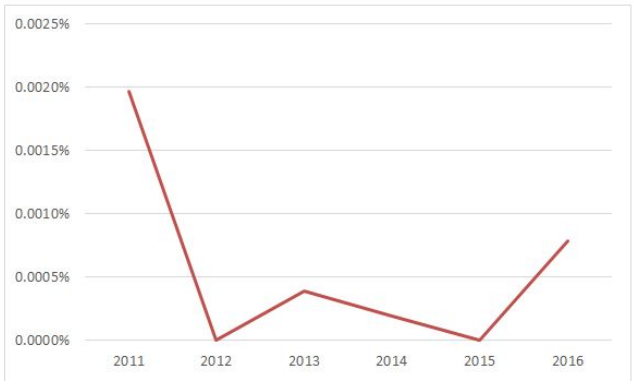

Figure 8: Dengue incidence in Cape Verde after the outbreak, 2011-2016.

Discussion

Dengue is one of the most significant infectious diseases in tropical and subtropical regions, in recent years, the communication among countries showed a rising trend due to the globalization, which caused an increased number of imported dengue cases worldwide (ref).

In Cabo Verde, the potential vector of dengue disease, *A. aegypti* has been reported since the 1930s and is present in all islands [8]. Despite the presence of the vector identified as *A. a. formosus* and the tropical climate, dengue cases were never registered in the country until the year 2009 [16].

This outbreak, the first one on the archipelago, came after three years of increased dengue activity in West Africa, with epidemics affecting Ivory Coast, Mali, and Senegal [3]. The outbreak was surprising by its severity (attack rate of 4.1% for the entire archipelago, higher in the most affected islands of the South), and by the occurrence of hemorrhagic forms (typically rare during first-time outbreaks). Whether a new outbreak may occur during the next rainy seasons is a matter of utmost concern for the local population and authorities.

The majority of cases were registered in Santiago Island, the biggest island in the country. All the nine municipalities of the country reported cases, with the highest of cases in the capital, Praia (80.04%) and with also the highest attack rate (15.80%). Sao Filipe, the biggest city in Fogo island was the municipality secondly the most affected in terms of cases and attack rate (11.93% and 13.19%, respectively). The highest of the case in the urban area is consistent with other countries as Brazil, [17,18] and other Asiatic and Latin America countries, where dengue affects mainly urban areas [19-22] and where the dengue virus (DENV) serotypes circulate, causing large epidemics. The cases of dengue in the country were basically in Sotavento islands (Maio, Santiago, Fogo, and Brava). Health facilities from all other islands reported few numbers of cases, the majority were from Sotavento islands. This cases in this region could be explained by the geographical location of Cape Verde makes the Sotavento Islands meet climatic characteristics similar to those of other dengue-endemic areas, such as confirms the previously known high density of *Aedes aegypti* in the various entomological studies carried out in the country [8].

The majority of cases occurred in young adults aged 15-40 years, is the group aged 21-30 years the most affected. The same situation was observed in Bhutan where the mean age was found to range from 15 to 32 years of age [20]. The high number of cases is adult than in adults is verified also in some countries. In the sense that Dengue is known as adult disease due to increased cases in adult populations in several countries. Although the pathogenesis of dengue symptoms in most adults in relation to children is not clear [20,23].

The mainly clinical forms were the dengue classic, flowed by viruses and dengue with grave signs. As the number of cases and attack rate, the hemorrhagic fever was Praia and São Filipe, two principal cities in the countries. In contrast with the cases of dengue Virus-Type 2 in Mozambique, 2014, where Clinical characteristics did not differ significantly for dengue case-patients and non-dengue patients. No severe cases of dengue hemorrhagic fever were noted, no hemorrhagic or shock signs and no non-dengue patients died [24]. In Cabo Verde, during the dengue outbreak, 174 cases of HDF were registered and 04 died were related with the DENV. Despite being the first time that the country recorded the first outbreak of the disease, health structures were capable to organize and to provide care, resulting in a low number of deaths from the disease. Even with the absence of disease immunity in the population, which on the other hand may explain the considerable number of hemorrhagic cases.

Americans countries report the co-circulation of all serotypes and thousands of cases of dengue deaths annually [25,26]. In Cabo Verde the DENV-3 was related to this first outbreak [16]. In the same times, these serotypes were identified in Senegal and the outbreaks in others West Africa countries, like Ivory Coast, suggesting the serotype spreading in the region [1].

Despite this low overall DHF rate in the relation of total cases (0.69%) the mortality by dengue in Cabo Verde during the outbreak, the number of death by dengue could be attributed either to the diagnostic delay or to the lack of access to treatment or both. Due to the fact, the number of cases exceeded the infrastructures available for health care, even leading to the adaptation of infrastructures conditions of care, namely the installation of the tent to the transformation of waiting rooms into infirmaries and the collaboration of volunteers and international specialists [27].

Studies carried out after the outbreak in 2009, results suggest that *A. a. formosus* from Cape Verde is susceptible to oral infection and is able to transmit the Yellow Fever Virus, DENV, CHIKV, and YFV at different magnitudes [16]. Also is a high vector competence for the DENV-2 and DENV-3 strains despite appears to be less susceptible to DENV-1 and DENV-4 [28]. These results demonstrate the challenge to the country for concern and for preventive policies for this vector-borne diseases. The frequent travelers from African and American countries could cause the future introduction of others DENV serotypes and others arboviruses, and outbreaks in Cape Verde, whose population is not immune to most arboviruses. Therefore, mosquito and virus surveillance, as well as a control, must be urgently undertaken and reinforced.

The urban expansion in the last decades, the increase in international travel and the global warming process are factors

justifying the spread of the disease [29,30]. This is verified in Praia and São Filipe, the major cities in Santiago and Fogo, respectively. The lack of truly effective measures of control of the mosquito, before the dengue outbreak, makes it possible to understand the real dimension of the problem at the moment. Despite the efforts and action against mosquitoes implemented during and after the epidemic to the present by the health structures, these two cities continue having high mosquito indices performed in the studies carried out. Hence, given the ubiquity of the virus in the tropics, with Asia and America considered to be areas of greatest risk, and with constant contact with Cabo Verde, through an increase in the incidence of international travelers the risk of dengue and other arboviruses is eminent in the country.

During the outbreak, the Ministry of Health of Cape Verde in collaboration with the Operational Nucleus of Information Society (NOSI) launched a system of alert and case reporting at the national level through text messages and the Internet, providing real-time information to experts and individuals at risk. WHO has also provided personal protection equipment, larvicides, fumigation machines, diagnostic tests and recommendations in Portuguese.

Following the 2009 dengue outbreak in Cabo Verde, it is essential to have a valid estimate of the infection attack rates in the population. Indeed, future outbreaks depend on the magnitude of the pool of susceptible individuals remaining in the population, and on their age and gender distribution. While the surveillance system put in place by local authorities during the 2009 outbreak has provided invaluable data about the epidemic [31], it may have missed pauci or asymptomatic forms of infections. The use of serological diagnosis of past infections based on a random sampling of the population and others specifics studies can obtain valid estimates of age- and gender-specific attack rates, the factors associated with infection clustering and risk analysis.

The introduction of DENV-3 in Cabo Verde in 2009 warned for the possibility of new dengue epidemics in the country, as the main vector, *Aedes aegypti* is widespread in all islands in the country. The facility communication and globalization of the country with Brazil and African and Asian countries continues to be a challenge to the country in the vector-borne diseases, especially the arboviruses as dengue, Zika virus yellow fever and others. The proof of the fragility as the Zika epidemic in the country in 2016. To address this situation, the country has opted for a strong epidemiological surveillance system and a control strategy for adult mosquitoes and larvae, including the mechanical, physical and chemical control, and even biological with Larvivorous fish. The community awareness and environmental management are other strategies in use in the country.

Conclusion

The first dengue outbreak in Cape Verde came as evidence of the country's ability to meet the new challenges in new vector-borne diseases. Therefore, a system of epidemiological surveillance should be reinforced with the new tools, coupled with the strategies of vector control, to maintain the rates of *Aedes aegypti* mosquitoes in the country in levels where it no longer constitutes a risk to the population. The lessons learned from this outbreak should serve as a basis for the definition of the best Arboviruses strategies in the country.

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Ethics Approval and Consent To Participate

Not applicable

Competing Interests

The authors declare that they have no competing interests.

Funding

Not applicable

Authors' Contributions

DePina and Sangare conceived and designed the study and analyzed the data. All authors read and approved the manuscript.

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